Montenegrin Journal of Economics

Volume 22, Number 2
April 2026
Quarterly publication

Print edition ISSN 1800-5845
Web edition ISSN 1800-6698
COBISS.CG-ID 9275920

Publishers

ELIT – *Economic Laboratory for Transition Research*
Dz. Washingtona 4/5, Podgorica, Montenegro

Partnering with:

University of Szczecin, Poland

Tomas Bata University in Zlín, Faculty of Management and Economics, Czech Republic

Faculty of Mediterranean Business Studies Tivat, Montenegro

INDEXING

ESCI - Emerging sources citation index Thomson Reuters (2015)
SCOPUS (2017)
Cabell's (2012)
ECONIS Datenbank (2012)
DOAJ - Directory of Open Access Journals (2012)
Genamics Journal Seek (2012)
NewJour (2012)
ProQuest - ABI/Inform, Research Library, Social Sciences (2012)
RePEc (2012)
Scirus (2012)
Ulrich's Periodicals Directory (2012)
World-Wide Web Virtual Library (2012)
EBSCO Publishing, Inc. (2011)
Index Copernicus International S.A. database (2011)
Journal of Economics Literature (2006)

Montenegrin Journal of Economics, Vol. 22, No. 2 (April 2026)

The journal is published four times a year

Printing: 150 copies

Journal customer service:

Telephone: + 385 95 825 82 33

Email: vesodraskovic@gmail.com

Website: **https://www.mnje.com**

Account: **510-21341-37** (*Crnogorska komercijalna banka*, Podgorica, Montenegro)

Decision of the Ministry of Culture and the Media No 05-962/2 of May 23, 2005
„Montenegrin Journal of Economics“ was registered to the records media under the number 560

CIP – Каталогизација у публикацији
Централна народна библиотека Црне Горе
33 (051)

Četiri puta godišnje.
ISSN 1800-5845 = Montenegrin Journal of Economics
COBISS.CG-ID 9275920

ISSN 1800-5845

9 771800 584007

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

Vol. 22, No. 2 (April, 2026)

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Economic Laboratory Transition
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Montenegrin Journal of Economics

For citation:

Taqi, M., Uzliawati, L., Muchlish, M., Kalbuana, N. (2026),
"Timeliness in Question: Analyzing the Impact of Financial Performance, Corporate Governance Mechanisms, and Audit Quality on Audit Report Late",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 7-17.

Timeliness in Question: Analyzing the Impact of Financial Performance, Corporate Governance Mechanisms, and Audit Quality on Audit Report Late

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ARTICLE INFO

Received August 19, 2024
Revised from September 20, 2024
Accepted October 20, 2024
Available online April 15, 2026

JEL classification:. M41, M42, G34

DOI: 10.14254/1800-5845/2026.22-2.1

Keywords:

Financial Performance,
Audit Quality,
Corporate Governance Mechanism,
Audit Report Late,
Agency theory

ABSTRACT

This study aims to analyze the factors that influence the audit reports late, by highlighting the influence of financial performance, corporate governance mechanisms, and audit quality. The timeliness of audit reports is a fundamental element in financial reporting that has a significant impact on decision-making by stakeholders as well as the perception of the reliability of the financial statements. This study adopts an explanatory approach using panel data analysis, which involves ordinary least squares (OLS), fixed effect, and random effect regression models. The secondary data used includes companies listed on the Indonesia Stock Exchange that experienced late submitting annual reports during the period 2018 to 2023. The results of the analysis show that financial performance has no significant effect on the audit reports late, although this variable shows a positive coefficient. Independent commissioners negatively significantly affect audit reports late, which is in line with agency theory that highlights the role of independent commissioners in reducing conflicts of interest. In contrast, the independent audit committee did not have a significant effect on audit reports late, indicating the need to strengthen the role of this committee in corporate governance. Audit quality was found to have a significant positive effect on audit reports late, suggesting that auditors with high reputations tend to take longer to complete the audit process. The findings of this study make an important contribution to the understanding of the determinants of audit reports late and its implications for corporate governance and auditing practices. This research is expected to contribute to the development of theory and practice in the field of financial reporting and auditing, as well as provide strategic recommendations to improve the timeliness of audit reports through strengthening financial performance, corporate governance, and audit quality.

INTRODUCTION

The timeliness of audit reports has long been recognized as a crucial aspect of financial reporting that has a significant impact on stakeholders' decision-making processes. The timely release of audit reports ensures that the information contained therein is relevant, accurate, and reflects the current financial condition of an organization (Ahmet, Halil, & Burcu, 2022). Audit reports late can create uncertainty and reduce the level of trust among investors, creditors, and regulators, which in turn can affect market valuations and company credibility (Gede & Ratna, 2021).

The importance of audit report timeliness is further emphasized by the regulatory framework imposed by authorities such as the Financial Services Authority (OJK) in Indonesia, which sets time limits for listed companies to submit their annual financial reports. However, despite these clear provisions, there are still companies that experience late in submitting their audit reports. This raises questions regarding the factors that contribute to such late (Gede & Ratna, 2021).

Previous research has examined various aspects that affect the delay of audit reports. (Abernathy, Barnes, Stefaniak, & Weisbarth, 2017) examined the impact of company complexity and auditor workload on the duration of audit completion, finding that these factors can extend audit time. Meanwhile, (Afify, 2009) identified the effect of company size, leverage, and foreign ownership on the timeliness of audit reports. While these studies provide valuable insights, there is a lack of literature examining the combined effect of financial performance, corporate governance, and audit quality together on audit reports late, especially in the context of companies listed on the Indonesia Stock Exchange. This study aims to fill this gap by exploring how these three factors-financial performance, corporate governance, and audit quality audit report late. With this approach, a more comprehensive understanding of the determinants of audit report late is expected.

Corporate governance is a framework that governs the relationship between a company's management, board of directors, shareholders, and other stakeholders. Strong corporate governance can help reduce the risk of fraud and financial data manipulation, which in turn can speed up the audit process (Anwar, Suleman, & Thalib, 2022). A larger composition of independent commissioners is believed to increase oversight of management and accelerate the audit reporting process.

Previous research shows mixed results regarding the effect of corporate governance on audit reports late. (Anwar et al., 2022; Gede & Ratna, 2021) found that a larger composition of independent commissioners can reduce audit reports late. On the other hand, research (Gede & Ratna, 2021) shows that the frequency of audit committee meetings does not always have a significant effect on the audit reports late. Other studies by (Al-Araj, 2023; Lajmi & Yab, 2022) also confirm the importance of corporate governance in reducing audit reports late, although the results vary depending on the proxies used.

Company financial performance is often the main indicator in determining the timeliness of audit reports. Companies with poor financial performance, as indicated by low profitability ratios or high levels of debt (leverage), tend to experience the latest in audit reporting. This is due to the additional complexity faced by auditors in evaluating companies that have financial problems. Some studies show that good financial performance can minimize audit reports late. For example, research by (Nawaiseh, 2017) shows that companies with high profitability ratios tend to complete audits faster. In contrast, research by (Arhinful & Radmehr, 2023) shows that a high level of leverage is correlated with late audit reports because auditors need more time to assess the financial risk and resilience of the company. However, research by (Agyei-Mensah, 2018) shows that despite high profitability, other factors such as company size and industry sector can also affect audit delay.

Audit quality, which is often measured by audit firm reputation and compliance with audit standards, also plays an important role in determining the timeliness of audit reports. Audit firms with high reputations tend to have a more efficient and professional audit process, which can accelerate audit completion. Research by (Fauziah & Setiawati, 2023; Leditho, Kusumastati, & Safiq, 2023) found that audit firms with international reputations tend to complete audits faster than smaller local firms. However, research by (Muhammad, 2020) shows that even if audit quality is high, factors such as company complexity and the

level of risk faced can still extend the audit completion time. In addition, research by (Leditho et al., 2023)also shows that good audit quality can mitigate the risk of delay, although the impact may differ depending on the industry context and firm size.

This study aims to deeply explore and analyze the effect of financial performance, corporate governance mechanisms, and audit quality on audit reports late. This research seeks to uncover the complex interactions between these three factors and their impact on the timeliness of audit reporting, which is a crucial aspect in maintaining the credibility and reliability of financial information. By identifying the key determinants of audit report lateness, this study is expected to make a significant contribution to the academic literature as well as offer practical guidance for companies, auditors, and regulators. The findings of this study are expected to not only enrich the theoretical understanding of audit report late, but also provide strategic recommendations to strengthen corporate governance, improve financial performance, and ensure high audit quality to minimize the risk of report delay.

1. LITERATURE REVIEW

1.1 Agency Theory

Agency Theory was first introduced by Jensen and Meckling in 1976. This theory explains the relationship between the principal, who is the owner of capital, and the agent, who is the manager hired to run the company on behalf of the principal (Jensen & Meckling, 1976). In this relationship, the principal authorizes the agent to make strategic decisions aimed at maximizing firm value. However, conflicts of interest often arise because agents may have different objectives from the principal including conflicts of interest. After all, managers may have personal objectives that differ from the principal's objectives, such as pursuing personal gain or maintaining their position, which is not always in line with the interests of the owner (Fama & Jensen, 1983).

Information asymmetry is where managers have greater access to important information than owners. This allows managers to hide information or make decisions that are more favorable to themselves but can be detrimental to owners (Eisenhardt, 1989). Moral hazard where managers may make risky decisions because they do not bear the full risk, which is borne by the owners of the company. Adverse selection occurs when the principal has difficulty assessing the manager's competence and intentions before the agency relationship is formed. As a result, principals may choose managers who are incompetent or who do not really have good intentions in carrying out their duties (Kalbuana et al., 2022).

1.2 Audit Report Late

Audit report late or audit report late occurs when the audit report is not submitted within the specified time. This delay is often influenced by company complexity, poor financial conditions, and uncooperative management (Gede & Ratna, 2021). Good corporate governance, such as an active board of commissioners and an effective audit committee, can help speed up the audit process and reduce late (Kalbuana et al., 2022). In addition, the use of high-quality auditors, such as Big 4 firms, is also associated with faster audit completion as they have superior resources and technology (Saleh & Ragab, 2023). Audit report lateness is often a signal of a larger internal problem, such as management's attempt to delay the disclosure of negative information (Oradi, 2021). Therefore, audit report lateness can be considered a risk indicator in assessing corporate performance and governance.

1.3 Financial performance

Financial performance refers to how well a company uses its assets to generate revenue and manage its liabilities. Good financial performance is generally measured by financial ratios such as profitability, liquidity, leverage, and operational efficiency (Nawaiseh, 2017). Companies with strong financial performance tend to have a better ability to complete audits on time because they have a more organized financial system and better financial stability. Financial performance can also affect market perception and investor confidence. Companies with poor financial performance may try to delay the audit or manipulate financial statements to hide problems, which may cause late audit reports (Ahmet et al., 2022).

H1: Financial performance has a positive effect on audit reports late.

1.4 Corporate governance mechanism

Corporate governance mechanisms refer to the various tools and processes used to ensure that companies are run by good governance principles. These mechanisms include the structure of the board of directors, audit committees, the composition of independent commissioners, and risk management policies, all of which are designed to oversee and control management actions to conform to the interests of shareholders and other stakeholders (Anwar et al., 2022). Effective governance mechanisms can help minimize conflicts of interest between management and shareholders by ensuring that there is adequate oversight of the firm's strategic decisions and operations (Uzliawati et al., 2024).

Independent commissioners are a crucial component of the corporate governance mechanism, serving to objectively oversee management and ensure that the company's strategic decisions are in line with the interests of shareholders and other stakeholders (Anwar et al., 2022; Gede & Ratna, 2021). With no material or financial ties to the company, independent commissioners can maintain transparency and accountability, and provide critical judgment on management decisions. In addition, they play an active role in the audit committee and remuneration committee, thus contributing significantly to strengthening corporate governance and increasing investor confidence.

H2: Independent commissioners have a negative effect on audit reports late.

The independent audit committee is one of the vital elements in the corporate governance mechanism that serves to oversee the financial reporting process and ensure company compliance with applicable accounting standards and regulations. This committee consists of board members who have no material or financial relationship with the company, which allows them to act objectively and free from conflicts of interest (Fama & Jensen, 1983). The main role of the independent audit committee includes oversight of internal and external audits, evaluation of the effectiveness of internal controls, and verification of the integrity of the company's financial statements. By maintaining professional skepticism and ensuring transparency in the audit process, independent audit committees contribute significantly to strengthening corporate governance and increasing stakeholder confidence in the reliability of corporate financial statements (Al-Araj, 2023; Gede & Ratna, 2021; Lajmi & Yab, 2022).

H3: Independent audit committee have a negative effect on audit reports late.

1.5 Audit Quality

Audit quality refers to the auditor's ability to identify material misstatements and apply professional skepticism during the audit process. High audit quality is achieved when auditors have a deep understanding of their client's industry, use sophisticated audit technology, and adhere to strict ethical and independence standards. Public Accounting Firm (KAP) reputation is often used as an indicator of audit quality, where reputable KAPs, such as the Big 4 firms, are considered capable of providing more reliable and comprehensive audits (Ado, Rashid, Mustapha, & Ademola, 2020).

These large firms are known to excel in terms of resource availability, intensive auditor training, and access to the latest audit technology. In addition, scrutiny from regulators and high public expectations encourage them to continuously update audit methods and maintain integrity in every assignment they take on. Therefore, audits conducted by highly reputable firms not only improve the quality of financial statements but also provide positive signals to the market about the transparency and reliability of the company's financial information. Selecting high-quality auditors is essential in maintaining stakeholder trust and reducing the risk of late audit reporting (Leditho et al., 2023; Leventis, Weetman, & Caramanis, 2005; Sumunar & Anita, 2022).

H4: Audit quality has a positive effect on audit reports late.

2. METHODOLOGY

This study uses a quantitative approach to provide empirical evidence regarding the effect of financial performance, corporate governance mechanisms, and audit quality on audit reports late. Using an explanatory approach, this study focuses on companies listed on the Indonesia Stock Exchange (IDX) that have experienced late in submitting audit financial reports during the period 2018 to 2023. The data used in this study are taken from the company's annual report accessed through the official IDX website (https://www.idx.co.id). This research utilizes panel data to combine relevant concepts, theories, and data in analyzing research variables using random effects, fixed effects, and Ordinary Least Square (OLS) models with the help of Stata software. This flexible regression model allows for a more in-depth analysis of the variables under study, providing significant flexibility in the analysis process. The results of these three models are presented in tabular form, which makes it easy to determine hypotheses and compare data thoroughly.

2.1 Research Regression Model

This study applies the panel data regression analysis method, which allows the analysis of data covering various periods as well as different units of analysis, such as selected companies. This approach provides flexibility in identifying and measuring the influence of variables such as financial performance, the presence of independent commissioners, independent audit committees, and audit quality on audit reports late. The use of panel data, also known as longitudinal or micro panel data, allows dynamic monitoring of changes over time while considering variations between units of analysis. By defining the research variables in detail, this study develops an in-depth analytical model to explore the relationship between these factors and audit report late. After identifying and describing in detail the relevant independent and dependent variables, this study develops the equation model to be used as follows:

$$ARL_{i,t} = \beta_0 + \beta_1 FNP_{i,t,} + \beta_2 ICM_{,t} + \beta_3 IAC_{i,t,} + \beta_4 QUA_{i,t} + \mathcal{E} \text{ .....(1)}$$

To explain the variable model of financial performance, the presence of independent commissioners, independent audit committees, and audit quality on audit report late, it can be explained as follows:

Table 1. Variable Description

Symbol		*Description*
i	=	*Cross-section data*
t	=	Time series data
ARL	=	Audit Report Late
FNP	=	Financial Performance
ICM	=	Independent Commissioners
IAC	=	Independent Audit Committees
QUA	=	Quality Audit
α	=	Constanta
β_1, β_2, β_3, β_4	=	Regression coefficients of variables FNP, ICM, IAC, QUA
ϵ	=	Error

Source: Compiled by the authors

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics

The results of descriptive statistical analysis display the minimum, maximum, mean, and standard deviation values of the variables studied based on the company sample. These descriptive statistics provide an overview of the data distribution and variations that exist among the variables used in the study. Data presentation for a sample of companies listed on the Indonesia Stock Exchange during the 2018-2023 period can be seen in the following table:

Table 2. Descriptive Variables

Variables	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*	*p1*	*p99*	*Skew.*	*Kurt.*
ARL	300	-1.257	23.715	-72.044	63.982	-67.515	61.843	-.178	3.851
FNP	300	-22.251	340.702	-5897.596	60.717	-68.207	57.594	-17.18	296.765
ICM	300	.419	.13	0	1	0	1	.939	8.202
IAC	300	.361	.142	0	1	0	1	1.773	10.872
QUA	300	20.174	1.168	17.767	23.448	17.842	23.108	.333	2.552

Source: Compiled by the authors

3.2 Pearson Correlation Test

The Pearson correlation test is used to measure the extent of the relationship between the variables of financial performance, independent commissioners, independent audit committees, and audit quality on audit report late. The results of this analysis are presented in the following output:

Table 3. Pearson Correlation Test

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
(1) ARL	1.000				
(2) FNP	0.037	1.000			
	(0.518)				
(3) ICM	-0.143	-0.035	1.000		
	(0.013)	(0.550)			
(4) IAC	-0.004	0.044	0.238	1.000	
	(0.946)	(0.451)	(0.000)		
(5) QUA	0.149	0.077	0.066	-0.075	1.000

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)
(1) ARL	1.000				
(2) FNP	0.037	1.000			
(3) ICM	-0.143	-0.035	1.000		
(4) IAC	-0.004	0.044	0.238*	1.000	
(5) QUA	0.149*	0.077	0.066	-0.075	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Source: Compiled by the authors

The table shows that the Independent Commissioner and Audit Fee variables have a significance value below 0.05 (5%), 0.013, and 0.010 respectively. This indicates that both variables have a significant relationship with audit report late, meeting the eligibility criteria for use in model validation. On the other hand, ROA and Independent Audit Committee variables have significance values above 0.05 (5%), indicating that these variables do not have a significant relationship with audit report lateness. However, the relationship between independent variables, such as between the Independent Audit Committee and Independent Commissioner, shows significance at the 1% level ($p<0.01$), which is consistent with the previous reliability test results, indicating that these variables provide consistent results when tested. These results confirm that variables with significance below 0.05 can be validly used in the research model.

3.3 Goodness of Fit Model Testing

Hypothesis testing plays an important role in research because it can determine the scientific level of the research conducted. To assess the feasibility of the model scientifically, three types of tests have been carried out, namely Ordinary Least Square (OLS) Regression, Fixed Effect, and Random Effect, with the following output results:

Table 4. Goodness of Fit Model

Variables	*(Model 1) Ordinary Least Square Test*	*(Model 2) Fixed Effect*	*(Model 3) Random Effect*
FNP	.001	-.001	.001
	(.004)	(.004)	(.004)
	0.764	0.783	0.846
ICM	-29.882***	-49.799***	-31.566***
	(10.724)	(16.569)	(11.141)
	0.006	0.003	0.005
IAC	7.777	22.478	8.745
	(9.862)	(18.106)	(10.377)
	0.431	0.216	0.399
QUA	3.285***	6.929	3.362***
	(1.166)	(4.398)	(1.257)
	0.005	0.116	0.007
Constant	-57.801**	-128.325	-59.002**
	(24.03)	(89.167)	(25.882)
Observations	300	300	300
R-squared	.048	.044	.z
Number of Year	5	5	5

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Compiled by the authors

3.4 Discussion of Research Results

3.4.1 Financial Performance Has A Positive Effect on Audit Report Late

Financial Performance (FNP) shows a positive coefficient estimate, but this result is not by the initial hypothesis which states that financial performance significantly affects audit report late. The t-test results show that FNP has no significant effect on audit report late in all models tested: p-value of 0.004 ≥ 0.05 (5%) in the OLS model, and the same p-value in the Fixed Effects (FE) and Random Effects (RE) models. This finding indicates that although the FNP coefficient is positive, the effect of financial performance on audit report late cannot be considered statistically significant in these models.

These empirical findings do not support the initial hypothesis proposed, where FNP is expected to have a significant influence on audit report late. The hypothesis is rejected because the p-value is greater than 0.05 (5%), and although the coefficient shows a positive direction, this is not enough to indicate a real relationship between financial performance and audit delay. The direction of this hypothesis is also inconsistent with some previous research findings that show a significant positive relationship between financial performance and audit delay in different contexts.

This study shows different results from previous studies, such as those conducted by (Ahmet et al., 2022), which found a positive and significant influence between good financial performance and audit report late. The discrepancy between the direction of the initial hypothesis and these empirical findings may be due to the greater complexity of financial performance in companies with better performance, which can actually extend the time required to complete the audit, or it may also be related to variations in the industry and period analyzed in this study.

From an Agency Theory perspective, these results can be interpreted in the context of the relationship between managers (agents) and shareholders (principals) (Jensen & Meckling, 1976).. In companies with good financial performance, managers may feel they are in a strong position, and therefore, they may not feel compelled to accelerate audit completion. Managers may focus on achieving short-term goals that enhance their image, such as showing impressive performance results, while potential issues that require the auditor's attention may be delayed or managed longer, ultimately leading to late in the audit report.

Furthermore, the insignificant effect of FNP on audit report late may also reflect a situation where managers may use additional time to fine-tune their financial statements to match shareholders' expectations or to minimize the risk of disclosure of information that could harm them. This could be a form of self-

serving behavior that reflects the misalignment of interests between agents and principals, which is at the core of Agency Theory.

3.4.2 Independent Commissioners Have a Negative Effect on Audit Reports Late

Independent Commissioners (ICM) shows a significant negative coefficient estimate, which supports the initial hypothesis that the presence of independent commissioners has a negative effect on audit reports late. The t-test results confirm that ICM has a significant effect on audit report late with a p-value below 1% ($p<0.01$) in all models tested, including OLS, Fixed Effects (FE), and Random Effects (RE) models. This indicates that an increase in the presence of independent commissioners significantly reduces the delay in submitting audit reports.

The results of these empirical findings support the previous studies, such as those conducted by (Anwar et al., 2022; Gede & Ratna, 2021), in which ICM is expected to have a negative and significant influence on audit report late. This hypothesis is accepted because the very small p-value indicates a strong relationship between ICM and the reduction of audit delay. This negative coefficient indicates that the greater the proportion of independent commissioners in the company, the faster the completion of the audit report.

In the context of Agency Theory, this result is in line with the expectation that independent commissioners serve as an effective supervisory mechanism to reduce conflicts of interest between management (agents) and shareholders (principals). Independent commissioners are expected to act objectively and free from management influence, so they can supervise the audit process more closely and ensure that financial statements are presented promptly. This more effective oversight helps reduce the possibility of management delaying audit reporting for personal gain or to hide internal company problems.

The presence of more independent commissioners on the board of commissioners can pressure management to act more transparently and efficiently, thus reducing the time required to complete the audit. The supervisory effectiveness of independent commissioners is reflected in the negative and significant coefficient found in this study, which indicates that they can affect the efficiency of audit reporting time.

This study is consistent with previous findings showing that independent commissioners can play an important role in reducing audit reports late. The effectiveness of independent commissioners may be related to their independence from management, which allows them to provide tighter supervision and reduce potential bias in the reporting process. This finding reinforces the importance of the role of independent commissioners in good corporate governance, especially in ensuring that financial reporting is conducted in a transparent and timely manner.

3.4.3 Independent Audit Committees Have a Negative Effect on Audit Reports Late

The results of the analysis show that the Independent Audit Committee (IAC) has a positive coefficient estimate on audit report late, which is not by the initial hypothesis. The initial hypothesis states that the existence of an independent audit committee has a negative effect, or reduces audit report late. However, the t-test results indicate that the effect of IAC is not significant, with a p-value greater than 0.05 (p-value > 0.05) in all models tested, including OLS, Fixed Effects (FE), and Random Effects (RE) models. Although the direction of the coefficient shows a positive relationship, the insignificance of this result suggests that the presence of an independent audit committee does not substantially affect the reduction of audit late. This study shows different results from previous studies, such as those conducted by (Al-Araj, 2023; Gede & Ratna, 2021; Lajmi & Yab, 2022).

In the context of Agency Theory, independent audit committees are expected to reduce conflicts of interest between management and shareholders by ensuring that financial statements are audited promptly and accurately. However, the results of this study suggest that the role of independent audit committees in reducing audit reports late may not be as effective as expected. Several factors may explain this ineffectiveness. Limited oversight effectiveness of independent audit committees may occur if they do not have full access to necessary information or do not have sufficient authority to influence changes in

the audit process. In this situation, despite the committee's efforts to ensure that the audit is completed on time, internal constraints within the company may hinder its oversight effectiveness. The positive coefficient found, although not significant, may indicate that the presence of an independent audit committee is associated with a more in-depth and detailed audit process. These committees may demand a higher level of scrutiny from auditors, which in turn extends the time taken to complete the audit. Thus, independent audit committees may indirectly lead to increased audit late due to their focus on quality and rigor in financial reporting.

The interaction between the independent audit committee and management may also affect the committee's effectiveness. In some cases, management may not be fully cooperative with the independent audit committee, especially if there are different views on how the audit should be conducted. Such conflicts can slow down the audit process as discussions and negotiations are required to reach an agreement on the content of the financial statements. Structural or cultural constraints within the company may also limit the role of the independent audit committee. For example, in a highly centralized corporate culture, audit committees may not be given full freedom to exercise their oversight, which may reduce their effectiveness in ensuring that audits are completed on time.

3.4.4 Audit Quality Has A Positive Effect on Audit Report Late

Empirical test results show that Audit Quality has a significant positive coefficient estimate on audit reports late. These results consistently support the initial hypothesis proposed, namely that higher audit quality is associated with increased audit reports late. The t-test results indicate that the effect of audit quality on audit report late is significant with a p-value below 1% ($p<0.01$) in the OLS and Random Effects (RE) models, although it is not significant in the Fixed Effects (FE) model. This indicates that auditors who are more thorough and careful, which is indicated by higher audit quality, tend to require more time to complete the audit, thus causing an increase in audit reports late.

The results of these empirical findings support the previous studies, such as those conducted by (Leditho et al., 2023; Leventis et al., 2005; Sumunar & Anita, 2022), that audit quality has a positive effect on audit delay (Hypothesis Accepted). The significant positive coefficient indicates that higher-quality auditors may apply more stringent and detailed examination standards, which in turn require more time to ensure that all aspects of the financial statements have been audited properly and according to standards.

In the context of Agency Theory, reputable and high-quality auditors serve as a stronger monitoring mechanism to reduce potential conflicts of interest between management and shareholders. Higher-quality auditors have an incentive to ensure that financial statements are not only accurate but also free from material misstatement, which may require additional time in the audit process. Therefore, while high audit quality increases confidence in financial statements, it may also lead to late audit reporting due to greater attention to detail and adherence to strict auditing standards.

This result is consistent with the existing literature, which suggests that higher audit quality is often accompanied by a more in-depth audit process, which may extend the audit duration. As such, this finding reinforces the importance of considering the trade-off between audit quality and timeliness of audit reporting, especially in the context of large companies audited by reputable audit firms that apply higher standards in audit execution.

CONCLUSION AND POLICY RECOMMENDATION

This study aims to investigate the effect of financial performance, corporate governance mechanisms, and audit quality on audit reports late in companies listed on the Indonesia Stock Exchange (IDX) during the period 2018-2023. Through panel data regression analysis, several important findings were identified. Financial performance shows a positive coefficient, but this variable does not have a significant effect on audit reports late. This finding suggests that there is higher complexity in the audit process for companies with good financial performance, which may require more detailed and extensive examinations that extend the audit time.

The existence of independent commissioners is proven to have a significant negative effect on audit reports late. This finding is consistent with Agency Theory which emphasizes the important role of independent commissioners in reducing conflicts of interest between management and shareholders, which in turn can accelerate audit completion through increased supervision and accountability. This result confirms the importance of effective corporate governance in ensuring the timeliness of audit reporting.

The independent audit committee did not show a significant effect on audit report lateness. Although these committees are expected to reduce audit late, the results suggest that their effectiveness may be limited by internal company constraints or lack of sufficient authority to substantially influence the audit process. This suggests the need to strengthen the role and authority of independent audit committees in the context of corporate governance.

Audit quality is shown to have a significant positive influence on audit reports late. Auditors with higher reputations and quality tend to apply more rigorous and detailed examination standards, which in turn require additional time to complete the audit. Nonetheless, these results emphasize the importance of the balance between audit quality and timeliness of reporting, especially in maintaining the reliability and integrity of financial statements.

Overall, this study highlights the crucial role of independent commissioners in expediting the audit process, while showing that higher audit quality may cause late, despite improving report quality. The findings also underscore the importance of further research to understand the more complex dynamics of the audit process, particularly about the insignificant role of financial performance and independent audit committees in this context. Further research is expected to provide greater insight into other factors that may influence audit reports late, as well as policy implications in improving the effectiveness of corporate governance in Indonesia.

REFERENCES

Abernathy, J. L., Barnes, M., Stefaniak, C., Weisbarth, A. (2017), "An International Perspective on Audit Report Lag: A Synthesis of the Literature and Opportunities for Future Research", *International Journal of Auditing*, Vol. 21, No. 1, pp. 100–127. https://doi.org/10.1111/ijau.12083

Ado, A.B., Rashid, N., Mustapha, U.A., Ademola, L.S. (2020), "The Impact of Audit Quality on the Financial Performance of Listed Companies Nigeria", *Journal of Critical Reviews*, Vol. 7, No. 9, pp. 37–42.

Afify, H.A.E. (2009), "Determinants of audit report lag: Does implementing corporate governance have any impact? Empirical evidence from Egypt", Journal of Applied Accounting Research, Vol. 10, No. 1, pp. 56–86. https://doi.org/10.1108/09675420910963397

Agyei-Mensah, B.K. (2018), "Impact of corporate governance attributes and financial reporting lag on corporate financial performance", *African Journal of Economic and Management Studies*, Vol. 9, No. 3, pp. 349–366. https://doi.org/10.1108/AJEMS-08-2017-0205

Ahmet, S., Halil, E.I., Burcu, B. (2022), "How Important is Corporate Governance Features and the Lags on Audit Reports in Firm Performance: The Case of Turkey", *Studies in Business and Economics*, Vol. 17, No. 1, pp. 218–237. https://doi.org/10.2478/sbe-2022-0015

Al-Araj, R. (2023), "Characteristics of ACs and their impact on the period of issuing the auditor's report: An Empirical study on Jordanian public shareholding companies", *Uncertain Supply Chain Management*, Vol. 11, No. 2, pp. 503–512. https://doi.org/10.5267/j.uscm.2023.2.014

Anwar, R., Suleman, N., Thalib, M. (2022), "Size board of commissioners, independent commissioners and audit Committee on Audit Report Lag", *Golden Ratio of Auditing Research*, Vol. 2, No. 1, taken from: https://doi.org/10.52970/grar.v2i1.166Website:https://goldenratio.id/index.php/grar

Arhinful, R., Radmehr, M. (2023), "The effect of financial leverage on financial performance: evidence from non-financial institutions listed on the Tokyo stock market", *Journal of Capital Markets Studies*, Vol. 7, No. 1, pp. 53–71. https://doi.org/10.1108/jcms-10-2022-0038

Eisenhardt, K.M. (1989), "Agency theory: An assessment and review", *Academy of management review*, Vol. 14 No. 1, pp. 57–74.

Fama, E. Jensen, M.C. (1983), "Separation of Ownership and Control", *The Journal of Law and Economics*, Vol. 26, pp. 301–325. https://doi.org/10.1086/467037

Fauziah, N. Setiawati, E. (2023), "The effect of auditor fees, audit opinions, audit tenure, profitability and

company size on audit delay", I*nternational Journal of Latest Research in Humanities and Social Science*, Vol. 6 No. 5, pp. 81–89.
Gede, W.A.A., Ratna, S.M.M. (2021), „The effect of gender of the audit committee, audit committee meetings, audit committee independence, independent commissioners and institutional ownership on audit delay", *Eurasia: Economics & Business*, Vol. 1, No. 43, pp. 5–24.
Jensen, M.C. Meckling, W.H. (1976), "Theory of the firm: Managerial behavior, agency costs and ownership structure", *Journal of Financial Economics*, Vol. 3, No. 4, pp. 305–360. https://doi.org/10.1016/0304-405X(76)90026-X
Kalbuana, N., Kusiyah, K., Supriatiningsih, S., Budiharjo, R., Budyastuti, T., Rusdiyanto, R. (2022), "Effect of profitability, audit committee, company size, activity, and board of directors on sustainability", *Cogent Business & Management*, Vol. 9, No. 1, pp. 1–17. https://doi.org/10.1080/23311975. 2022. 2129354
Lajmi, A., Yab, M. (2022), "The impact of internal corporate governance mechanisms on audit report lag: evidence from Tunisian listed companies", *EuroMed Journal of Business*, Vol. 17, No. 4, pp. 619–633. https://doi.org/10.1108/EMJB-05-2021-0070
Leditho, M.D., Kusumastati, W.W., Safiq, M. (2023), "Do company performance, multinational company, and audit fee affect audit delay?", *Journal of Applied Accounting and Finance*, Vol. 7, No. 1, pp. 13–27.
Leventis, S., Weetman, P., Caramanis, C. (2005), "Determinants of audit report lag: some evidence from the Athens stock exchange", *International Journal of Auditing*, Vol. 9, No. 1, pp. 45–58. https://doi.org/10.1111/j.1099-1123.2005.00101.x
Muhammad, M.I. (2020), "Effects of auditor attributes on audit reporting lag: empirical evidence from nigerian service firm", *Asian Journal of Empirical Research*, Vol. 10, No. 4, pp. 127–136. https://doi.org/10.18488/journal.1007/2020.10.4/1007.4.127.136
Nawaiseh, M.A.L.I. et al. (2017), "The Impact of the Financial Performance on Firm Value: Evidence from Developing Countries", International Journal of Applied Business and Economic Research, Vol. 15, No. 16, pp. 329–341, www.serialsjournal.com
Oradi, J. (2021), "CEO succession origin, audit report lag, and audit fees: Evidence from Iran", *Journal of International Accounting, Auditing and Taxation*, Vol. 45, 100414. https://doi.org/10.1016/j.intaccaudtax.2021.100414
Saleh, M.A., Ragab, Y.M. (2023), "Determining audit fees: evidence from the Egyptian stock market", *International Journal of Accounting & Information Management,* Vol. 31, No. 2, pp. 355–375. https://doi.org/10.1108/IJAIM-07-2022-0156
Sumunar, K.I., Anita (2022), "CEO overconfidence, audit fee, and audit report lag", *Journal of Social Sciences and Education*, Vol. 6, No. 4, pp. 2849–2861. https://doi.org/10.36312/jisip.v6i4.4184/http
Uzliawati, L., Kalbuana, N., Utami, A. (2024), "Board Commissioner and Intellectual Capital Disclosure on Ownership Concentration in Indonesia Banking Industries", *Quality Access to Success*, Vol. 25 No. 200, pp. 299–308. https://doi.org/10.47750/QAS/25.200.31

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Weis, E., Janoskova, M., Olexova, C., Weis, R., Zuzik, J. (2026),
"Some Aspects of Purchasing Process in Suppliers' Selection,
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 19-32.

Some Aspects of Purchasing Process in Suppliers' Selection

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ARTICLE INFO

Received October 01, 2024
Revised from November 02, 2024
Accepted December 02, 2024
Available online April 15, 2026

JEL classification:. M29, M31, M15

DOI: 10.14254/1800-5845/2026.22-2.2

Keywords:

DMAIC method,
price,
effectiveness,
purchasing process,
strategic importance

ABSTRACT

In a dynamic business environment, it is important for companies to permanently maintain their competitiveness and achieve the highest possible efficiency in all areas of business activities. This includes not only the production and sale of products but also purchasing. The purchasing process is one of the important tools for understanding its strategic importance and the success of the company. The contribution orientates to the importance of the efficiency of the purchasing process in the selected company belonging to the IT sector, dealing with procurement of the advertising items. The authors performed the analysis of the purchasing process using the DMAIC method, enabling an effective and systematic approach to the monitored problem, and providing a consistent framework for the design of processes effectiveness increasing. In addition to the analysis of possible suppliers also their comparison and selection for the most advantageous supplier for the purchase of advertising items in the selected company results from the research. Changes in procurement cannot eliminate in full the human factor and its possible failure, therefore the authors suggest artificial intelligence use, e.g. in historical data processing, consumer trends analysis or prediction of good and services demand.

INTRODUCTION

Globalization and rapidly advancing technologies create a challenging business environment. In a highly competitive environment and due to market dynamics, effective purchasing becomes a key aspect of business success. Thus, purchasing presents no longer just an administrative obligation, but also a strategically important activity that has a direct impact on achieving the goals of the company and creating value for customers.

The understanding of the purchasing and its position changes over time and gradually develops. In the past, purchasing presented an executive function, when the main task was to secure product sales in the shortest possible time and at the lowest possible price. Currently, many authors characterize purchasing as a set of management and physical functions to ensure the necessary material inputs and services for the production and business activities of the company in the required time, quantity and quality, at the right place. Fulfillment of the needs and satisfaction of customers with reasonable costs depends on the fulfillment of the mentioned goal (Gros et al., 2016).

The purchasing process is of strategic importance for the company; therefore, it is important to address it with due attention. This contribution focuses on the efficiency of the purchasing process in a selected company belonging to the IT sector when procuring advertising items.

1. LITERATURE REVIEW

Purchasing is a process, providing suitable business resources and serving for further use. It presents of finding and providing goods, services and raw materials for the business from external entities (Synek et al., 2011). This includes all activities associated with the selection of goods and services, supported by business processes (Dolzhenko, 2023). These help the purchasing team to provide each purchase and thus control the costs of the company.

Is of strategic importance for the company, as it can achieve the goals and objectives of the business through effective purchasing. It presents an organizational function, which presents the process of obtaining supplies and inputs. For a business to grow, purchasing without a clear strategy can have some disadvantages. Lack of control, ambiguous purchasing rules, no or minimal relationships with suppliers and inaccurate evaluation metrics mean a business can be at risk of fraud. On the contrary, a proper and well-set procurement process helps the company minimize costs and at the same time increase the overall quality of supplies (Muheesi, 2022).

One of the tools for analyzing and illustration of the value creation is also the "value chain" proposed by Porter in 1985 (Porter, 1985; Antosova, 2012; Chai, 2024; etc.). Due to the value chain, the company can identify primary and secondary activities, evaluate their effectiveness and orientate to the possible process improvements to increase its competitiveness.

From an economic point of view, it is necessary to perform all activities in the company in such a way that the complex generated value is higher than the sum of the costs. In the context of the value chain, the term procurement presents rather than purchasing, considered as a supporting activity of various business activities. In the frame of the primary activities, it means mainly ensuring the material requirements related to input and output logistics and requirements related to the operations of the company (Kennedy, 2023). Depending on the industry, in which the company operates, individual procurement activities may differ.

Purchasing presents, a holistic view of the business that can lead to removing the internal barriers and reducing duplicity in the whole company. In addition to the value added, which can be created by the effective purchasing process, belong except for classic cost reduction and a positive impact on income, also improving cash flows, return on investment (ROI), risk mitigating, avoiding unnecessary expenses, strategic partnerships, and supply chain management. The mentioned benefits of the purchasing process present a proof of its important role in the company and bring a deeper insight into its significance (Loges, 2018).

Marketing presented for several decades an equally important concept in the creation of value delivered for all interested. Simply said, we can state that individuals get what they need in exchange for another value (Hanulakova et al., 2021). Bielik et al. (2020) define the current century as the century of

marketing. It is not possible to characterize marketing by only one sentence or definition. However, all definitions agree that the customer and satisfaction of his needs presents a common indicator.

Even marketing has been developing and changing since the 1950s due to changing market conditions (Kotler, 2007). Marketing significantly contributes to the prosperity of the company, thus becoming one of its basic functions. Business success lies in the understanding of the importance and essence of marketing. While classic sales marketing is customer-oriented, purchase marketing is supplier-oriented.

Purchasing marketing presents according to Kita (2017) process of purchase behavior of the business. The purchasing process lacks a clearly defined procedure. Several factors influence the specific steps of the purchasing process. Therefore, the individual steps in the literature differ. The purchasing process is influenced by the size of the company, the industry in which the company operates and the organizational structure, as well as the purchasing department in the company, the nature of the purchased goods or services, the amount of financial resources for the purchase, etc. Most often, authors describe the purchasing process in eight steps as follows: Identification of the problem; The needs analysis; Search for potential suppliers; Solicitation and analysis of offers; Negotiation with suppliers; Supplier selection; Order; Purchase evaluation and control (Grandia & Volker, 2023; Gu, 2023; Codeless Platform, 2019).

For example, Kita (2017) divides the marketing approach to the purchasing process into two parts, which also represent the individual stages of the purchase and the steps that the company takes on the market.

Similarly, trends in the measurement of company performance are developing and changing, with a particular focus on supporting corporate strategy, tracking financial and non-financial indicators, or the system for measuring the performance of individual levels of management. The EFQM Excellence Model, Six Sigma and the Balanced Scorecard present so far the most successful systems in the practice, based on the above principles (Janoskova et al., 2018; Ottou et al., 2020; Manova et al., 2021).

2. METHODOLOGY

The object of the investigation is a company operating in the information technology (hereinafter IT) sector, belonging to the Deutsche Telekom AG Group (hereinafter DT), which operates in several countries worldwide. The company is a modern provider of information and communication technologies with the aim of constant innovation and improvement. The attention of the research focuses to the analysis of the process of purchasing advertising items belonging to marketing costs.

We implemented the description and analysis of the purchasing process using the DMAIC method. This method represents a structured process within Six Sigma. The goal of the method is to improve processes and solve problems (DMAIC = Define, Measure, Analyze, Improve and Control). Applying the method enables an effective and systematic approach to the monitored problem, providing a consistent framework for possibly increasing the process´s effectiveness.

3. RESULTS OF RESEARCH

The entire purchasing process at Deutsche Telekom IT Solutions Slovakia consists of the so-called operational procurement process (internal guidelines "Global Procurement Policy and One Procurement Processes"). The purchasing department procures goods and services according to the company's needs, including supply chain management and contract management. We analyzed operational purchasing, namely all activities from entering the request to sending the invoice. These purchasing processes must be processed and documented in such a way that a third party can access them at any time and gain insight.

3.1 Defining

The entire purchasing process demands several tools, by which individual consumers or suppliers work. Such tools are following:

- MyStore / SRM: purchasing system and electronic purchases for DT company, connected to SAP system;
- SAP OFI: backend system, through which the orders and all other connected operations are registered;
- OneSource: internal system for managing the suppliers and contracts;
- HowToBuy: internal web side, where mentioned processes of the company are mentioned, together with all necessary steps;
- ServisPortal: portal for creating the requests (RFQ);
- DocuSign: portal for electronic signing the contract.

The assumed price and characteristics of the procured items influence the purchasing process as well. Internal purchases create three groups according to the possibility of how to make a purchase. The groups are as follows:

A. Order OnePortal: serving for small expenses to the value 500 EUR. The consumer creates a request (RFQ), where he mentions what and by which value he wants to make a purchase. After approval by the purchasing department, he buys a necessary good or service at his costs and consequently, he gives a cash receipt or invoice to the accounting department to be overpaid.
B. Catalogue order: The catalogue contains a list of items from various suppliers that the company regularly purchases. Suppliers has contracts with DT and the offered prices are determined according to the auctions, when regarding a number of factors, such as price, quality, and reliability of supplier and delivery time.
C. Order Free – text: when the consumer did not manage to find necessary material or service in the catalogue, or in case of any specific item, which is necessary to evaluate individually by the supplier.

We used the RASCI Matrix for the identification of the position and tasks of the individual participants in the purchasing process. Table 1 illustrates all activities.

Table 1. RACI matrix

Activities / participants	*Requestor*	*Procurement specialist*	*Account Specialist*	*Controlling*	*Budget approver*
Request for quotation – RFQ	R	A			
Supplier and contract management	R	A			
Creating Shopping Cart	C	R		C / I	
Approving Shopping Cart		A	A	A	A
Releasing Purchase order	I	R			
Confirmation of delivery – GR	R	I	I		
Invoice receiving and verification	R	C	R		R
Invoice payment			R		
Monitoring and Archiving of documents		R			

Source: created by authors

Legend:

R / responsible: the responsible person for the activity;
A / accountable: the responsible person for the activity approval before taking the effect;
C / consulted: the responsible person for the questions or council;
I / informed: the responsible person, informing about the results.

3.2 Measurement

Measurable outputs from the purchasing process are orders, providing detailed review of DT, its volume and value. The period of the analyzed data is 2023. The data of orders are in Table 2.

Table 2. Orders from the analyzed period

	All orders	*Orders for advertising items*
Analyzed period	2023	2023
Number of orders	3,328	237
Number of purchased items	9,104	306
Total value of orders / EUR	58,899,019.50	438,423.26
Average sum of orders / EUR	17,698.02	841.50
Number of catalogue orders	1,015	198
Number of free-text orders	2,313	39

Source: created by authors

3.3 Analysis

When analyzing the purchasing process, we compared the current prices on the market from several suppliers. We have selected a list of 12 items that are purchased most often and price offers from five suppliers (A, B, C, D, E). Supplier B is very important for DT, providing a wide portfolio of products and services in the field of advertising. Its prices are higher, but the quality and speed of delivery of goods and services compensate for the higher price. Suppliers A and C are protected workrooms, and cooperated with DT for a long time because large companies have a legal obligation to allocate a certain part of their costs to such type of business. The company cooperated with supplier D for a long time in the past, but supplier D did not offer favorable conditions for the purchase at the last auction. The last supplier E is new one, DT has no experience with supplier D. The new supplier presents well known in the region, so we consider it as interesting to request him and consider his prices and offer. Table 3 shows the prices that suppliers offer for selected, most frequently purchased products. The prices are without VAT, during the purchase of 10 and 100 pieces.

Table 3. Comparing of prices of advertising items

Item / Supplier	*Number / pieces*	*A*	*B*	*C*	*D*	*E*
T-shirt basic	10	6.66	7.50	14.40	7.16	7.00
	100	4.75	5.75	5.80	7.16	5.00
Printed sweatshirt	10	20.92	19.00	28.00	18.23	19.70
	100	16.26	17.00	21.80	18.23	18.00
Poster A4	10	0.60	0.70	0.40	0.32	0.50
	100	0.18	0.35	0.34	0.32	0.40
Poster A3	10	1.00	1.00	0.80	0.64	0.90
	100	0.25	0.50	0.67	0.64	0.70
Mug	10	8.00	6.00	5.70	7.07	8.00
	100	4.20	3.00	2.70	3.42	4.80
Coffee mug	10	11.01	9.00	6.70	6.76	10.20
	100	5.95	7.50	3.38	4.47	7.00
Sticker	10	1.00	1.00	0.80	0.90	1.00
	100	0.20	0.15	0.18	0.50	0.30
Pen	10	3.25	3.00	3.64	2.90	3.20
	100	0.58	0.75	0.70	0.80	0.80
USB 32 GB	10	9.00	8.50	9.25	9.00	9.50
	100	4.50	7.00	5.95	6.60	7.60
Neck cord	10	2.00	3.00	4.48	1.26	3.50
	100	1.16	2.50	1.20	1.26	2.10

Booklet	10	5.80	5.00	5.85	4.46	6.00
	100	2.55	3.50	2.90	4.46	4.50
Linen bag	10	3.35	3.50	5.95	4.20	6.00
	100	1.83	2.75	1.75	4.00	4.00

Source: created by authors

We have chosen three ways, in which we will analyze the price offers from suppliers, namely: average price, price indexes and the importance of quantity or weight. The analysis results serve for comparison and decision of the supplier selection.

3.4 Calculation of average price

The average price of products presents an important factor, offering the consumers an overview of price competition and the market situation. From the calculations, we can find out, which of the suppliers offers the best prices for different products and different order volumes. We calculated the average prices for quantities of 10 and 100 items and consequently, we calculated the total average price. We present a sample calculation for a T-shirt from supplier A in detail, other calculations are shown in table 4.

$$Average\ price\ of\ T-shir\ from\ A\ supplier\ for\ 10\ pieces\ \frac{6.66+7.50+14.40+7.16+7.00}{5}=8.54$$

Table 4. Calculation of average price of advertising items

Item	*Price for 10 pieces*	*Price for 100 pieces*	*Average price*
T-shirt basic	8.54	5.69	7.118
Printed sweatshirt	21.17	18.25	19.71
Poster A4	0.50	0.32	0.41
Poster A3	0.87	0.55	0.71
Mug	6.95	3.62	5.29
Coffee mug	8.73	5.66	7.20
Sticker	0.94	0.27	0.60
Pen A	3.19	0.73	1.96
USB 32 GB	9.05	6.33	7.69
Neck cord	2.85	1.64	2.25
Booklet	5.42	3.58	4.50
Linen bag	4.60	2.867	3.733

Source: created by authors

The calculations show that out of 24 average prices, supplier A has 15 items under the average value, similarly to supplier D. In comparison, the highest prices have supplier E, which has the better prices in only 6 cases. Suppliers B and C have the better prices in 13 cases.

3.5 Calculation of price indexes

Price index analysis is a key tool for comparing prices from different suppliers with average market prices. It helps to understand how the current prices offered by suppliers differ from each other. The price index quantifies the percentage change in price compared to the average price. As a reference point, we chose the average prices of individual products obtained from previous calculations. The resulting values are given in percentage, expressing by what percent the price from the supplier is higher (or lower) than the average prices of other suppliers. We present a sample calculation for a T-shirt from supplier A. Table 5 shows the following calculations.

$$T-shirt\ from\ A\ supplier\ for\ 10\ pieces = \frac{6.66}{8.54} * 100 = 77.95\ \%$$

Table 5. Calculation of price indexes

Item / Supplier	*Number of pieces*	*A*	*B*	*C*	*D*	*E*
T-shirt basic	10	77.95	87.78	168.54	83.80	81.93
	100	83.45	101.02	101.90	125.79	87.84
Printed sweatshirt	10	98.82	89.75	132.26	86.11	93.06
	100	89.06	93.11	119.40	99.85	98.59
Poster A4	10	119.05	138.89	79.37	63.49	99.21
	100	56.60	110.06	106.92	100.63	125.79
Poster A3	10	115.21	115.21	92.17	73.73	103.69
	100	45.29	90.58	121.38	115.94	126.81
Mug	10	115.04	86.28	81.97	101.67	115.04
	100	115.89	82.78	74.50	94.37	132.45
Coffee mug	10	126.06	103.05	76.71	77.40	116.78
	100	105.12	132.51	59.72	78.98	123.67
Sticker	10	106.38	106.38	85.11	95.74	106.38
	100	75.19	56.39	67.67	187.97	112.78
Peen	10	101.63	93.81	113.82	90.68	100.06
	100	79.89	103.31	96.42	110.19	110.19
USB 32 GB	10	99.45	93.92	102.21	99.45	104.97
	100	71.09	110.58	94.00	104.27	120.06
Neck cord	10	70.22	105.34	157.30	44.24	122.89
	100	70.56	152.07	72.99	76.64	127.74
Booklet	10	106.97	92.22	107.89	82.26	110.66
	100	71.19	97.71	80.96	124.51	125.63
Linen bag	10	72.83	76.09	129.35	91.30	130.43
	100	63.85	95.95	61.06	139.57	139.57

Source: created by authors

Through the analysis of price indexes, we found that supplier A is the most advantageous, followed by supplier D, supplier C, and supplier B. Supplier E provides the least favorable prices in relation to average prices.

3.6 Weight analysis

When analyzing price offers from different suppliers, in addition to the price, we will consider the importance, or the weight of the various quantities DT purchases. Since the most of the analyzed orders were in small quantities, we assign a weight of 80% to the number of 10 pieces and 20% to the number of 100 pieces. The resulting amount will provide information about the average price at which the company would purchase the items in the current state of the purchasing process. In the next part, we will change the ratio and analyze the opposite case, to compare the current purchase process with the recommended one. The process of the weighted average calculation is as follows:

$$Weight\ avetage\ for\ T-shirt\ from\ A\ supplier\ (0.80 * 6.66) + (0.20 * 4.75) = 6.28$$

Table 6. Weight analysis 80/20

Item / Supplier	*A*	*B*	*C*	*D*	*E*
T-shirt basic	**6.28**	7.15	12.68	7.16	6.60
Printed sweatshirt	19.99	18.60	26.76	**18.23**	19.36
Poster A4	0.52	0.63	0.39	**0.32**	0.48
Poster A3	0.85	0.90	0.77	**0.64**	0.86
Mug	7.24	5.40	**5.0**	6.34	7.36
Coffee mug	10.00	8.70	**6.04**	6.30	9.56
Sticker	0.84	0.83	**0.68**	0.82	0.86
Pen	2.72	2.55	3.05	**2.48**	2.72
USB 32 GB	**8.10**	8.20	8.59	8.52	9.12
Neck cord	1.83	2.90	3.82	**1.26**	3.22
Booklet	5.15	4.70	5.26	**4.46**	5.70
Linen bag	**3.05**	3.35	5.11	4.16	5.60

Source: created by authors

As for this indicator, the lowest price values after considering the determined weights are important. The supplier with the lowest weight price is the most advantageous for DT, as it offers the lowest prices with regard to the weight of the quantities of ordered items. The best prices are in Table 6 highlighted in color. Supplier D is the most advantageous, offering the lowest price for only seven items, followed by supplier A and supplier C. Supplier B and E are not advantageous. Based on previous comparisons using different methods, we listed the order in which the suppliers ranked within the three presented analyses in Table 7. The ranking also represents the number of points.

Table 7. Comparing of the analysis results

Analysis method / Supplier	*A*	*B*	*C*	*D*	*E*
Average prices	1	3	3	1	5
Price indexes	1	4	3	2	5
Weight analysis	3	5	3	1	5
SUM	5	12	9	4	15

Source: created by authors

The results of the above analysis are important for the observed problem in DT Company, according to which we determine the comparison of suppliers:

- Supplier D is the best choice for the company, achieving the best results and ranking. Within the framework of average prices and weight analysis, the supplier proved to be the most advantageous; the price indices were also favorable. It is a suitable alternative as a future supplier.
- The second rank belongs to supplier A. The ordered quantity most significantly affects his prices; it is most convenient to buy products from supplier A in larger volumes. It also offers the best prices compared to the average prices for the given products. In the weight analysis supplier, A has a third rank, which still means that it represents one of the more advantageous partners for the company.
- Supplier C has stable and competitive results and prices in the frame of all analyses. The prices are optimal, for some specific products even the most advantageous among the analyzed competition.
- Supplier B is currently the largest supplier of advertising items for DT, but the analysis results show that it currently does not represent the best possible solution.
- Supplier E is a new one, with whom DT has no previous experience. Considering the results of the analyses, it does not achieve better or comparable results than other suppliers, which means that supplier E presents the least suitable supplier. However, this does not mean that it cannot offer suitable marketing solutions in other areas in the future.

3.8 Improvement

The disposal data reveals several problem areas that accompany the purchase process. These are mostly recurring deficiencies that the company can eliminate in a few steps, making the purchase process more efficient. We pointed out the current prices of twelve selected advertising items that DT buys most often. The difference in prices among the selected suppliers is significant and points to the fact that it is more profitable for the company to purchase such items in larger quantities and in sufficient advance.

The aim is to select from among possible suppliers the one that can provide the best prices. The company can also conclude a contract with the price list of the most frequently purchased advertising items so that buyers can provide favorable prices in the long term.

In the purchasing process, we have currently identified an uncertain process for purchasing advertising items. A suitable solution would be imitating the purchasing process of hardware and software; which competent employees oversee. In the first step, the company needs to contact them; they will collect the demand and only then enter a purchase request where several items are in larger quantities. In this way, the company can have an accurate overview of purchases and volumes, so that it can ensure the purchase of only necessary and high-quality products and services. Similarly, it is advisable to adjust the purchase of advertising items, when the authorized employee would oversee such an agenda. He would also collect the requirements of the employees and assess the necessity and suitability of the given items, the location of the logo and the suitability of the selected print. Only then would he enter a request for the purchase of a larger quantity. In this way, the company would be able to use the so-called quantity rebate that suppliers offer during purchasing of more products.

3.9 Control

Ensuring the effectiveness of changes and their maintenance is very important for achieving long-term favorable results of DT. Control of the purchasing process should include monitoring of performance indicators, control, or auditing processes and, last but not least, feedback from interested parties.

The proposed solution for increasing the effectiveness of the purchasing process of advertising items is grouping the requests for such purchases and subsequently ordering them in larger quantities. This means to realize the least purchases as possible in a small volume. The goal is to create orders where company purchases larger quantities, but still under the assumption of procuring only those volumes that are necessary for the specified purposes. For comparison, we will follow up on the weight analysis from the previous section, but in this case, we will adjust the weights for individual purchase volumes so that 10 pieces will represent 20% and 100 pieces will represent 80%. This means that 80% of purchases will be for 100 or more units, and only 20% of purchases will be orders of small quantities of products. We carry out the calculation as follows:

$$Weight\ average\ for\ T-shirt\ from\ A\ supplier\ (6.66 * 0.20) + (4.75 * 0.80) = 5.13$$

Weight average for other advertising items and from other suppliers are in Table 8.

Table 8. Weight analysis 20/80

Item / Supplier	*A*	*B*	*C*	*D*	*E*
T-shirt basic	5.13	6.10	7.52	7.16	5.40
Printed sweatshirt	17.19	17.40	23.04	18.23	18.34
Poster A4	0.26	0.42	0.35	0.32	0.42
Poster A3	0.40	0.60	0.70	0.64	0.74
Mug	4.96	3.60	3.30	4.15	5.44
Coffee mug	6.96	7.80	4.04	4.93	7.64
Sticker	0.36	0.32	0.30	0.58	0.44
Pen	1.11	1.20	1.29	1.22	1.28

USB 32 GB	5.40	7.30	6.61	7.08	7.98
Neck cord	1.33	2.60	1.86	1.26	2.38
Booklet	3.20	3.80	3.49	4.46	4.80
Linen bag	2.13	2.90	2.59	4.04	4.40

Source: created by authors

Through weight analysis, we demonstrated changes in the average prices at which the company purchased the products if approximately 80% of orders were in volume of more than 100 items from one product Supplier A is the most advantageous since he could provide up to eight items at the cheapest price.

We can do the check simply by comparing the fictitious purchase and costs under the current and proposed purchasing process. For this purpose, we will use data from internal sources, based on which we have calculated the average prices of purchased items for the year 2023 (Note: some prices have changed depending on the supplier and the ordered quantity. For calculation purposes, we have identified their averages).

Table 9. Comparing of present and recommended purchasing process

	Average purchase price	*Actual process*		*Suggestion*	
		A	*D*	*A*	*D*
T-shirt basic	12.95	6.28	7.16	5.13	7.16
Printed sweatshirt	21.85	19.99	18.23	17.19	18.23
Poster A4	0.80	0.52	0.32	0.26	0.32
Poster A3	1.00	0.85	0.64	0.40	0.64
Mug	6.50	7.24	6.34	4.96	4.15
Coffee mug	10.50	10.00	6,3	6.96	4.93
Sticker	0.80	0.84	0.82	0.36	0.58
Pen	2.80	2.72	2.48	1.11	1.22
USB 32 GB	9.75	8.10	8.52	5.40	7.08
Neck cord	1.95	1.83	1.26	1.33	1.26
Booklet	5.48	5.15	4.46	3.20	4.46
Linen bag	3.1	3.05	4.16	2.13	4.04
SUM	77.48	66.57	60.69	48.43	54.07

Source: own processing

Table 9 shows the sum of the prices, for which DT purchased in 2023. In case the purchasing process would not change, the purchase is for following sums of prices in the same proportion, i.e. 20% of purchases would be large purchases - over 100 pcs and 80% would be small purchases of 10 pcs. The change would only occur when selecting a supplier. According to the previous analysis, supplier A and supplier D appear to be the best selection. Calculation of the sum of the prices when we adjusted the purchasing process and the ratio is 80% for large purchases and 20% for small purchases is below. The current price gives a value of 77.48 EUR. If DT concluded a contract with only supplier A or D, while not modifying the purchasing process, it could record savings. We calculate their amount using the following formulas:

$$Saving: supplier\ A\ = \left(1 - \frac{66.57}{77.48}\right) x\ 100 = \ 14.08\ \%$$

$$Saving: supplier\ D = \left(1 - \frac{60.69}{77.48}\right) x\ 100 = 21.67\%$$

The result is a saving in the case of supplier A in the average amount of 14.08%; the savings with supplier D would reach up to 21.67%.

If the company decided to modify the purchasing process, mainly to collect demand, only then create larger orders, and thus obtain savings from scale, the percentage savings would be even higher.

$$Saving: supplier\ A = \left(1 - \frac{48.43}{77.48}\right) x\ 100 = 37.\ 49\ \%$$

$$Saving: supplier\ D = \left(1 - \frac{54.07}{77.48}\right) x\ 100 = 30.21\%$$

In this case, the savings would be up to 37.49% for supplier A and 30.21% for supplier D. Such a high percentage of savings means great potential for DT Company and an opportunity to reduce the costs spent on the purchase of marketing items.

Based on the analysis of price offers, we selected two suppliers for the company that provide the most favorable prices for different purchase quantities of advertising items. The current supplier with whom the company cooperates is reliable and friendly, but currently no longer providing the best prices. Therefore, we propose to expand cooperation with another supplier and consider the possibility of negotiations and concluding a possible contract. At the same time, after concluding the contract with the price list, it would be appropriate to include these new products in the internal catalogue, so that employees can also independently purchase items and printed materials at advantageous, contractually agreed prices.

The marketing department should have an overview of all purchases to promote the company in any way. The department must assess whether the company's logo is used and presented by the marketing policy, whether the color scale is respected - whether there are objects that can be suppressed by the company's logo, etc. The solution could also be to designate the marketing department as the only one competent to act in this matter and to be the only entity with the authority to purchase advertising items.

CONCLUSION AND DISCUSION

Purchasing is one of the necessary processes in every business; in addition to financial factors, it also affects overall competitiveness and efficiency. The purchasing process of a large company such as Deutsche Telekom IT Solutions Slovakia is not simple, several guidelines at the local level, take into account the processes of the entire global DT group. The company has extensively developed various internal systems; one of them is the portal, where each department has its own space for the agenda, news and processes.

However, any changes in the procurement of advertising items cannot eliminate the human factor and possible failure. There may still be purchases without sufficient time reserve in case of purchases, made in the shortest possible time (Moretto et al., 2017). In such a case, when selecting a supplier, its production and delivery capabilities are important, not the price. Shopping in a time of distress may continue to be costlier for the company. Therefore, we recommend setting a price range with the most suitable supplier, within which it can vary even if the goods need to be produced and delivered within a very short time. However, the price should still be more favorable than the current market prices.

The paper authors present the identification and comparison of the most advantageous suppliers for the purchase of advertising items in the selected company of the IT industry. The analysis showed suppliers D and A offer the best prices compared to other suppliers, when supplier D achieved the best results under various evaluation methods, including average price, price indexes and weight analysis. Optimizing the purchasing process could lead to a cost reduction up to 37.49% in case of supplier A and 30.21% in case of supplier D. Such result could be recorded if bulk purchases would be realized in larger volumes. This result demonstrates the potential for significant cost savings through better planning and management of the purchasing process.

The paper is a comprehensive analysis of the purchasing process in an IT company, which provides practical solutions for improving efficiency. Offers knowledges of the DMAIC method use in the field of procurement, which enables a systematic approach to problem solving and improving performance. The

findings point to the possibilities of optimizing cooperation with suppliers, identifying the most advantageous supplier and cost reduction through more effective management of purchases of the advertising items.

It is also important to mention the possibilities of using modern technologies, including artificial intelligence (AI). Its contribution could be used mainly in the processing of historical data and its use to predict future needs and purchases and provide recommendations, which would make it easier for buyers to make their decisions (Kehayov et al., 2022). The company could also use artificial intelligence to evaluate the performance of suppliers. In this way, it is possible to ensure the monitoring of key performance indicators and to analyze the behavior of suppliers, thereby increasing transparency, reducing possible human errors and increasing the efficiency of relations with suppliers. In recent years, AI has become a key tool for optimizing various business processes, including procurement. AI algorithms are able to analyze consumer trends, predict demand for goods and services, and provide recommendations to optimize orders.

Another significant benefit of AI is the automation of repetitive tasks, such as evaluating price offers and selecting suppliers. This expedites procurement process, as well as reduces manual errors, and improves the accuracy of decision-making (Sakyoud et al., 2024). AI also allows for continuous monitoring of supplier performance through key performance indicators (KPIs), such as reliability, delivery times, and product quality. This allows companies to manage supplier relationships more effectively and make better-informed decisions.

Moreover, AI can enhance process transparency by analyzing large amounts of data in real time and providing recommendations for increasing efficiency. This technology not only reduces costs but also boosts the overall competitiveness of the company. However, the implementation of AI should be gradual, with appropriate employee training and expert support to ensure effective use of this technology.

These recommendations represent only a part of the potential that artificial intelligence has in relation to the efficiency of any processes in the company, not only the purchasing. However, the implementation of such measures must be gradual, with a focus on specific characteristics and goals. The analyzed company should consider also the need for professional advice and training of stakeholders and employees.

The research presented of the paper is limited to the IT sector, dealing with procurement of advertising items by DMAIC method. Future research will be oriented to the other sectors and comparison of the common characteristics of the procurement and purchase process.

ACKNOWLEDGEMENT

This research was funded by KEGA grant number 032EU-4-2024.

REFERENCES

Antosova, M. (2012), *Strategic management and decision making*, Iura Edition, Bratislava, (in Slovak).

Bielik, P. et al. (2020), *Economics, management and marketing of an agricultural enterprise*, SPU v Nitre, Nitra, (in Slovak).

Codeless Platforms (2019), "Procurement Process Flow – A Guide to Procurement in Business", https://www.codelessplatforms.com/blog/procurement-process-flow/ (accessed 22 February 2024)

Deutsche Telekom IT Solutions (2024), "About us", https://www. deutschetelekomitsolutions.sk/ (accessed 15 April 2024)

Dolzhenko, R.A. (2023), "Experience of Centralization and Transformation of Procurement Activities in a Large Company", *World of Economics and Management*, Vol. 23, No. 2, pp. 142-160.

Grandia, J., Volker, L. (2023), *Public Procurement. Theory, Practices and Tools*, Palgrave Macmillan, https://doi.org/10.1007/978-3-031-18490-1 (accessed 12 June 2024)

Grega, M., Orviska, M., Nemec, J., Lawson, C. (2019), "Factors Determining the Efficiency of Slovak Public Procurement", *Journal of Public Administration and Policy*, Vol. 12, No. 1, pp. 43-68, https://doi.org/10.2478/nispa-2019-0002

Gros, I., Barancik, I., Cujan, Z. (2016), *Big book of logistics*, VSCHT v Praze, Praha, (in Czech).

Gu, J. (2023), "KPI Design Method for Performance Appraisal of Media Advertising Company Based on Entropy Value Method", *International Business & Economics Studies*, Vol. 5, No. 1, pp. 37-46, DOI: 10.22158/ibes.v5n1p37.

Chai, J., Qian, Z., Wang, F., Zhu, J. (2024), "Process innovation for green product in a closed loop supply chain with remanufacturing", *Annals of Operations Research*, Vol. 333, No. 2, pp. 533–557, https://doi.org/10.1007/s10479-020-03888-y

Hanulakova, E., Oresky, M., Drabik, O., Zak, S. (2021), *Marketing – Tools, Strategies, People and Trends*, Wolters Kluwer, Bratislava, (in Slovak).

Janoskova, M., Csikosova, A., Culkova, K. (2018), "Measurement of Company performance as part of its Strategic Management", in Leon, R. (Ed.), *Managerial strategies for Business Sustainability during Turbulent times*, IGI Global, Hershey, pp. 309-335. DOI: 10.4018/978-1-5225-2716-9.ch017.

Kehayov, M., Holder, L., Koch, V. (2022), "Application of artificial intelligence technology in the manufacturing process and purchasing and supply management", in *The 3rd International conference on Industry 4.0 and Smart manufacturing*, Vol. 200, pp. 1209-1217, https://doi.org/10.1016/j.procs.2022.01.321

Kennedy, J. (2023), "*5 "Rights" of Procurement",* https://www.procurementexpress. com/best-practices/5-rights-procurement/ (accessed 18 June 2024)

Kita, J. (2017), *Buying and selling: business functions of industrial enterprises*, Wolters Kluwer, Bratislava, (in Slovak).

Kotler, P. (2007), *Modern marketing,* Grada, Praha (in Czech).

Loges, P. C. (2018), "*Key Performance Indicators for Evaluating Purchasing Performance",* https://publication.sipmm.edu.sg/key-performance-indicators-evaluating-purchasing-performance/ (accessed 15 June 2024)

Manova, E., Kopcakova, J., Kuhnova, L., Simonidesova, J., Culkova, K. (2021), "Use of Multivariable Decision Methods in Decision of Retail Organizations", *TEM Journal*, Vol. 10, No. 4. pp. 1992-2000.

Moretto, A., Ronchi, S., Patrucco, A.S. (2017), "Increasing the effectiveness of procurement decisions: The value of big data in the procurement process", *International Journal of RF Technologies*, Vol. 8, No. 3, pp. 79-103. DOI: 10.3233/RFT-171670.

Muheesi, A. (2022), "Procurement management", https://www.researchgate.net/publication/363337725_PROCUREMENT_MANAGEMENT (accessed 10 June 2024)

Ottou, J. A., Baiden, B. K., Nani, G. (2020), "Six Sigma Project Procurement application in public procurement", *International Journal of Quality & Reliability Management*, Vol. 38, No. 2, pp. 646-662, https://doi.org/10.1108/IJQRM-04-2019-0111

Porter, M. E. (1985), *The Competitive Advantage: Creating and Sustaining Superior Performance*, Free Press, New York.

Sakyoud, Z., Aaroud, A., Akodadi, K. (2024), "Optimization of purchasing business process in Moroccan public universities based on COBIT and artificial intelligence techniques", *Kybernetes,* Vol. 53, No. 5, pp. 1607-1635. https://doi.org/10.1108/K-02-2022-0167

Synek, M. et al. (2011), *Managerial economics*, Grada, Praha.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Santoso, R.P., Sidiq, S., Hakim, A. (2026),
"Financial Resilience of Informal Workers in Indonesia",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 33-41.

Financial Resilience of Informal Workers in Indonesia

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ARTICLE INFO

Received October 01, 2024
Revised from November 02, 2024
Accepted 20, December 02, 2024
Available online April 15, 2026

JEL classification: G52, G51, J46

DOI: 10.14254/1800-5845/2026.22-2.3

Keywords:

Resilience,
Literacy,
Planning,
Satisfaction,
Financial,
Informal Workers

ABSTRACT

Informal workers are vulnerable to various economic shocks, which makes them less financially resilient. Given the lower pay and unpredictable income, effective financial planning is considered to play a more significant role than merely financial literacy in strengthening financial resilience. Since the informal workers contribute 60 percent of labour absorption in Indonesia, it is urgent to understand the factors determining informal workers' financial resilience. This study aims to analyse to what extent financial planning and literacy can improve the economic resilience of informal workers. The primary data is 178 informal worker families collected by a questionnaire in 2024. The model is a partial least-squared-structural equation model (PLS-SEM). The independent variables are financial literacy, planning, financial satisfaction, and demographic variables of age, education, and income. The dependent variable is financial resilience with financial satisfaction as a mediating variable. The study results confirm that informal household financial resilience increases more due to effective financial planning than financial literacy. Financial literacy does not always correlate with informal workers' financial resilience improvements without sufficient income. In this study, income is proven significant in boosting financial resilience. This study implies that the financial resilience of informal households, which generally have low and uncertain incomes, can be improved through proper financial planning accompanied by strengthening their economic capacity and social protection, especially for the poorest.

INTRODUCTION

The informal worker families typically have lower pay and unpredictable incomes, limited access to formal financial resources, and lack of social security and protection. Consequently, this group of households is financially vulnerable to multiple financial shocks from idiosyncratic and aggregate risks that threaten their economic stability (Santoso and Sriyana, 2021). The empirical studies suggest that financial resilience determines economic stability (Salignac et al., 2019). Financial resilience is how an individual or household can withstand various shocks and uncertainties. Previous research suggests that financial literacy and planning empirically make households financially resilient (Klapper and Lusardi, 2020). However, those previous researches mainly observe the effect of financial literacy and planning on households' resilience with a fixed or regular income of formal households. On the other hand, the financial behaviour

of informal households has yet to be the focus of the previous studies. As far as researchers have read, only a few studies explicitly analyse the resilience of informal workers. Therefore, it is urgent to study the factors determining informal workers' financial resilience since this kind of family in Indonesia is enormous, around 60 percent of the total workforce.

In shaping the financial resilience of informal workers, financial planning is thought to play a more significant role than financial literacy. Financial planning refers to how a household considers its current financial condition to plan future financial decisions such as saving, investment, debt, and other expenses. Arguments supporting this assumption include the ability to plan expenditures, budgets, and savings or emergency funds, which will determine financial resilience under conditions of lower and unpredicted informal workers' income. People who plan their finances will accumulate assets or invest in anticipation of their old age. Empirical studies show that effective financial planning prepares them to face economic uncertainty better. In addition, financially literate individuals do not necessarily have skills in long-term financial planning. Although the relationship is positive, the correlation between the two is low. People with good financial literacy will likely make bad financial decisions (Alhenawi and Elkhal, 2013). Even though financial planning can help informal households manage family finances, the problem of financial planning in developing countries is even more complex. Lower-middle-class households in have poor financial planning because they rarely have a surplus of income and are disturbed by frequent financial shocks.

Financial literacy, on the other hand, can only increase household financial resilience conditional to sufficient income level. Financial literacy is associated with low income, which will discourage people from improving their literacy. In fact, the level of financial literacy in developing countries is still low. This level also correlates with lower level of informal worker's education. A study conducted in Indonesia showed that financial training had no impact on increasing financial literacy, such as opening a bank account (Cole et al., 2011). On the other hand, a high level of financial literacy cannot guarantee a high level of resilience because it induces conservative financial behaviour, which is less productive.

Based on the background above, informal workers' financial resilience is unique compared to formal workers with fixed incomes. This study aims to analyse how important financial planning over financial literacy is in improving the economic resilience of informal worker families. After the introduction, the next section is a literature review, followed by methodology, results and discussion, and conclusion.

1. LITERATURE REVIEW

The informal sector is the backbone of the Indonesian economy, and 60 percent of business actors in Indonesia are informal businesses. The informal sector in Indonesia can absorb 60 percent of total employment opportunities. The characteristics of the informal workforce in Indonesia generally have low levels of education and low skills. Therefore, their productivity is lower, and so is their average income. Another characteristic of informal sector workers is unpredictable wage payment. On the other hand, the social security system does not fully protect them, such as social and health insurance. Such conditions make them vulnerable to any adverse effects of risks. The experience of the COVID-19 pandemic crisis provides a lesson that many informal workers end up in poverty (Suryahadi et al., 2021).

One of the coping mechanisms to mitigate the adverse effect of any shock is to take extra job (Leonard, 2000) or utilize savings if they have it. However, if they do not have, they will borrow money from relatives or informal financial institutions. The last alternative is to sell assets, both unproductive and productive assets (Santoso and Sriyana, 2021). The last two choices will significantly reduce economic resilience. However this potential problem can be minimized if they can manage their finances effectively.

Financial resilience is households' capacity to cope with income or expenditure shocks and how quickly they recover from the hardship. These shocks can come from idiosyncratic/specific risks or aggregate risks (Santoso and Sriyana, 2021). In dealing with these shocks, households use many forms of coping strategies, including utilizing savings or emergency funds. Households that do not anticipate will be trapped in debt. The financial hardship forces consumption smoothing and will likely reduce allocations for expenses such as nutrition, health, and education.

Financial resilience is correlated to financial planning (Setyorini et al., 2021). Financial planning is a process of setting short-term and long-term financial goals, as well as developing strategies to achieve these financial goals. Financial planning includes budget, savings, investment, and risk management. In informal household groups with limited access to the social protection system, this financial planning is one of the keys to dealing with the uncertainty caused by economic hardship. Through proper financial planning, informal households can allocate limited financial resources wisely while mitigating the risks, and provide extra protection against risks.

On the contrary, financial literacy independently is insufficient to cope with potential risks. Inadequate protection and social security for informal families require them to manage limited financial resources and make financial decisions strategically. Systematic financial planning can help them prepare emergency funds for unexpected events. So, financial planning is not only a practical skill for financial management but also a strategy to overcome the higher potential risks of informal families. Financial planning enables one to reach short- and long-term goals and maintain financial resilience and stability (Aassouli and Ahmed, 2023).

Informal household financial planning is closely related to saving and debt behavior (Brounen et al., 2016). If a household has set short-term and long-term financial goals, they can determine the right economic strategy to save or apply for a credit loan. Through sound financial planning, they can manage expenses according to their priorities and use the rest to save. Good saving behavior requires high-budget discipline. An informal household will be more aware of their financial condition with adequate financial planning skills. This awareness is then helpful for self-control so they can allocate their budget wisely (Strömbäck et al., 2017). They better understand their desires or needs. This is very useful to avoid excessive debt, worsening their financial resilience (Klapper and Lusardi, 2020). The increase in the debt ratio will limit future debt.

Households that plan their finances well are better able to face financial hardship than those that only rely on financial literacy. However, financial literacy is still essential in supporting good financial planning (Huang et al., 2015). Financial literacy is a person's knowledge and ability to manage financial products, budgeting, investment, and debt. With sound financial literacy, individuals can make the right decisions and minimize risks. However, effective financial literation requires an adequate level of income. The lower and unpredictable income makes financial literacy only partially realized in increasing financial resilience (Khan et al., 2022).

In addition to literacy and sound financial planning factors, financial satisfaction factors also improve the financial resilience of informal households. Financial satisfaction measures how satisfied a household is with its current financial condition (Owusu, 2021). Financial satisfaction is a combination between proper financial management and achieving financial goals. Thus, high financial satisfaction is usually the result of effective budget planning and management (Ali et al., 2015). Ultimately, this can improve informal households' financial resilience because they can cope adversity well.

Literature studies show that financial resilience is also significantly influenced by the demographic structure of its population. Demographic factors such as age, education level, and income contribute significantly to shaping household financial resilience. A person's age can reflect experience, knowledge accumulation, and higher finances. Higher education correlates with better financial literacy and financial planning skills. However, high financial literacy sometimes translates into financial resilience when income levels are too low (Friedline and Kepple, 2017). Thus, good education does not guarantee the financial stability and resilience of informal households if they do not have adequate access to financial resources. Another important demographic factor is the income level of informal households. Adequate income levels increase financial capacity to respond to financial shocks and uncertainties (Salignac et al., 2019). With high incomes, informal households have enough cushion to absorb shocks.

2. METHODOLOGY

2.1 Research Method

2.1.1 Structural Equation Model

This study uses a structural equation model (SEM) estimated with the partial least square technique (PLS). The path analysis of PLS-SEM shows the relationship between latent variables and exogenous control variables affecting financial resilience (Figure 1). The financial literacy (X_1) has a direct and indirect influence on financial resilience (Y) through the mediating variable of financial satisfaction (Z). Financial literacy can also affect financial satisfaction and indirectly affecting financial resilience. Meanwhile, financial planning (X_2) also has a direct influence on financial resilience as well as an indirect influence through financial satisfaction. In addition, financial resilience is also influenced by demographic variables such as age, education and income.

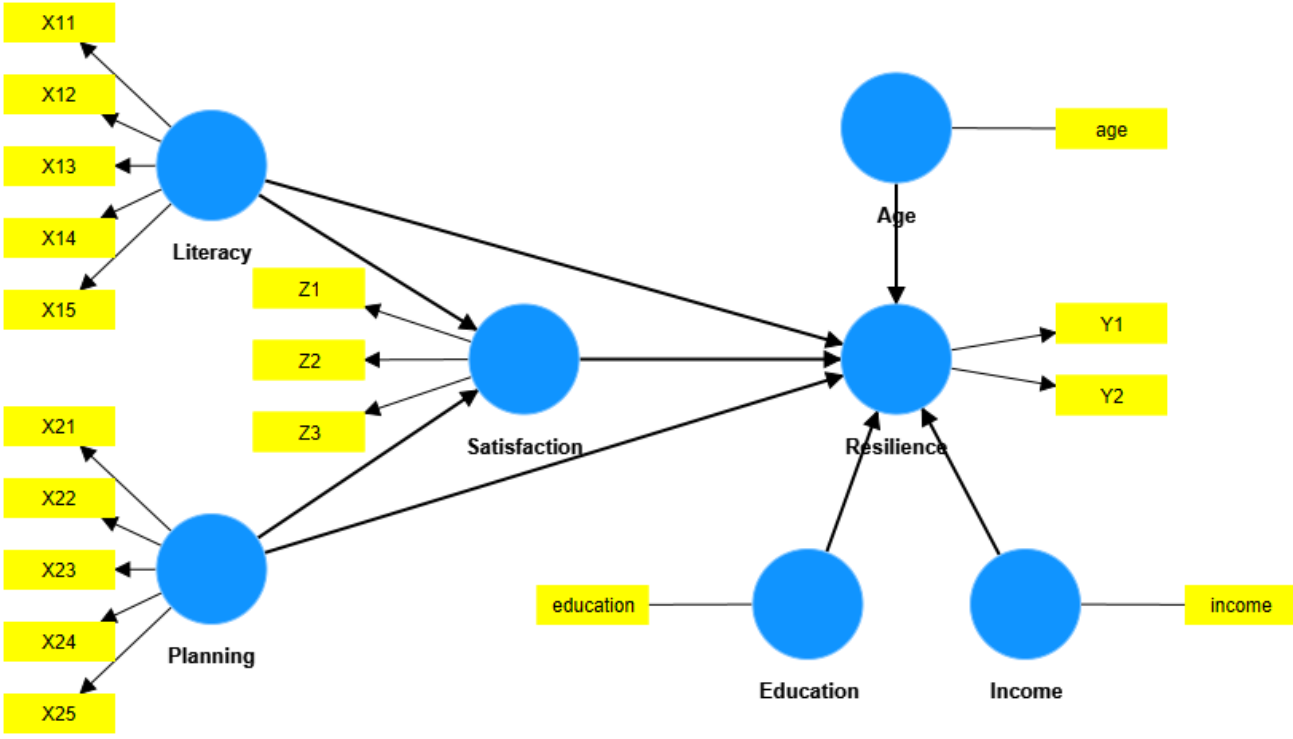

Figure 1. Path Diagram of Structural Equation Model
Source: own

Using SEM, we can analyse the relationship between latent variables and their indicators. This analysis is called model measurement analysis or outer model. In this study, the outer model equation is as follows.

(Eq. 1 - (Eq. 4 present the outer model equation of financial literacy, planning, satisfaction, and resilience, respectively.

$$X_1 = \lambda_{11}X_{11} + \lambda_{12}X_{12} + \lambda_{13}X_{13} + \lambda_{14}X_{14} + \lambda_{15}X_{15} + \varepsilon \quad \text{(Eq. 1)}$$

$$X_2 = \lambda_{21}X_{21} + \lambda_{22}X_{22} + \lambda_{23}X_{23} + \lambda_{24}X_{24} + \lambda_{25}X_{25} + \varepsilon \quad \text{(Eq. 2)}$$

$$Z = \lambda_1 Z_1 + \lambda_2 Z_2 + \lambda_3 Z_3 + \varepsilon \quad \text{(Eq. 3)}$$

$$Y = \lambda_1 Y_1 + \lambda_2 Y_2 + \varepsilon \quad \text{(Eq. 4)}$$

λ is the loading coefficient, and ε is the error terms.

In addition to the outer model, SEM also allows for studying relationships between latent variables called structural model analysis or inner model.

(Eq. 5 and (Eq. 6 present the structural model equation of financial resilience and satisfaction, respectively.

$$Y = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 Z + \alpha_4 Age + \alpha_5 Education + \alpha_6 Income + \omega \quad \text{(Eq. 5)}$$

$$Z = \alpha_7 X_1 + \alpha_8 X_2 + \omega \quad \text{(Eq. 6)}$$

α is the path coefficient, and ω is the structural errors.

(Eq. 5 and (Eq. 6 show that financial literacy and planning directly affect financial resilience and indirectly through the financial satisfaction as a mediating variable.

2.1.2 Reliability and Validity Test

Before applying the PLS-SEM model, it performs a construct's reliability and validity test. The indicators used to measure a construct must have internal consistency to provide stable and consistent results. The reliability measures are Composite Reliability (CR) and Cronbach's Alpha. The criteria used for the reliability of a construct are CR and Cronbach's Alpha values greater than 0.7. The indicators must also be able to measure the desired concept. Specifically, the validity measure is the Average Variance Extracted (AVE). The validity criterion is if the AVE is greater than 0.5.

2.2 Data Aand Source

The population is households whose income source is informal work in Indonesia. Using the purposing random sampling method, this study surveyed 178 respondents in 2024. The survey instrument was a questionnaire to measure financial literacy, planning, satisfaction, resilience and demographic variables.

Specifically, Table 1. presents the operational definition of the variables.

Table 1. Operational Definition of Variables

Symbol	*Variable*	*Indicator*	*Definition*
X_1	Financial Literacy	X_{11}	Knowledge of basic financial management such as budgeting, saving, and debt.
		X_{12}	Regular access to information on personal finance management.
		X_{13}	Awareness of the importance of having an emergency fund.
		X_{14}	Comparison of prices and quality before purchasing.
		X_{15}	Understanding the difference between needs and wants.
X_2	Financial Planning	X_{21}	Creation of a regular budget to manage income and expenses.
		X_{22}	Consistent allocation for savings.
		X_{23}	Establishment short-term and long-term financial goals.
		X_{24}	Timely debt management.
		X_{25}	Regular review of household financial conditions.
Z	Financial Satisfaction	Z_1	Stability and security of household finances in the past six months.
		Z_2	Confidence in handling unexpected changes in income.
		Z_3	Support from financial literacy and planning in managing financial risks.
Y	Financial Resilience	Y_1	Ability to handle unexpected expenses with current financial conditions.
		Y_2	Rare reliance on loans to meet daily needs.
Age	Age		Years
Education	Education Level		Years
Income	Income Level		Rupiah

3. EMPIRICAL RESULT AND DISCUSSION

The partial least square estimation of the structural equation model shows that all indicators can explain the construct variable. The outer loading values of each indicator are greater than 0.7, except for X_{11} and X_{24}. Although the value is lower than 0.7, the outer loading value is still acceptable in the case of this exploratory research.

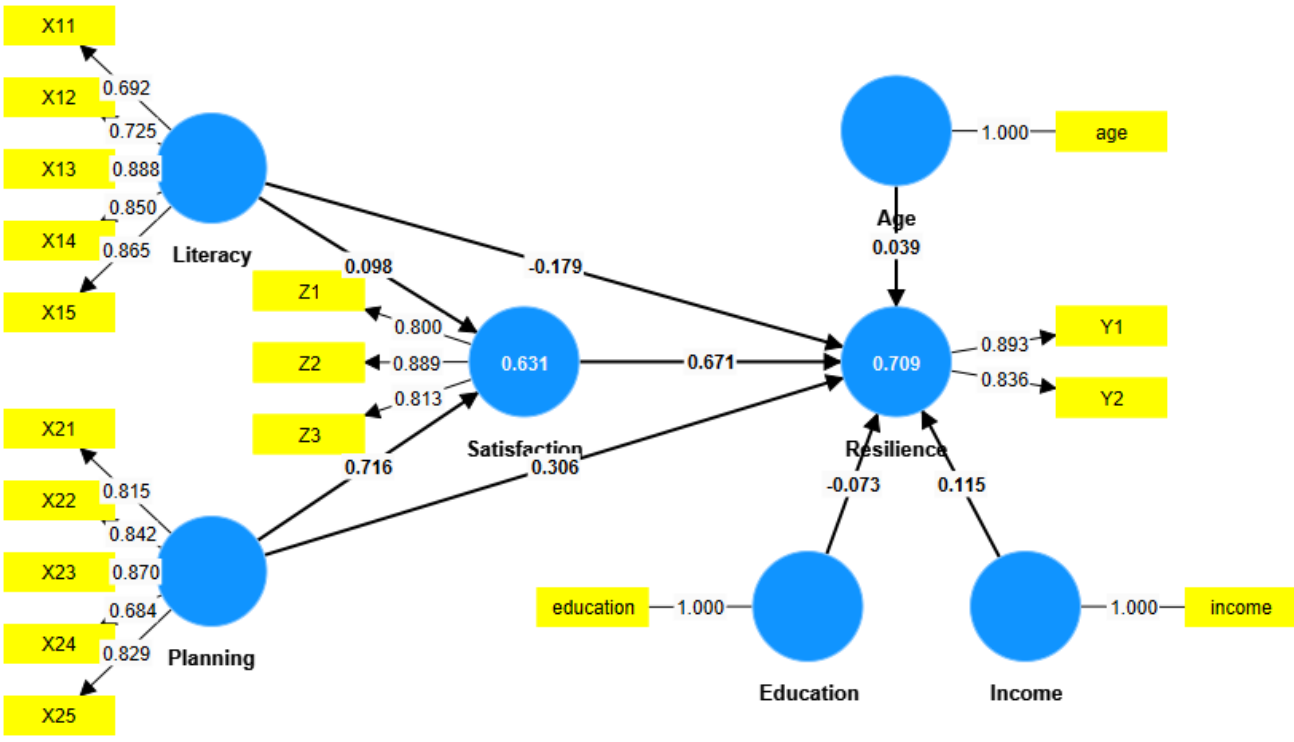

Figure 2. Estimation of Partial Least Square
Source: own

The strongest indicator explaining financial literacy is their awareness of the importance of emergency funds to anticipate unexpected events (X_{13}). In comparison, the strongest indicator of financial planning is clarity in setting short-term and long-term financial goals (X_{23}). Self-confidence in dealing with financial changes is the strongest indicator of financial satisfaction. Meanwhile, financial resilience is mainly explained by the indicator of the ability to cope with unexpected expenses with current financial conditions (Y_1).

The reliability and construct validity test results are presented in Table 2.. The reliability test result show that all variables of financial literacy, planning, satisfaction, and resilience are reliable. This Cronbach's Alphas are more than 0.7, except for the financial resilience variable. Meanwhile, the composite reliability criteria (rho_c) of all variables are greater than 0.7. Thus, all variables surely meet the reliability criteria. Meanwhile, The AVE show that all financial literacy, planning, resilience, and satisfaction variables have values above 0.5. Thus, all variables meet the validity criteria. All imply that the chosen model can be estimated using path analysis.

Table 2. Construct Reliability and Validity Test

Variables	*Cronbach's alpha*	*Composite reliability (rho_a)*	*Composite reliability (rho_c)*	*Average variance extracted (AVE)*
Literacy	0.865	0.881	0.903	0.653
Planning	0.868	0.879	0.905	0.657
Resilience	0.666	0.684	0.856	0.748
Satisfaction	0.782	0.787	0.873	0.697

Source: author's calculation

To test the path coefficient's statistical significance, PLS-SEM uses the bootstrapping technique. The estimation shows that financial planning indirectly affects the financial resilience of informal workers in Indonesia. On the other hand, the financial resilience is not affected by the financial literacy (Table 3).

Table 3. Total Indirect Effect

	Ori. sample	*Sample mean*	*Std. dev*	*T Stat.*	*P values*	*Note*
Literacy -> Resilience	0.066	0.067	0.049	1.335	0.182	Not Significant
Planning -> Resilience	0.480	0.482	0.076	6.283	0.000	Significant

Source: author's estimation

Table 4. presents the total effect of financial literacy, planning, satisfaction, and demographic control variables of income, age, and education on the financial resilience. The path coefficient of financial literacy to financial resilience is -0.179 indicating that financial literacy directly has a significant negative effect on financial resilience. Friedline and Kepple (2017) suggest that financial literacy is only sometimes articulated into effective financial behaviour, moreover, under the condition of lower informal worker's income. With inadequate income, the financial literacy does not lead to effective financial actions. The finding is also in line with the study of Bialowolski et al. (2022), where the role of financial literacy is asymmetrical where financial literacy plays only a more significant role in protecting older people from losing financial resilience than in increasing financial resilience. Another possible explanation is that people with financial literacy but not accompanied by good financial planning may take unwise financial risks.

Table 4. Total Effect

	Ori. sample	*Sample mean*	*Std. dev*	*T Stat.*	*P values*	*Note*
Literacy -> Resilience	-0.179	-0.179	0.059	3.032	0.002	Significant
Literacy -> Satisfaction	0.098	0.101	0.073	1.333	0.183	Not Significant
Planning -> Resilience	0.306	0.303	0.096	3.191	0.001	Significant
Planning -> Satisfaction	0.716	0.712	0.069	10.371	0.000	Significant
Satisfaction -> Resilience	0.671	0.675	0.075	9.004	0.000	Significant
Income -> Resilience	0.115	0.113	0.045	2.587	0.010	Significant
Age -> Resilience	0.039	0.038	0.039	0.978	0.328	Not Significant
Education -> Resilience	-0.073	-0.073	0.039	1.894	0.058	Not Significant

Source: author's estimation

Meanwhile, financial planning has a significant influence both directly and indirectly on financial resilience. The path coefficient of financial planning on financial resilience is 0.306, indicating that financial planning significantly increases financial resilience. Financial planning also has a considerable influence on financial satisfaction. People with sound financial planning are usually more confident in making responsible financial decisions (Ali et al., 2015). The path coefficient is very high, 0.716. Variations in financial planning and literacy can explain 63.1 percent of the variation in financial satisfaction of informal workers.

Furthermore, financial satisfaction also significantly affects financial resilience, with a path coefficient of 0.671. The financial satisfaction will increases resilience because they have a better ability to cope with shocks. In addition to financial literacy, planning, and satisfaction, several demographic control variables also significantly affect the level of financial resilience of informal worker households. Income level has a very significant influence on increasing financial resilience. The path coefficient of income level is 0.115. This finding supports the argument that sufficient income is a condition for effective financial literacy and planning to shape the economic resilience of informal workers.

Meanwhile, the level of education and age of informal workers have little effect on the level of financial resilience. Although education usually correlates to financial literacy and planning skills, limited financial resources have hindered the implementation of these skills. So, literacy and financial planning are not fully translated into financial resilience (Friedline and Kepple, 2017). Age also does not affect resilience. Empirical studies show that literacy and resilience are not correlated, especially in seniors over 50 (Bialowolski et al., 2022).

In terms of the model, the selected path model has good fit. As much as 70.9 percent of the variation in financial resilience can be explained by variations in financial literacy, planning, and satisfaction, as well as demographic variables. From this model, financial planning plays a more significant role than financial literacy in shaping the economic resilience of informal workers, with financial satisfaction as a mediating role.

CONCLUSION

Informal workers are more vulnerable to financial hardships threatening their economic resilience. The study concluded that they are financially resilient with sound financial planning. This skill can increase the financial resilience of informal workers both directly and indirectly. On the other hand, financial literacy does not contribute to shaping financial resilience under conditions of lower and unpredictable informal workers' income. This argument is supported by the significant effect of income level on financial resilience. Consistency in setting short-term and long-term financial goals is essential to financial planning. This consistency is expected to create budgeting, saving, and debt discipline.

From the study results above, the policy to shape the financial resilience of informal workers is improving financial planning skills and providing incentives for saving behavior to anticipate economic hardship. The government should develop more practical financial planning strategies suitable for the unique characteristics of informal workers. Although financial planning plays a more significant role than financial literacy, it does not mean that the two are mutually exclusive. Financial planning, literacy, and income have simultaneously increased financial resilience. Therefore, the government can encourage policies that raise the economic capacity of each household, such as providing greater access to affordable credit. In addition, it is necessary to develop a social security and protection system as the last safety net when they experience economic hardship, especially for the poorest.

ACKNOWLEDGEMENT:

Research funding from the Directorate of Research, Technology, and Community Service, Directorate General of Higher Education, Research, and Technology, Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia in 2024 under the Fundamental Grant - Regular scheme with contract number: 006/DirDPPM/70/DPPM/PFR-KEMDIKBUDRISTEK/VI/2024

REFERENCES

Aassouli, D., Ahmed, H. (2023), "Supporting SMEs financial resilience during crises: A framework to evaluate the effectiveness of financial literacy programs targeting SMEs", Malaysian Journal of Economic Studies, Vol. 60, No. 1, pp. 105–121. https://doi.org/10.3316/informit.172828087637247

Alhenawi, Y., Elkhal, K. (2013), "Financial Literacy of U.S. Households: Knowledge vs. Long-Term Financial Planning", Financial Services Review, Vol. 22, No. 3, pp. 211-244

Ali, A., Rahman, M.S.A., Bakar, A., (2015), "Financial Satisfaction and the Influence of Financial Literacy in Malaysia", Social Indicators Research: An International and Interdisciplinary Journal for Quality-of-Life Measurement, Vol. 120, No. 1, pp. 137-156. https://doi.org/10.1007/s11205-014-0583-0

Bialowolski, P., Cwynar, A., Weziak-Bialowolska, D. (2022), "The role of financial literacy for financial resilience in middle-age and older adulthood", International Journal of Bank Marketing, Vol. 40, No. 7, pp. 1718–1748. https://doi.org/10.1108/IJBM-10-2021-0453

Brounen, D., Koedijk, K.G., Pownall, R.A.J. (2016), "Household financial planning and savings behavior", J. Int. Money Finance, SI - Tribute Jim Lothian Vol. 69, pp. 95–107. https://doi.org/10.1016/j.jimonfin.2016.06.011

Cole, S., Sampson, T., Zia, B. (2011), "Prices or Knowledge? What Drives Demand for Financial Services in Emerging Markets?", The Journal of Finance, Vol. 66, No. 6, pp. 1933–1967. https://doi.org/10.1111/j.1540-6261.2011.01696.x

Erdem, D., Rojahn, J. (2022), "The influence of financial literacy on financial resilience – New evidence from Europe during the COVID-19 crisis", Managerial Finance Vol. 48, No. 9/10, pp. 1453–1471. https://doi.org/10.1108/MF-09-2021-0442

French, D., McKillop, D. (2016), "Financial literacy and over-indebtedness in low-income households", International Review of Financial Analysis, Vol. 48, pp. 1–11. https://doi.org/10.1016/j.irfa.2016.08.004

Friedline, T., Kepple, N. (2017), "Does Community Access to Alternative Financial Services Relate to Individuals' Use of These Services? Beyond Individual Explanations", Journal of Consumer Policy, Vol. 40, No. 1, pp. 51–79. https://doi.org/10.1007/s10603-016-9331-y

Hamid, F.S., Loke, Y.J., Chin, P.N. (2023), "Determinants of financial resilience: insights from an emerging economy", Journal of Social and Economic Development, Vol. 25, No. 2, pp. 479–499. https://doi.org/10.1007/s40847-023-00239-y

Hassan, E.I., Kassim, Mohd Hassan, N., Kassim, E., Ma'on, S. (2018), "Factors Influencing Individual Financial Resilience in facing Economic Crisis: Does Financial Literacy really help?", International Journal of Academic Research in Business and Social Sciences, Vol. 8, No. 11, pp. 1613–1623. https://doi.org/10.6007/IJARBSS/v8-i11/5284

Huang, J., Nam, Y., Lee, E.J. (2015), "Financial capability and economic hardship among low-income older Asian immigrants in a supported employment program", Journal of Family and Economic Issues, Vol. 36, No. 2, pp. 239–250. https://doi.org/10.1007/s10834-014-9398-z

Khan, F., Siddiqui, M.A., Imtiaz, S. (2022), "Role of financial literacy in achieving financial inclusion: A review, synthesis and research agenda", Cogent Business and Management, Vol. 9, No. 1, pp. 2034236. https://doi.org/10.1080/23311975.2022.2034236

Klapper, L., Lusardi, A. (2020), "Financial literacy and financial resilience: Evidence from around the world", Financial Management, Vol. 49, No. 3, pp. 589–614. https://doi.org/10.1111/fima.12283

Leonard, M. (2000), "Coping strategies in developed and developing societies: the workings of the informal economy", Journal of International Development, Vol. 12, No. 8, pp. 1069–1085. https://doi.org/10.1002/jid.696

Lowe, P. (2017), "Household debt, housing prices and resilience", Economic Analysis and Policy, Vol. 55, pp. 124–131. https://doi.org/10.1016/j.eap.2017.05.007

McKnight, A., Rucci, M. (2020), "The financial resilience of households: 22 country study with new estimates, breakdowns by household characteristics and a review of policy options", URL https://sticerd.lse.ac.uk/CASE/_new/publications/ (accessed 9.22.24).

Owusu, G.M.Y. (2021), "Predictors of financial satisfaction and its impact on psychological wellbeing of individuals", Journal of Humanities and Applied Social Sciences, Vol. 5, No. 1, pp. 59–76. https://doi.org/10.1108/JHASS-05-2021-0101

Salignac, F., Marjolin, A., Reeve, R., Muir, K. (2019), "Conceptualizing and Measuring Financial Resilience: A Multidimensional Framework", Social Indicators Research, Vol. 145, No. 1, pp. 17–38. https://doi.org/10.1007/s11205-019-02100-4

Santoso, R., Sriyana, J. (2021), "The Effect of Idiosyncratic Shocks on Labor Market Outcomes of Informal Households in Indonesia", Jurnal Ekonomi Malaysia, Vol. 54, No. 2, pp. 13–27.

Setyorini, N., Indiworo, R.H.E., Sutrisno, S. (2021), "The Role Financial Literacy and Financial Planning to Increase Financial Resilience: Household Behaviour as Mediating Variable", Media Ekonomi dan Manajemen, Vol. 36, No. 2, pp. 243–255. https://doi.org/10.24856/mem.v36i2.2179

Strömbäck, C., Lind, T., Skagerlund, K., Västfjäll, D., Tinghög, G. (2017), "Does self-control predict financial behavior and financial well-being?", Journal of Behavioral and Experimental Finance, Vol. 14, pp. 30–38. https://doi.org/10.1016/j.jbef.2017.04.002

Suryahadi, A., Al Izzati, R., Yumna, A. (2021), "The Impact of Covid-19 and Social Protection Programs on Poverty in Indonesia", Bulletin of Indonesian Economic Studies, Vol. 57, No. 3, pp. 267–296. https://doi.org/10.1080/00074918.2021.2005519

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Fazekas, B., Becsky-Nagy, P. (2026), "Where is the EXIT? – The Exit Characteristics of Venture Capital Through the Case of Hungarian JEREMIE Investments", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 43-54.

Where is the EXIT? – The Exit Characteristics of Venture Capital Through the Case of Hungarian JEREMIE Investments

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ARTICLE INFO

Received November 01, 2024
Revised from December, 02, 2024
Accepted 20, January 02, 2025
Available online April 15, 2026

JEL classification: G18, G24, G32

DOI: 10.14254/1800-5845/2026.22-2.4

Keywords:

Venture capital;
exit;
government support;
developing markets

ABSTRACT

For developing markets, including those in the Central and Eastern European region, the available data on the venture capital sector at the investment level are rather limited. While surveys on investment activity and capital outflows are becoming more comprehensive, the study of firm-level effects, in particular exits, is considered a major research gap. Using one of the most active venture capital markets' example in the region, this paper examines the exit characteristics of firms in the region by exit type, as well as the main financial characteristics that influence each exit method. Our analysis is based on a unique hand collected dataset covering the entire population of the Hungarian JEREMIE investments including the data from 340 companies that received funding between 2010 and 2016. The approach includes a detailed assessment of key financial metrics, such as revenue growth, to understand their impact on exit events. Firms are classified into three categories based on exit mode, which are sale to 3rd party, manager buy-back and failed exit. Logit models were used to examine the factors influencing each exit mode. Our results show that among the financial characteristics, rapid revenue growth is considered to be the most important success factor, while financial characteristics can explain exit types only to a small extent. Due to the significant regional state involvement, the characteristics of exit types do not necessarily coincide with the exit patterns of traditional market-based investments despite of the hybrid investment strategy. The study addresses a significant research gap concerning firm-level effects, particularly exits, in the venture capital sector of the Central and Eastern European region. Due to significant state involvement, the characteristics of exit types do not necessarily align with those of traditional market-based investments. This discrepancy underscores the differences inherent in hybrid investment strategies and emphasizes the unique economic context of the region.

INTRODUCTION

The European venture capital market is still lag behind the US market (Karpa and Grginovic, 2019), and the industry in the Central and Eastern European region is underdeveloped compared to developed countries and faces significant new challenges due to the increase in regional risks (Karsai, 2022). The

importance of the topic is heightened by the fact that many countries in the region have faced the problem of the middle-income trap in the process of economic convergence. One of the ways to overcome this is to create an ecosystem that supports the development of high value-added enterprises, of which the venture capital sector is an integral part. Overcoming the financing constraints of these firms can contribute to higher innovation performance (Khalid et al., 2023; Bontempi et al., 2024; Juskaite et al., 2024).

In recent years, venture capital research has increasingly relied upon extensive databases. While in advanced sectors, the processes ranging from resource acquisition, investments, and their impacts on company performance to exits are well-mapped areas. On the other hand, the available data in developing markets, including the countries of the Central and Eastern European region, is notably limited. Zinecker et al. (2021) highlighted that more focused data gathering is required to enhance the development of the financing of the startup entrepreneurial system. This holds particularly true for in-depth analyses of exits from ventures on larger samples.

The present study aims to address the gap existing in the context of venture capital exits. Specifically, when exits occur outside the public market, the characteristics of equity sales are considered confidential data. Consequently, the analysis of exits has long been an uncharted territory, even in international markets, especially when conducted through non-public market mechanisms. This gap has been partially alleviated by international organizations relying on voluntary disclosure-based databases. However, these analyses primarily pertain to more developed markets. In the case of developing markets, such as the Central and Eastern European region, the examination of exits has predominantly been conducted through case studies and individual instances. While studies in Hungary's venture capital market have presented exits through case studies, a comprehensive analysis of exits on a large sample has not been undertaken previously. This study seeks to narrow this research gap through the analysis of JEREMIE investments' exits. JEREMIE venture capital programme had a significant role in the regions' venture capital market, as it was introduced in many countries besides Hungary.

The analysis of exits is done through the identification of the type of exits. While actual returns on exits from JEREMIE investments are not available due to the confidential nature of the data, the types of exits can be indirectly identified through an examination of the composition of the ownership structure. Accordingly, 3 different types of exits have been distinguished, namely sale to third parties, managerial buyout (MBO) and write-off as a loss. While in general IPOs are considered to be the most successful exits, in the framework of JEREMIE in Hungary there was no exit via stock exchange initiation. Our aim is to assess the success of investments through the types of exits and to isolate the characteristics that emerge for each type of exit, with a particular focus on the financial characteristics of the investee companies. Firm level anaylsis is especially important, as the factors influencing aggregate and firm-level exit patterns are different (Frimpong et al., 2024). In the field of exit evaluation, the results of this research can be considered as a gap in the venture capital market of the Central and Eastern Europe region. Institutions, public policy and culture shaping the entrepreneurial context and this relationship can be reversed, as entrepreneurship can influence these factors (Audretsch, 2023). In this sense the findings of this study may contribute to a deeper understanding of the regional venture capital market and facilitate more effective planning of future programs. From a research perspective, the findings can provide a basis for comparison in further studies. From a policy point of view the results can contribute to the more efficient design of private and government backed sovereign funds (Teti et al., 2024).

1. LITERATURE REVIEW

Hungarian venture capital market has been active since the 1990s but has seen negligible activity. The JEREMIE venture capital programme, which was launched in the 2010s, was a significant stimulus for the Hungarian venture capital market, with around 340 companies receiving funding from 28 venture capital funds. While prior the programme the Hungarian venture capital market was characterised by scarce supply, a low number of deals and a concentrated investor base, after JEREMIE the oversupply of capital led to a high number of deals and a wider range of intermediaries providing venture capital type investments. At the same time, the role of public funding in the sector has increased significantly. Accordingly, the programme has attracted a lot of attention, but the less transparent nature of venture capital has

hampered the development of a comprehensive and reliable picture, as the publicly available data is very limited.

Initially, Hungarian research presented the programme primarily through capital disbursement, mainly highlighting the problems of capital transfers and the purpose of the use of funds. Kállay and Jáki (2019) investigated the impact of Hungarian venture capital investments on firms based on limited data and a narrow set of indicators. More detailed studies on the impact on enterprises that received funding have been published only later, mainly examining the impact of investments on firm growth, sales and employment through a comparison of different types of public backed venture capital investors (Becsky-Nagy-Fazekas, 2023). The conclusion of these studies is that, although the JEREMIE venture capital programme has played an important catalytic role, it contributes indirectly to the development of the venture capital sector. However, in terms of direct impact, on average, it has not been able to have a significant positive impact on the investee companies in terms of either employment or growth. This was enhanced by the extensive moral hazard problems and the two-goal system of the hybrid scheme of JEREMIE funds, where the economic policy goals and private interests were in conflict (Fazekas and Becsky-Nagy, 2021). Karsai (2021) synthesized international experiences and concluded that public involvement can be an effective financing instrument in the venture capital market by building on cooperation with market actors. However, it should be stressed that in the cooperation between market and state actors, economic development and yield maximisation objectives may lead to conflicts of interest and increasing moral hazard, which may reduce the efficiency of the financing scheme (Fazekas and Becsky-Nagy, 2021). Karsai (2022) points out that the emergence of rent seeking behaviour due to state subsidies may reduce the competitiveness of startups and thus the market efficiency of the venture capital sector, which may also reduce the possibility of exits, especially in the light of increasing risks in the region. Based on a systematic literature review, Jáki and Molnár (2021) find that the primary success criterion for public venture capital investments is not the exit return. This type of investment also has economic development objectives.

There are 5 typical ways to exit risk capital, namely: initial public offering (IPO), strategic sale to a third party, managerial buy-out by a co-owner (MBO), buy-out by a financial intermediary and write-off as a loss. Among these exit routes, IPOs and strategic sales to third parties have traditionally been considered successful exit routes, while the financial return of the other exit types are usually lower.

Schweinbacher (2002) finds that IPOs have more distinguishable characteristics, while strategic sales do not have significant distinguishing investment characteristics, as they can be considered 'average' investments. Cumming (2008) highlights the characteristic of takeovers, based on a sample of European investments. His findings suggests that investors gain more control in takeovers than in write-offs or IPOs. Grežo (2024) highlights the importance of entrepreneurial experience in the venture performance. Félix et al. (2012) also highlight the impact of contractual clauses on exits in a European sample and the role of investor background. Their results show that exit takes longer for investors with a financial background, especially for strategic sales. Guo et al. (2015) find that the investment duration of venture capital with a corporate backing is longer than that of independent fund managers. Their results show that longer investment duration increases the probability of a firm being acquired, while larger investments are more likely to lead to an IPO. Cumming and Johan (2008a) find that investors are more likely to use contractual clauses with higher control than veto rights or convertible securities in the case of planned exits. Focusing on information asymmetries, Cumming and Johan (2008b) highlight that the more venture capitalists are able to reduce information asymmetries with potential investors, the more likely they are to exit their investments successfully.

Regarding the performance of venture capital invested firms, studies agree that firms with a venture capital background are able to achieve higher growth in turnover compared to other similar firms (Chemmanur et al. 2011; Puri and Zarutskie, 2012; Dankiewicz et al., 2022). In terms of employment, Lerner (1999) and Cowling et al. (2009) confirmed the positive impact of venture capital. In addition, one of the most important features of traditional venture capital is its positive impact on innovation performance (Kortum and Lerner, 1998; Olah et al., 2021).

In line with international evidence, we have used financial indicators of business growth to explain the differences between the different types of exits. Accordingly, company revenues, income, assets and employment are highlighted. In addition, the role of innovation was also examined, building on the specific

characteristics of venture capital. The next section describes the database and methodology of the research.

2. DATA AND METHODOLOGY

The present research is a continuation of previous research that analysed the Hungarian venture capital market through the performance of companies that received investments under the JEREMIE programme. Previous studies investigated the use of capital with regards to the geographic and industrial focus, the model of hybrid financing and the impact of investments on firm growth and innovation performance (Becsky-Nagy and Fazekas, 2023). Using this updated database, we analyse the exit patterns of JEREMIE backed venture capital investments in Hungary.

The dataset on which the study is based includes around 340 companies that received venture capital investments through JEREMIE funds between 2010 and 2016. The investments were identified through company registry database and investor disclosures; thus we identified the full set of investee companies. The data set containing the financial data of the enterprises under investigation was updated annually on the basis of the annual financial reports (Tamini and Orbán, 2022).

We identified failed investments and write-offs in cases where the company was in bankruptcy, liquidation, winding-up or compulsory liquidation according to the Hungarian Company Register. We classified exits as MBOs, where the venture capitalist sold their ownership stakes in the company and after the sale there was no new stakeholder in the ownership structure of the invested firm, but the sold equity was acquired by parties with a previous ownership interest in the company. Investments where the venture capitalist sold their shares of the enterprise with a new owner taking their place in the ownership structure are classified as third-party sales. The ownership data for MBOs and third-party sales were determined on the basis of the company register and the annual financial reports of the invested enterprises.

The data set including financial and ownership data is structured as shown in Table 1.

Table 1. Data set of enterprises that have received venture capital investments with JEREMIE backing in Hungary in 2010-2016

Name of the variable	*Description of the Variable*
name	Name of the invested enterprise.
investmentyear	Year, when the enterprise received venture capital funding. (range: 2010-2016)
exityear	Year, when the venture capitalist exited the enterprise. (range: 2012-2022)
term	Length of the investment in years.
bankrupt	Dummy variable. 1, if the investment failed, 0 if not.
MBO	Dummy variable. 1, if the venture capitalist's ownership stake was sold to a co-owner, 0 if not.
tradesale	Dummy variable. 1, if the venture capitalist's ownership stake was sold to a third-party previously not present among the owners, 0 if not.
age	The age of the enterprise at the time of the investment.
revenues	The total annual revenue of the enterprise in thousand HUF.
assets	The total assets of the enterprise in thousand HUF.
ebt	The annual earnings before taxes of the enterprise in thousand HUF.
employment	The number of employees of the enterprise.
haspatent	Dummy variable. 1 if the invested enterprise has a patent application, 0 if not.
ownership	Ownership stake in the business acquired by the venture capitalist.
Δrevenues	The difference between annual revenue in the year of exit and the year of investment (turnover at exit - turnover at investment).
Δassets	Difference between the value of total assets in the year of exit and the year of investment (total assets at exit - total assets at investment).
Δebt	Difference between the earnings before taxes in the year of exit and the year of investment (total EBT at exit - total EBT at investment).
Δemployment	Difference between the number of employees in the year of exit and the year of investment (total employees at exit - total employees at investment).

industry variables	Dummy variables. Their value is 1 if the activity of the enterprise is classified in the industry. The sectoral classification is consistent with the Hungarian Statistical Office's classification according to the TEÁOR number of the main activity.

Source: Authors' compilation

The research question is whether the expected mode of exit can be predicted based on certain financial characteristics. This is an indirect way of investigating what critical financial criteria a successful exit firm must meet and what characteristics might predict a failed investment.

To answer the research question, we use a binary logit model in which the dependent variable is a dummy variable denoting the exit mode, while the explanatory variables are the main financial indicators of the firms, as well as venture capital-specific indicators such as the ownership share acquired by the venture capitalist and the innovative nature of the firm as measured by patent activity. Accordingly, 3 models have been developed according to the 3 different exit modes, where the dependent variables are the dummy variables for the different exit methods. The models are specified as follows:

$$logit(exit) = \beta_0 + \beta_1 \Delta revenues + \beta_2 \Delta employment + \beta_3 \Delta assets + \beta_4 \Delta ebt + \beta_5 haspatent + \beta_6 lnownership + \beta_7 lnage + \beta_8 lnrevenues + \beta_9 lncapital + \varepsilon_i \quad (1)$$

The financial variables explaining exits are designed to capture the growth of the firm, so the change between the value of sales (*Δrevenue*s), number of employees (*Δemployee*s), total assets (*Δasset*s) and earnings before tax (*Δebt*) at the time of investment and at the time of exit are included as explanatory variables. The logarithm of the age of the firm (*lnage*), its total annual revenues (*lnrevenue*s*)* and the ownership stake acquired by the venture capitalist (*lnownership*) for the year of investment is incorporated in the model. Finally, assuming a significant role for innovation, the variable *haspatent* was included in the model.

The major financial indicators of the model describe the growth of companies during the investment period by the difference between the first and last year of investment. In order to eliminate the variation due to the different investment duration, the impact of the annual average value of the above financial ratios on exits was also examined, and the model was specified as follows:

$$logit(exit) = \beta_0 + \beta_1 \Delta annualrevenues + \beta_2 \Delta annualemployment + \beta_3 \Delta annualassets + \beta_4 \Delta annualebt + \beta_5 haspatent + \beta_6 lnownership + \beta_7 lnage + \beta_8 lnrevenues + \beta_9 lncapital + \varepsilon_i$$

3. RESULTS AND DISCUSSION

The surge in venture capital investment in the first half of 2010 in Hungary was largely due to the fact that JEREMIE funds were under a resource allocation constraint, as they committed to allocate 80% of their capital to portfolio companies. The increase in market-based investment would most likely be in response to the widening financing gap created by the demand-side boom, but this could be tempered by artificial supply-side push by the state. Consequently, it could not be concluded from the increase in investment activity that the venture capital sector, and within it the demand side of the market, has developed at the same pace as the increase in investment activity. Exits can be seen as the primary measure of investment success. Figure 1 illustrates the evolution of exits over time, broken down by the three exit modes.

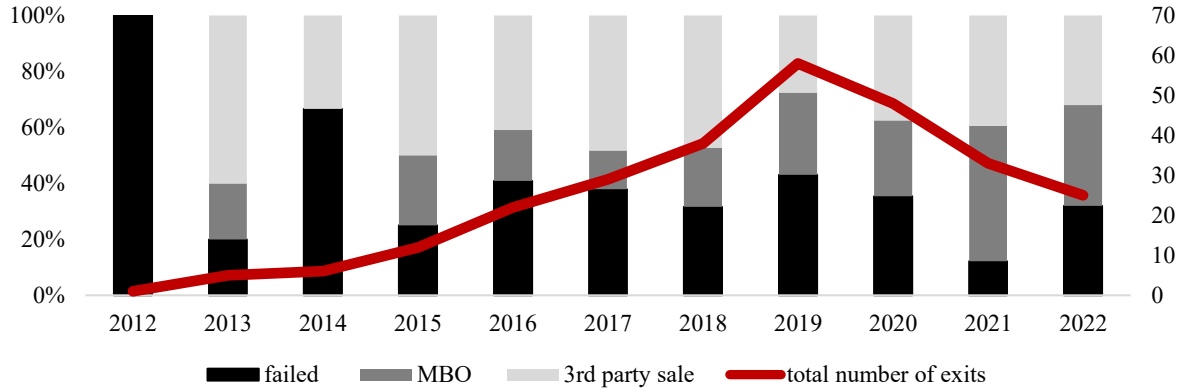

Figure 1. Evolution of exits from venture capital investments made by Hungarian JEREMIE funds between 2010 and 2016 by type of exit between 2012 and 2022
Source: Authors' compilation

The average maturity of the investments exiting the market was between 4 to 5 years. While the period of 2014-16 was the most dominant in terms of investment activity, the period of 2018-2020 was the most active in terms of the year of exits. In total, nearly 280 exits took place in the given years under review, with around 60 enterprises having not yet exited at the end of the investigated timeframe. The period of slowdown due to the COVID-19 epidemic also made it difficult to sell investments that were still in active status. However, international experience suggests that the lengthening of the investment period reduces the chances of a successful exit, so that these investments are likely to be written off as losses.

Table 2 illustrates the course of the main financial indicators and the number of employees of the exited firms in the first year of investment and in the year of exit. There is no clear difference in the number of employees between the two events. Depending on the type of exit, it can be observed that the invested enterprises had a low number of employees throughout the whole period of the investment. Even in the case of a successful exit, the average number of employees was below 10, while the median number of employees was 2, suggesting a more skewed distribution of enterprises in terms of the number of employees, with a few larger employers and a majority of firms with a minimum number of employees.

In terms of total revenues, there were larger variations for unsuccessful exits and for sales to co-owners and third parties. Unsuccessful exits also had lower revenues at the time of entry, and on average had lower turnover at the time of exit. This indicates that one of the main reasons for the failure of unsuccessful investments is their inability to successfully enter the market and generate significant revenues. In contrast, in the case of investments that resulted in tradesales, companies were able to quintuple their sales revenue on average. However, it should be noted that the distributions are strongly skewed to the left, i.e. the majority of companies had relatively lower sales, while some companies had high sales, which shifts the average upwards. The distribution of enterprises by total assets shows similar characteristics. While both average and median asset values increased for investments where ownership stakes were sold, unsuccessful investments show a loss of assets by median values. Although the average total asset value has also increased for unsuccessful investments, this is mainly due to the fact that the distribution is highly skewed to the left and thus the average cannot be considered a typical central value.

The final financial characteristic examined is the profit of the enterprises at the level of earnings before taxes. Based on the averages, no differences of magnitude can be observed in this respect by type of exit. It is worth noting, however, that the majority of enterprises are unprofitable even if co-owners or third parties outside the enterprise are willing to buy out the venture capitalists' share. Based on this we might conclude, that profitability should not be considered as a major condition for successful exit for early-stage investments. Given the characteristics of the businesses concerned, this is not surprising, as the increase in capacity following investment is accompanied by an increase in costs (e.g. depreciation and amortization), which can only be followed later by an increase in revenues, assuming successful market entry.

Table 2. Descriptive statistics of the number of employees (number of persons), turnover (thousand HUF), total assets (thousand HUF), earnings before taxes of the exited enterprises in the year of investment and exit

Number of employees						
	Third-party sale		*MBO*		*Failed exits*	
	investment year	*exit year*	*investment year*	*exit year*	*investment year*	*exit year*
n	104	93	73	69	91	81
mean	3.44	9.33	2.81	6.49	2.19	2.66
standard deviation	6.63	15.14	4.44	11.02	3.44	5.41
median	1	2	1	1	1	1
skewness	3.38	2.28	2.73	2.80	2.53	3.35
Total revenues (thousand HUF)						
n	105	93	76	68	95	83
mean	44 616	228 020	32 284	180 714	24 484	22 120
standard deviation	122 664	453 247	85 169	406 413	77 363	63 601
median	0	10 623	678	26 693	0	895
skewness	4.19	3.07	3.67	3.92	4.60	4.92
Total assets (thousand HUF)						
n	105	93	76	69	94	83
mean	306 800	580 214	222 364	499 262	182 961	358 128
standard deviation	304 962	915 965	247 642	865 364	255 139	2 167 372
median	250 314	298 505	123 168	163 722	50 945	44 896
skewness	2.07	4.16	1.57	3.73	2.22	8.82
Earnings before taxes (thousand HUF)						
n	105	93	75	69	95	83
mean	-19 909	-15 648	-22 895	-37 914	-20 699	-57 834
standard deviation	49 938	520 270	38 641	122 384	50 377	142 848
median	-5 979	-17 281	-13 714	-3 197	-6 614	-11 101
skewness	-1.63	7.19	-1.28	-1.68	-5.64	-4.75
Duration of investment (years)						
n	104		75		94	
mean	4.69		5.37		4.18	
standard deviation	2.28		2.30		2.14	
median	5		5		4	
skewness	0.55		0.24		0.52	

Source: Authors' compilation

In the following, the results of logistic regression models are presented to investigate the factors influencing the exit outcomes. Table 3 presents the models where the difference between the investment and exit values for the financial indicators is used to explain the type of exit; in Table 4, on the other hand, the annual average change in the financial indicators is included in the models among the explanatory variables.

It should be noted that the explanatory power of the models for the type of exit is rather low. This suggests that financial indicators of firms cannot capture the success of exits from early-stage investments. Neither for sales to third parties nor for managerial buyouts by co-owners does the model have significant explanatory power, and the financial indicators are not significant. Only in the case of unsuccessful exits was a financial variable significant in the model, where the change in total revenues was significant in the model with a negative coefficient. This suggests that the main financial characteristic of unsuccessful investments is their inability to increase their sales revenues. In contrast, the change in the value of the company's assets and earnings before tax did not turn out to be significant. This is in line with the characteristics of this specific group of enterprises, which show that young enterprises predominantly accumulate losses in the initial stages of their operations in the search for and development of a sustainable business model. In the 'valley of death' stage, sales are the only way out toward a successful business model, and in their absence the company cannot sustain its operations.

For the non-financial variables, we have assumed that the effect of innovation performance as evidenced by patent activity is significant, but the results suggest that this assumption should be rejected. The logit models suggest that innovation activity did not have a significant role in any exit mode. It did not reduce the probability of bankruptcy but did not significantly increase the probability of successful exit.

Among the non-financial variables, ownership by venture capitalists played a significant role, with a negative coefficient for MBOs and a positive coefficient for sales to third parties. For MBO, the result is consistent with prior expectations, as a significant ownership stake in the firm reduces the chance of a buy-back by a co-owner. If the founders' objective is to run the business on a long run, they are less likely to be willing to transfer a significant ownership stake in the investment. In contrast, the positive coefficient observed in the case of a sale to a third party suggests that a higher ownership stake acquired by venture capitalists increases the likelihood of a sale, which is contrary to prior expectations that an increase in the ownership stake transferred indicates moderate business potential. The explanation for the empirical result, which contradicts theoretical expectations, is that the sale of JEREMIE venture capital investments to third parties was not always consistent with the sale of the business to strategic investors in case of market-oriented private backed venture capital investments. Exits were observed where venture capitalists sold their stakes to actors who were not independent of the investors, and the proportion of these sales was higher for companies where the venture capitalist had a significant qualifying majority stake.

Table 3. Results of logit models explaining exits from JEREMIE venture capital investments in Hungary between 2010 and 2016 (financial variables measure the total change between the values at the time of investment and exit)

	Logit		
Dependent variables	*third-party sale*	*MBO*	*failed*
Δrevenues	2.88e-07	1.79e-07	-6.66e-06***
	[3.91e-07]	[4.01e-07]	[2.11e-06]
Δemployment	0.020	-0.003	-0.012
	[0.017]	[0.014]	[0.022]
Δasset	-7.13e-08	-1.58e-11	1.19e-07
	[9.66e-08]	7.98e-08	[8.91e-08]
Δebt	4.15e-07	-2.21e-07	-1.32e-06
	[3.30e-07]	[2.98e-07]	[1.01e-06]
haspatent	0.294	-0.549	-0.153
	[0.464]	[0.595]	[0.561]
lnownership	0.600**	-0.560**	0.004
	[0.247]	[0.221]	[0.206]
lnrevenues	-0.020	0.011	-0.006
	[0.029]	[0.031]	[0.032]
lncapital	0.043	0.054	-0.047
	[0.032]	[0.038]	[0.031]
lnage	0.286	0.317	-0.878**
	[0.270]	[0.290]	[0.374]
constant	-0.933**	-2.310***	-0.040

	[0.389]	[0.463]	[0.361]
number of observations	334	334	334
Pseudo R^2	0.0394	0.0377	0.1168

Note: ***, **, * denote significance at 1%, 5% and 10% respectively. The table presents the coefficients and their robust standard errors in brackets.
Source: Authors' compilation

Measuring the change in financial indicators on an annual basis, the models lead to similar results, but the role of some variables becomes significant. The change in the role of financial indicators over the annual and full investment period is due to the different investment duration between each exit and the still active investment. For market-backed investments, there is an inverse proportionality between the duration of the investment and the success of the investment, i.e. the duration of the most successful investments is on average lower than the holding period observed for other investments.

Table 4. Results of logit models explaining exits from JEREMIE venture capital investments in Hungary between 2010 and 2016 (financial variables measure the average annual change between the values at the time of investment and exit)

	Logit		
Dependent variables	*tradesale*	*MBO*	*failed*
Δannualrevenues	5.54e-06**	-4.16e-07	-2.30e-05**
	[2.38e-06]	[2.54e-06]	[1.15e-05]
Δannualemployment	0.587	0.001	-0.070
	[0.064]	[0.066]	[0.082]
Δannualasset	-4.11e-07	5.66e-08	3.39e-07
	[5.11e-07]	[4.06e-07]	[5.13e-07]
Δannualebt	2.71e-06**	-1.21e-06	-1.14e-05**
	[1.25e-06	[9.74e-07]	[5.39e-06]
haspatent	0.258	-0.525	-0.240
	[0.463]	[0.588]	[0.551]
lnownership	0.635**	-0.562**	-0.023
	[0.255]	[0.220]	[0.205]
lnrevenues	-0.022	0.012	-0.008
	[0.028]	[0.031]	[0.030]
lncapital	0.043	0.054	-0.050*
	[0.033]	[0.039]	[0.030]
lnage	0.271	0.318	-0.828**
	[0.273]	[0.288]	[0.374]
constant	-0.956**	-2.294***	-0.079
	[0.393]	[0.464]	[0.354]
Number of observations	334	334	334
Pseudo R^2	0.0552	0.0383	0.0996

Note: ***, **, * denote significance at 1%, 5% and 10% respectively. The table presents the coefficients and their robust standard errors in brackets.
Source: Authors' compilation

The change in financial indicators on an annual basis confirms the result of the previous specifications that an increase in revenues reduces the probability of failure. In other words, the main reason for failure is insufficient sales and thus low turnover. Although the sign of a change in the level of pre-tax profit measured on both time bases was negative, i.e. an increase in income reduced the chances of failure, the indicator only had a significant role for changes on an annual basis. These results suggest that the rapid accumulation of losses led to bankruptcy or negative exit events for venture capital investee firms. This is in line with the 'grow fast or die trying' attitude prevalent in venture capital investments, i.e., given the higher cost opportunity of growing fast, if the firm is unable to achieve significant revenue growth, investors exit the firm, perceived as a failed investment.

The above argument is consistent with the significant role of the increase in revenues on an annual basis in the case of sales to third parties. In the models specified in Table 4, the increase in annual revenues was found to be significant for exits with sales to third parties. Based on the positive coefficient of the variable, it can be concluded that the rapid rate of sales growth significantly improved the probability of exiting via a sale to a third-party. The result confirms the international evidence that venture capitalists primarily seek opportunities for rapid growth in their portfolio companies. At the same time, the annual increase in earnings also increases the likelihood of exiting through sales.

When examining the role of the variables that are significant in terms of exits, we see that the same variables, profitability and sales growth, played a significant role, but they have a different coefficient. They impact differently the probabilities of the two exit types

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CONCLUSION

Venture capital can be a means of financing high value-added businesses that can be a major driver of economic development. This has led to a number of initiatives at national and EU level to develop the sector, including in the Central and Eastern European region. Venture capital may be one significant element to overcome the problem of the middle-income trap that is emerging during the convergence process in many countries in the region.

One way to address this issue was the hybrid venture capital schemes in the region under the JEREMIE programme, which allowed market investors to invest a combination of private and public funds in the targeted young and innovative companies. Among JEREMIE investments, the Hungarian market has been particularly active at regional level. In our study, we analysed the performance of the sector by looking at the exits of JEREMIE-backed venture capital investments in Hungary. In parallel, we examined the factors that increase the likelihood of different exit routes from the business.

The research gap that we targeted with our study was that an analysis of the regional venture capital market based on extensive, large sample data collection of exits, that has not been done before. From this perspective, the results of our research could provide a basis for future studies besides giving a better understanding of the regional market.

In the course of our research, we analysed around 340 investments in hybrid structures in Hungary, of which we were able to identify 277 exits. When evaluating the exits, we were unable to determine the financial returns due to the confidential nature of the data, and we inferred the performance of the exits based on the type of the exit. In this sense we separated 3 different exit methods: sale to a third party previously not present among the owners, MBOs where ownership stakes were sold to previous co-owners, and failed investments where the invested firm went bankrupt, were liquidated or was written-off as loss. As venture capital funds have committed to investing the capital entrusted to them, the artificially enhanced investment activity has not been a faithful reflection of market developments, but the exits give a more realistic picture.

The results show that there are no sharp dividing lines between investee firms according to the exit route through which investors sold their ownership stakes. A general characteristic of investments, regardless of exit type, is that on average they did not experience significant growth, whether we look at the dimensions of employment, turnover, income or asset value. However, there were strongly left-skewed distributions for each indicator, suggesting that the best performing investments were able to achieve outstanding returns, although this was not the case for investments in general. This strengthens the conclusion that in emerging, relatively underdeveloped sectors, supply and demand-side challenges are present together. This is attributed to the insufficient number of commercially prospective ventures capable of successfully leveraging the increased capital.

According to the logit models, financial indicators based on annual growth rates were identified, significantly influencing the likelihood of various exit methods. Nevertheless, even with the financial indicators, the models depicting exit modes exhibited relatively low explanatory power. This suggests that the exit paths of young, innovative ventures are far from being solely determined by their financial characteristics.

On the other hand, the reason for the low explanatory power of financial indicators may also lie in the fact that business considerations did not always play the most important role behind the exits. Consequently, financial characteristics could not be consistently aligned with the traditional features of exits. Practical manifestations of this include cases where the sale of equity acquired in the venture occurs towards a party not entirely independent of the investors.

Among the financial indicators, the revenue of the ventures played a significant role. As anticipated, the growth in revenue increases the likelihood of successful third-party sales of equity while reducing the occurrence of negative exit events. The role of the earnings before taxes of invested firms had a similar role. The growth of employment and assets were not significant in any of the model specifications.

Beyond financial indicators, we also examined the role of innovation performance measured by patent activity. Contrary to our initial expectations, the variable did not prove to be significant in any model variant or for any exit mode. Overall, it can be concluded that the exits show a picture indicating that a significant number of successful investments was not carried out, and hybrid venture capital funds utilizing state funding partially were not able to directly contribute substantially to economic development during the examined period. The indirect impact on the market development of investments could provide a topic for future research. Within this framework, examining the performance and exits of a new set of state-backed programs, as well as investments carried out by market investors, could provide insights into whether the entrepreneurial ecosystem was evolved. To achieve this, further and more detailed data collection efforts specific to Hungary and the region are necessary.

REFERENCES

Audretsch, D.B. (2023), "Institutions and entrepreneurship. Eurasian Business Review", Vol. 13, No. 3, pp. 495–505. https://doi.org/10.1007/s40821-023-00244-5

Becsky-Nagy, P. (2016), "The Special Aspects of Venture Capital's Value Creating Mechanisms in Hungary. Journal of Entrepreneurship", *Management and Innovation*, Vol. 12, No. 3, pp. 31–55. https://doi.org/10.7341/20161232

Becsky-Nagy, P., Fazekas, B. (2023), "Spurring entrepreneurship with public venture capital in developing industries – evidence from Hungary", *Journal of Entrepreneurship in Emerging Economies*, https://doi.org/10.1108/jeee-06-2022-0167

Bontempi, M. E., Lambertini, L., Parigi, G. (2024), "Exploring the innovative effort: duration models and heterogeneity", *Eurasian Business Review*, https://doi.org/10.1007/s40821-024-00272-9

Chemmanur, T. J., Krishnan, K., Nandy, D. K. (2011), "How Does Venture Capital Financing Improve Efficiency in Private Firms? A Look Beneath the Surface", *Review of Financial Studies*, Vol. 24, No. 12, pp. 4037–4090, https://doi.org/10.1093/rfs/hhr096

Cowling, M., Baden-Fuller, C., Mason, C.M., Hopkins, M., Murray, G.C. (2009), "From Funding Gaps to Thin Markets: UK Government Support for Early-Stage Venture Capital", *SSRN Electronic Journal*, https://doi.org/10.2139/ssrn.1478902

Cumming, D. (2008), "Contracts and Exits in Venture Capital Finance", *Review of Financial Studies*, Vol. 21, No. 5, pp. 1947–1982. https://doi.org/10.1093/rfs/hhn072

Cumming, D., Johan, S. A. B. (2008a), "Preplanned exit strategies in venture capital", *European Economic Review*, Vol. 52, No. 7, pp. 1209–1241, https://doi.org/10.1016/j.euroecorev.2008.01.001

Cumming, D., Johan, S. (2008b), "Information asymmetries, agency costs and venture capital exit outcomes", *Venture Capital*, Vol. 10, No. 3, pp. 197–231. https://doi.org/10.1080/13691060802151788

Dankiewicz, R., Balawejder, B., Chudy-Laskowska K., Britchenko I. (2022), „Impact factors and structural analysis of the state's financial security", *Journal of International Studies*, Vol. 15, No. 4, pp. 80-92. doi:10.14254/2071-8330.2022/15-4/5

Fazekas, B., Becsky-Nagy, P. (2021), "A new theoretical model of government backed venture capital funding", *Acta Oeconomica*, Vol. 71, No. 3, pp. 487–506. https://doi.org/10.1556/032.2021.00024

Félix, E. G. S., Pires, C. P., Gulamhussen, M. A. (2012), "The exit decision in the European venture capital market", *Quantitative Finance*, Vol. 14, No. 6, pp. 1115–1130. https://doi.org/10.1080/14697688.2012.714903

Frimpong, F. A., Akwaa-Sekyi, E. K., Anyars, I. S., Peprah-Yeboah, A., Saladrigues Sole, R. (2024), "Macroeconomic factors and venture capital market liquidity: evidence from Europe", *Cogent Economics and Finance*, Vol. 12, No. 1, https://doi.org/10.1080/23322039.2024.2401477

Grežo, M. (2024), "Entrepreneurial experience and venture success: A comprehensive meta-analysis of performance determinants", *Journal of Entrepreneurship, Management and Innovation*, Vol. 20, No. 1, pp. 5–29. https://doi.org/10.7341/20242011

Guo, B., Lou, Y., Pérez-Castrillo, D. (2015), "Investment, Duration, and Exit Strategies for Corporate and Independent Venture Capital-Backed Start-Ups", *Journal of Economics and Management Strategy*, Vol. 24, No. 2, pp. 415–455. https://doi.org/10.1111/jems.12097

Jáki, E., Molnár, E. M. (2021), "Venture capital and government involvement from a qualitative systematic literature review perspective", *Acta Oeconomica*, Vol. 71, No. 4, pp. 645–663. http://doi.org/10.1556/032.2021.00044

Juskaite, L., Gudelyte-Zilinskiene, L., Tamosiuniene, R. (2024), "Investment Portfolio's Including Different Cryptocurrencies Efficiency Study", *Transformations in Business & Economics*, Vol. 23, No 2 (62), pp. 272-295.

Kállay, L., Jáki, E. (2019), "The impact of state intervention on the Hungarian venture capital market", Economic Research-Ekonomska Istraživanja, Vol. 33, No. 1, pp. 1130–1145. https://doi.org/10.1080/1331677x.2019.1629979

Karpa, W., Grginović, A. (2019), "Long-term perspective on venture capital investments in early stage life-science projects related to health care", *Economic Research-Ekonomska Istraživanja*, Vol. 33, No. 1, pp. 2526–2540. https://doi.org/10.1080/1331677x.2019.1629326

Karsai, J. (2021), "International experiences of government start-up financing", *External Economic Bulletin*, Vol. 65, No. 11–12, pp. 28–52. https://doi.org/10.47630/kulg.2021.65.11-12.28

Karsai, J. (2022), "Eastern European start-ups looking for international venture capital", *Economic Review*, Vol. 69, No. 9, pp. 1009–1030. https://doi.org/10.18414/ksz.2022.9.1009

Khalid, B., Dacko-Pikiewicz, Z., Szczepanska-Woszczyna, K. (2023), "Gamification and Its Influence on Financial Management Behaviors of Young Investors", *Transformations in Business & Economics*, Vol. 22, No 3 (60), pp. 206-225.

Kortum, S. S., Lerner, J. (1998), "Does Venture Capital Spur Innovation?", *SSRN Electronic Journal*, https://doi.org/10.2139/ssrn.10583

Lerner, J. (1999), "The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program", *The Journal of Business*, Vol. 72, No. 3, pp. 285–318. https://doi.org/10.1086/209616

Oláh, J., Hidayat Y.A., Popp, J., Lakner, Z., Kovács, S. (2021), "Integrative trust and innovation on financial performance in disruptive era", *Economics and Sociology*, Vol. 14, No. 2, pp. 111-136. doi:10.14254/2071-789X.2021/14-2/6

Puri, M., Zarutskie, R. (2012), "On the Life Cycle Dynamics of Venture-Capital- and Non-Venture-Capital-Financed Firms", *The Journal of Finance*, Vol. 67, No. 6, pp. 2247–2293. Portico. https://doi.org/10.1111/j.1540-6261.2012.01786.x

Schwienbacher, A. (2002), "An Empirical Analysis of Venture Capital Exits in Europe and the United States". *SSRN Electronic Journal*, https://doi.org/10.2139/ssrn.302001

Tamimi, O., Orbán, I. (2022), "Financial engineering and its impact on audit efficiency in the opinion of experts", *Journal of International Studies*, Vol. 15, No. 2, pp. 50–62, https://doi.org/10.14254/2071-8330.2022/15-2/4

Teti, E., Dell'Acqua, A., Bovsunovsky, A. (2024), "Diversification and size in venture capital investing", *Eurasian Business Review*, Vol. 14, No. 2, pp. 475–500. https://doi.org/10.1007/s40821-024-00258-7

Zinecker, M., Skalicka, M., Balcerzak, A. P., Pietrzak, M. B. (2021), "Business angels in the Czech Republic: characteristics and a classification with policy implications", *Economic Research-Ekonomska Istraživanja*, Vol. 35, No. 1, pp. 273–298. https://doi.org/10.1080/1331677x.2021.1890179

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Kurmanov, N., Spankulova, L., Sabyrzhan, A., Kudebayeva, A., Kirichok, O. (2026), "Factors Influencing Income Inequality in the Regions of Kazakhstan", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 55-67.

Factors Influencing Income Inequality in the Regions of Kazakhstan

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ARTICLE INFO

Received October 06, 2024
Revised from November 06, 2024
Accepted 20, December 06, 2024
Available online April 15, 2026

JEL classification: D63, R13, R15

DOI: 10.14254/1800-5845/2026.22-2.5

Keywords:

Income Inequality,
Gini Coefficient,
Regional Economic Disparities,
Panel Data Analysis,
Unemployment,
Poverty Rate.

ABSTRACT

Income inequality remains a critical issue in Kazakhstan, despite overall improvements in living standards. This study aims to explore the impact of various economic factors on income inequality across 16 regions of Kazakhstan from 2001 to 2022, addressing gaps in existing research. The study's primary goal is to identify key variables, such as the funds coefficient, household consumption income, unemployment rate, inflation, and minimum subsistence level, that influence the Gini coefficient, which measures income inequality. The research utilizes panel data models, specifically applying fixed effects and random effects models, to conduct a comprehensive analysis of these factors. The data were sourced from official records, including those of the Bureau of National Statistics of the Republic of Kazakhstan. The study includes a Hausman test to determine the appropriate model for analysis. The findings reveal that the funds coefficient, household consumption income, unemployment levels, and poverty rate have a significant positive impact on income inequality, indicating that disparities between the wealthiest and poorest groups contribute to increasing inequality. Conversely, inflation exhibits a negative but minor effect on inequality, suggesting that price stability policies might mitigate income disparity slightly. These results underscore the importance of targeted economic policies to reduce income inequality and support the poorest population groups. The study's limitations include not accounting for migration flows and social factors like access to education, which could further influence inequality levels. The results can inform policy development aimed at improving social and economic conditions in Kazakhstan. Future research should incorporate social and institutional factors to provide a more precise analysis of the dynamics of inequality. This study contributes to the understanding of how macroeconomic variables shape regional income distribution in a transitioning economy.

INTRODUCTION

Income inequality and its impact on economic development are among the key issues attracting the attention of both scholars and policymakers. In Kazakhstan, where there is a significant disparity in income levels across various regions, this problem is particularly relevant. Despite substantial improvements in living standards since the 1990s, the Gini coefficient, which measures income inequality, has remained relatively high, with some regions experiencing particularly severe forms of poverty.

The issue of economic inequality is not only a social concern but also an economic one, as increasing inequality can adversely affect economic growth and social stability. Classical economic theories, beginning with the work of Kuznets, offer different understandings of the relationship between economic growth and inequality. On one hand, Kuznets argued that as an economy grows, inequality initially increases, then stabilizes, and eventually decreases. However, more recent studies (De Dominicis et al., 2008; Higgins & Williamson, 2002; Barro, 2000) suggest that this relationship is far more complex and may vary depending on the stage of economic development.

There are numerous studies (Asian Development Bank, 2023; Islyami, 2020; Turganbayev, 2016; Frey et al., 2013) focused on inequality in Kazakhstan, including analyses of migration, access to education and healthcare, fiscal policy, and its impact on poverty levels. However, there is still a lack of comprehensive research that examines the influence of key economic factors on income inequality. This study aims to fill this gap by modeling the influence of a range of economic variables on the Gini coefficient, which reflects the level of income inequality in Kazakhstan.

The goal of this study is to identify the economic factors affecting income inequality in Kazakhstan, using panel data from 16 regions over the period from 2001 to 2022. This study differs from previous research through its focus on a comprehensive analysis of key variables using panel data models, allowing for the consideration of temporal changes and regional characteristics. The primary research questions include: how does income inequality change under the influence of economic factors, and which variables have the most significant impact on the Gini coefficient in Kazakhstan? The study employs fixed effects and random effects models and conducts a Hausman test to determine the most appropriate model.

The structure of the article is organized as follows: the "Literature Review" section discusses previous studies and knowledge gaps; the "Materials and Methods" section outlines the methodology and data used in the study. The "Results" section presents findings based on panel regression models, while the "Discussion" section analyzes the results and offers recommendations for economic policy. The conclusion summarizes the key findings and outlines directions for future research.

1. LITERATURE REVIEW

The adverse political consequences of income inequality for both the state and society include undermining trust in government and public institutions, reducing social cohesion and civic engagement (Uslaner and Brown, 2005), increasing corruption, and hindering social mobility (Rothstein and Uslaner, 2005; Wilkinson and Pickett, 2009). This inequality can even lead to the escalation of protests and social unrest, as exemplified by the events in Kazakhstan in January 2022.

Despite the significant improvement in living standards in Kazakhstan since the 1990s, the official absolute poverty rate was 5.2% in 2022. Although the Gini index, which measures income inequality, decreased from 0.36 in 2001 to 0.263 in 2009, it subsequently rose to 0.294 in 2021. In 2022, 5.2% of households reported incomes below the subsistence level, with particularly high poverty rates in the Turkestan (9.7%) and Mangystau (8.1%) regions, while in the city of Astana, this figure was 1.9%.

The literature lacks consensus regarding the relationship between income inequality and economic growth. The classical theory proposed by Stiglitz (1969) posits a positive correlation between economic growth and inequality. Conversely, the political economy approach (Alesina and Perotti, 1996; Galor and Zeira, 1993) argues that income inequality negatively affects economic growth. The perspective offered by

Caraballo et al. (2017) suggests that the relationship between inequality and economic growth varies with the stage of economic development: it is negative in the early stages and becomes positive in later stages.

Kuznets' hypothesis (1955) describes the relationship between income and inequality as an inverted U-shape, where income inequality initially increases during the early stages of development, stabilizes, and then decreases as income continues to grow in developing countries. Early studies using cross-country datasets confirmed the Kuznets hypothesis, whereas later studies (Higgins and Williamson, 2002; Barro, 2000; De Dominicis et al., 2008) found that this relationship is complex and depends on factors such as sample size, data quality, and methods used to measure economic growth and income inequality.

Among the early works on transition economies is the study by Milanovic (1998), which describes the dramatic period of development from 1987 to 1996 in 18 former communist countries, including Kazakhstan, focusing on income, poverty, and inequality. Additionally, the work by Recepoğlu (2022) thoroughly examines the causal relationship between government expenditures, economic growth, and income inequality in CIS countries with transitional economies.

In large and geographically diverse countries like Kazakhstan, differences in regional economic development contribute significantly to overall socio-economic inequality (Oshchepkov, 2020; Milanovic, 2005; Sankar and Shah, 2003). Various studies have explored the comparative economic development and convergence of Kazakhstan's regions (Frey et al., 2013; Turganbayev, 2016), differences in quality of life and well-being (Asian Development Bank, 2023), as well as patterns of internal migration (Islyami, 2020). Nevertheless, many critical issues remain largely unresolved and insufficiently addressed.

Many authors aim to identify specific factors that can be managed to mitigate the effects of inequality. Education is often cited as one of the main factors in this regard (Anuarbek et al., Parker et al., 2020; Shahbaz et al., 2017; Kudasheva et al., 2015). Access to quality healthcare is also recognized as an important factor in reducing social inequality (Bhattacharjee et al., 2017; Kaestner and Lubotsky, 2016; Spankulova et al., 2020; Abikulova et al., 2013). The significance of fiscal measures and the development of financial institutions is also noted (Shahbaz et al., 2017; Johansson, 2016; Kyriacou et al., 2016; Burman, 2013; Kanseitova et al., 2012; Demirgüç-Kunt and Levine, 2009). Research by Agrawal (2007) emphasizes the importance of government spending on pensions and social welfare projects. Howie and Atakhanova (2014) also concluded that the resource boom in Kazakhstan contributes to reducing income inequality, taking into account changes in labor income, institutional quality, education levels, and healthcare expenditures. Studying household data from Kazakhstan for the period 2001–2005, Hare and Naumov (2008) found that the increase in oil exports left income inequality unchanged but reduced the number of people living in poverty.

Research on gender inequality in Kazakhstan is limited. Anuarbek et al. (2022) examined income statistics from 2011 to 2019, finding higher incomes among men but with a more uneven distribution compared to women. Akybayeva and Mussabekova (2023) identified a significant negative impact of traditional beliefs on women's participation in the labor force.

One of the aims of this study is to identify key factors that can reduce poverty and inequality in Kazakhstan. However, the complex relationship between income inequality and economic growth, characterized by periods of growth, decline, and stagnation, highlights the challenge of addressing these issues (Berg and Ostry, 2011). Therefore, developing countries like Kazakhstan must approach inequality reduction cautiously to avoid undermining incentives for growth.

A particular point of interest is the debate on the necessity of redistribution mechanisms (Arandarenko and Pavlovic, 2023). The neoliberal school, which has strongly influenced the leaders of former post-communist countries, asserted that market forces would naturally create opportunities for all, leading to reduced inequality along the Smith curve (Fukuyama, 2022; Slobodian, 2018; Lucas, 2002). However, empirical evidence suggests that this has not occurred in many post-socialist economies (Jalles, 2011).

A key question arises: is it necessary to combat inequality? In addressing this question, we refer to the theory of equal opportunities (Arneson, 1990; Dworkin, 2081a, 2081b; Cohen, 1989; Rawls, 1971). This theory postulates two categories of factors influencing individual achievements: circumstances beyond individual control and effort-related factors that fall within the realm of personal responsibility. Inequality in outcomes resulting from circumstances is referred to as inequality of opportunity. This type of inequality

is considered unjust and thus subject to correction through public social policy tools. Moreover, it is considered socially "harmful" as it erects barriers to the realization of human potential. Conversely, inequality in outcomes arising from differences in effort is seen as fair and socially beneficial. It ensures proper rewards for efforts made, motivates individuals to realize their potential, and thus contributes to an overall increase in aggregate social outcomes. Our study specifically aims to address inequality of opportunity rather than inequality of effort.

Thus, the literature review reveals a lack of comprehensive research focused on the combined effects of various factors on inequality and poverty in Kazakhstan. Given the transitional nature of Kazakhstan's economy, there is a need for studies that offer concrete measures for addressing these challenges.

2. MATERIALS AND METHODS

The study utilizes panel data from 16 regions of Kazakhstan for the period from 2001 to 2022. The data source is the official statistical databases of the Bureau of National Statistics, Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. The observations include key economic variables that reflect the socio-economic status of the regions and levels of income inequality.

Table 1. Variables Selected for Model Construction

Variable Code	*Variable*	*Source*
Gini	Gini coefficient by 10 percent (decile) groups	BNS
Fund	Funds coefficient (ratio of the top 10% to the bottom 10% of the population)	BNS
ConsInc	Household income (used for consumption) per capita, KZT	BNS
Infl	Consumer Price Index, %	BNS
Unempl	Unemployment rate, %	BNS
PrMin	Minimum subsistence level, KZT	BNS

.

Source: a) Compiled by the authors; b) BNS – Bureau of National Statistics, Agency for Strategic Planning and Reforms of the Republic of Kazakhstan

For the model construction, the following independent variables were selected (Table 1):

- Gini – The Gini coefficient, which measures the level of income inequality.
- Fund – The funds coefficient, representing the income ratio between the top 10% of the population and the bottom 10%.
- ConsInc – Household income (used for consumption).
- Infl – Inflation, measured as the annual rate of price growth in percentage.
- Unempl – Unemployment rate, reflecting the share of the economically active population without work.
- PrMin – Minimum subsistence level, representing the minimum income needed to meet basic needs - official poverty line in Kazakhstan.

The variables were lagged by one period, allowing for the consideration of the delayed effect of these factors on income inequality. Lagging the variables is justified as many economic processes (e.g., changes in the unemployment rate or inflation) can impact inequality with a time delay.

Data Collection and Processing.

Data were collected from official reports and statistical databases. Initial data processing included checking for missing and anomalous values. Missing data were interpolated based on average values for the corresponding period or region. All data were organized and structured into a panel format, where each row represents an observation for a specific region in a given year.

Analysis Methods

To analyze the impact of economic factors on the Gini coefficient, panel regression models were used, including the following methods:

- Pooled OLS (Ordinary Least Squares). This model assumes that all regions have the same characteristics and performs estimation based on pooled data without accounting for individual regional differences.
- Fixed Effects Model (FE). The fixed effects model was used to account for time-invariant characteristics of each region (e.g., institutional features, cultural factors). This allowed for the elimination of bias caused by such factors and enabled the assessment of the influence of variables that change over time.
- Random Effects Model (RE). The random effects model assumes that individual differences between regions are random and uncorrelated with the independent variables. This approach captures variations between regions as random effects, independent of the other factors.

A panel data model with lagged variables was employed to assess the impact of key economic factors on the Gini coefficient.

$$x'_{it} = (Gini_{it-1}, Fund_{it-1}, Unempl_{it-1}, Infl_{it-1}, ConsInc_{it-1}, PrMin_{it-1}, 1). \quad (1)$$

The vector of independent variables x'_{it} includes lagged values of the variables: $Gini_{it-1}$ (Gini coefficient from the previous period), $Fund_{it-1}$ (funds coefficient from the previous period), $Unempl_{it-1}$ (unemployment rate), $Infl_{it-1}$ (inflation), $ConsInc_{it-1}$ (household income), $PrMin_{it-1}$ (minimum subsistence level).

Lagging the variables is justified by the need to account for the time delay in economic processes that can influence the level of income inequality. The constant term (1) accounts for a fixed effect associated with unobserved factors.

To select the most appropriate model, the Hausman test was applied. This test helps determine whether a fixed effects or random effects model is more suitable for data analysis. It checks for systematic differences between the coefficient estimates of the two models. A significant result from the Hausman test suggests using the fixed effects model. If the differences are insignificant, preference is given to the random effects model.

The models were estimated using Stata software, which enabled efficient panel data analysis and interpretation of results. The main findings are presented in Tables 3 and 4. All independent variables were tested for multicollinearity using correlation coefficients and were also checked for heteroscedasticity.

Thus, the selected methods and analytical tools enable conclusions about the impact of economic factors on income inequality in Kazakhstan, which are discussed in detail in the respective sections of the paper.

3. RESULTS

Table 2 provides information on the key variables used in the study. These variables measure various economic factors that influence the Gini coefficient, which is a measure of income inequality. The data cover the period from 2017 to 2021 and include 352 observations across 16 regions of Kazakhstan (see Table 1 in the Appendix).

Table 2. Descriptive Statistics

VarName	*Obs*	*Mean*	*SD*	*Min*	*Max*
Gini	352	0.267	0.042	0.16	0.43
Fund	352	5.475	1.402	2.84	11.11
ConsInc	352	33395.847	22545.752	3421.50	105896.08
Infl	352	108.400	4.055	103.20	127.10
Unempl	352	6.394	1.946	4.40	13.90
PrMin	352	17474.017	10855.398	3685.00	52367.00

Source: Compiled by the authors

The average Gini coefficient is 0.267, ranging from 0.16 to 0.43, indicating a moderate level of income inequality in Kazakhstan. The data presented in Figure 1 of the Appendix shows that the Gini coefficient varies across the regions of Kazakhstan and over the years. For example, in the Atyrau region in 2002, the coefficient was 0.43, indicating high inequality, while in the Mangystau region in 2009, it was 0.16, indicating lower inequality. In other regions, such as the Akmola and Almaty regions, the coefficient remains relatively stable, suggesting persistent income inequality in these areas.

The average value of the fund's coefficient is 5.475, indicating significant disparity between the top 10% and the bottom 10% of the population. In some regions, such as the Aktobe region in 2001, the coefficient was very high (11.11), indicating severe economic inequality. In contrast, in regions like the Mangystau region in 2017, the value was much lower (2.84), reflecting a more even income distribution.

The average household consumption income is 33395.847 KZT per capita, with a large standard deviation, indicating significant regional differences in income levels across Kazakhstan. For instance, in Almaty city in 2022, the average income reached 105,896 KZT, the highest among all regions. Meanwhile, in regions like the Zhambyl region, this indicator is lower, highlighting substantial disparities in living standards across Kazakhstan.

The inflation rate in the sample is relatively stable, averaging 108.4%, which suggests a controlled rate of price growth.

The average unemployment rate is 6.394%, indicating a relatively low level of unemployment in some regions but a significant level in others during certain years.

The average minimum subsistence level in the sample is 17474.017 KZT, reflecting the basic needs across different regions.

Table 3 presents the estimation results of the economic factors influencing the Gini coefficient using three methods: Pooled OLS (Ordinary Least Squares), Fixed Effects model, and Random Effects model.

Table 3. Estimation Results

	Pooled OLS	*Fixed efefcts*	*Random effects*
VARIABLES	Gini	Gini	Gini
$Gini_{(t-1)}$	0.385***	0.206**	0.385***
	(0.0806)	(0.0827)	(0.0806)
$Fund_{(t-1)}$	0.00896***	0.00830***	0.00896***
	(0.00225)	(0.00229)	(0.00225)
$ConsInc_{(t-1)}$	1.33e-06***	1.37e-06***	1.33e-06***
	(1.92e-07)	(2.39e-07)	(1.92e-07)
$Infl_{(t-1)}$	-0.000941***	-0.000562*	-0.000941***
	(0.000334)	(0.000324)	(0.000334)
$Unempl_{(t-1)}$	0.00306***	0.00764***	0.00306***
	(0.00101)	(0.00118)	(0.00101)
$PrMin_{(t-1)}$	-2.27e-06***	-1.86e-06***	-2.27e-06***
	(3.88e-07)	(4.68e-07)	(3.88e-07)
Constant	0.189***	0.162***	0.189***
	(0.0380)	(0.0367)	(0.0380)
Observations	336	336	336
R-squared	0.771	0.744	0.771
Standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Source: Compiled by the authors

All three models (Pooled OLS, Fixed Effects, and Random Effects) indicate a positive and significant impact of the fund's coefficient on the Gini coefficient, with high levels of significance ($p < 0.01$). This means that an increase in the gap between the top 10% and the bottom 10% of the population leads to a rise in income inequality. The coefficient ranges from 0.206 in the Fixed Effects model to 0.385 in the Pooled OLS and Random Effects models.

All three models also show that the Gini coefficient from the previous period ($Gini_{(t-1)}$) positively affects the current Gini coefficient, indicating a certain inertia in the level of inequality. This means that the previous level of inequality influences the current one.

The positive and significant effect of the fund's coefficient on the Gini coefficient ($p < 0.01$) across all models suggests that an increase in the disparity between the most affluent and the least affluent segments of the population contributes to a rise in income inequality.

Household consumption income also shows a significant positive impact on the Gini coefficient across all models ($p < 0.01$). The very small coefficients suggest that while an increase in per capita consumption income does affect the level of inequality, this effect is minor in magnitude (coefficients range from 1.33e-06 to 1.37e-06).

The impact of inflation on the Gini coefficient is negative and statistically significant, although with low coefficients (values range from -0.000562 to -0.000941). This indicates that inflation can reduce the level of income inequality, but the effect is minor in magnitude.

The coefficients range from 0.00306 to 0.00764, indicating a consistent effect of unemployment on inequality. The positive and significant impact of unemployment on the Gini coefficient shows that an increase in the unemployment rate is associated with a rise in income inequality.

The effect of the poverty rate is also positive and significant across all models ($p < 0.01$). This confirms that an increase in the proportion of the poor population leads to a rise in income inequality, which is logical.

The value of the constant is also statistically significant, indicating a baseline level of inequality even in the absence of the model's variables.

The analysis results show that the key factors influencing income inequality in Kazakhstan are the funds coefficient, consumption income, unemployment levels, inflation, and poverty. These variables have a significant impact on the Gini coefficient, as confirmed by all three estimation models.

The Hausman test (Table 4) is used to choose between two primary panel data models: the Fixed Effects model (FE) and the Random Effects model (RE). Fixed Effects (FE) assumes that individual (regional) characteristics affecting the Gini coefficient are constant and fixed over time. Random Effects (RE) considers these characteristics as random and uncorrelated with the variables included in the model.

Table 4. Hausman Test

```
Test:  Ho:  difference in coefficients not systematic

              chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       58.55
            Prob>chi2 =      0.0000
            (V_b-V_B is not positive definite)
```

Source: Compiled by the authors

According to Table 4, the p-value of the Hausman test is 0.000. Since the p-value is less than 0.01, we reject the null hypothesis at the 1% significance level. This means that at the 1% level, random effects may be consistent and efficient, and thus the RE model can be used.

4. DISCUSSION

The findings of this study shed light on the key economic factors influencing income inequality in Kazakhstan, providing a deeper understanding of their impact in the regional context. Based on the analysis of panel data across 16 regions from 2001 to 2022, significant variables such as the funds coefficient, household consumption income, unemployment rate, inflation, and minimum subsistence level were identified. These factors significantly affected the Gini coefficient, indicating that economic inequality in Kazakhstan is closely linked to macroeconomic indicators that shape income distribution.

Our research demonstrated that the funds coefficient has a positive impact on the Gini coefficient, confirming the hypothesis that an increase in the gap between the wealthiest and the least affluent segments of the population contributes to rising income inequality. This finding is consistent with previous studies (Uslaner and Brown, 2005; Rothstein and Uslaner, 2005), which also note the negative impact of economic inequality on social stability. Moreover, the positive effect of household consumption income on income inequality, as revealed in our study, underscores the need to consider consumer behavior when formulating measures to reduce inequality.

Interestingly, inflation showed a negative impact on the level of inequality, although this effect was minor in magnitude. This aligns with theoretical assumptions (Barro, 2000), suggesting that inflation may help to curb inequality by reducing the real incomes of the wealthiest segments of the population. However, our analysis indicates that this effect remains limited and warrants further investigation, particularly considering regional specificities.

A key finding of this study is the confirmed relationship between unemployment and income inequality. The results showed that an increase in the unemployment rate leads to greater economic disparity, which supports the conclusions of Alesina and Perotti (1996) and Galor and Zeira (1993) that unemployment exacerbates economic inequality. This highlights the importance of developing employment programs and support mechanisms for the working population as a crucial tool in addressing inequality (Burman, 2013; Shahbaz et al., 2017).

This study has advanced scientific knowledge by offering a comprehensive analysis of the influence of macroeconomic factors on income inequality in Kazakhstan based on panel data. We also emphasized the significance of factors such as the funds coefficient and household consumption income, allowing for more precise policy recommendations aimed at reducing inequality. It is important to note that despite the significance of the findings, our study has limitations, including the lack of consideration for migration flows and social factors, which may also affect income inequality.

The practical application of these results can be directed toward the development of targeted social support programs and measures to improve employment, especially in regions with high unemployment rates and economic disparities. Future research should include additional social factors, such as access to education and healthcare, as well as consider the impact of migration processes on the economic development of regions.

CONCLUSION

This study has identified key economic factors influencing income inequality in Kazakhstan. The primary drivers of inequality include the gap between the wealthiest and the least affluent segments of the population (funds coefficient), household consumption income, the unemployment rate, and the proportion of the poor population. These factors consistently affect the Gini coefficient across different regions of the country. However, contrary to expectations, inflation did not show a significant impact on income inequality. This may be attributed to economic policies aimed at price stabilization and relatively low levels of inflation during the study period.

The Hausman test indicated that, within the framework of the panel data model, the Random Effects (RE) model is more appropriate at the 1% significance level, while the Fixed Effects (FE) model may be preferred at the 10% significance level. This suggests the presence of both fixed and random effects in the analyzed data, highlighting the complexity of the economic processes influencing income inequality.

Despite the findings, the study has several limitations. The use of only macroeconomic indicators may not fully capture all social and institutional factors influencing income inequality. Additionally, while the panel data includes all regions of Kazakhstan, it does not account for potential migration flows and their impact on regional economic development.

Future research is recommended to explore the impact of other social factors, such as access to education and healthcare, which, as shown in other studies (Kudasheva et al., 2015; Spankulova et al., 2020), can significantly influence the reduction of inequality. Furthermore, it is essential to consider gender inequality, which also affects the overall picture of economic disparity (Anuarbek et al., 2022).

Thus, to gain a more comprehensive understanding, future studies should incorporate not only economic but also social aspects, as well as consider the impact of various government programs aimed at reducing inequality and improving the population's living standards.

ACKNOWLEDGMENTS

This research has been funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19680043).

REFERENCES

Abikulova, A. K., Tulebaev, K. A., Akanov, A. A., Turdalieva, B. S., Kalmahanov, S. B., Kumar, A. B., Izekenova, A. K., Mussaeva, B. A., Grjibovski, A. M. (2013), "Inequalities in self-rated health among 45+ year-olds in Almaty, Kazakhstan: a cross-sectional study", *BMC Public Health*, Vol 13, 654.

Agrawal, P. (2007), "Economic growth and poverty reduction: Evidence from Kazakhstan", *Asian Development Review*, Vol. 24, No. 2, pp. 90–115.

Akybayeva, G., Mussabekova, A. (2023), "Factors impact on women's participation in the workforce in Kazakhstan", *Universum: Economics and Law,* Vol. 4, No. 103, pp. 35–38.

Alesina, A., Perotti, R. (1996), "Income distribution, political instability, and investment", *European Economic Review,* Vol. 40, No. 6, pp. 1203–1228.

Arneson R. (1990), "Liberalism, Distributive Subjectivism, and Equal Opportunity for Welfare", *Philosophy and Public Affairs*, Vol. 19, No. 2, pp. 158—194.

Anuarbek, A., Kuatova, A., Tulemetov, D. (2022), "Economic inequality in Kazakhstan: causes and consequences", *Thesis,* International School of Economics, Narikbayev KAZGUU University.

Arandarenko, M., Pavlovic, D. (2023), "Egalitarianism and redistributive reform in Serbia after 2000", *Economic Annals,* Vol. 68, No. 237, pp. 7–36.

Asian Development Bank. (2023), "Regional well-being across Kazakhstan: harnessing survey data for inclusive development". https://www.adb.org/publications/regional-well-being-kazakhstan-survey-data

Barro, R.J. (2000), "Inequality and growth in a panel of countries", *Journal of Economic Growth,* Vol. 5, pp. 87–120.

Berg, A., Ostry, J.D. (2011), "Inequality and unsustainable growth: Two sides of the same coin?" IMF Staff Discussion Note. https://www.imf.org/external/pubs/ft/sdn/2011/sdn1108.pdf

Bhattacharjee, A., Shin, J. K., Subramanian, C., Swaminathan, S. (2017), "Healthcare investment and income inequality", *Journal of Health Economics,* Vol. 56, pp. 163–177.

Burman, L.E. (2013), "Taxes and inequality", *Tax Law Review,* Vol. 66, pp. 563–592.

Caraballo, M.Á., Dabús, C., Delbianco, F. (2017), "Income inequality and economic growth revisited. A note", *Journal of International Development,* Vol. 29, No. 7, pp. 1025–1029.

Cohen G. (1989), "On the Currency of Egalitarian Justice", *Ethics*, Vol. 99, No. 4, pp. 906— 944.

De Dominicis, L., Florax, R., de Groot, H. (2008), "A meta-analysis on the relationship between income inequality and economic growth", *Scottish Journal of Political Economy,* Vol. 55, No 5, pp. 654–682.

Demirgüç-Kunt, A., Levine, R. (2009), "Finance and inequality: Theory and evidence", *Annual Review of Financial Economics,* Vol. 1, No. 1, pp. 287–318.

Dworkin R. (1981a), "What is Equality? Part 1: Equality of Welfare", *Philosophy and Public Affairs*, Vol. 10, No. 3, pp. 185—246.

Dworkin R. (1981b), “What is Equality? Part 2: Equality of Resources”, *Philosophy and Public Affairs*, Vol. 10, No. 4, pp. 283—345.
Frey, D., Frey, M., Wieslhuber, C. (2013), “Do natural resources define convergence clubs? Empirical evidence from the Kazakh regions”, *Economic Systems,* Vol. 37, No. 3, pp. 404-414.
Fukuyama, F. (2022), “Liberalism and its discontents. Farrar, Straus and Giroux”. https://profilebooks.com/wp-content/uploads/wpallimport/files/PDFs/9781800810082_preview.pdf
Galor, O., Zeira, J. (1993), “Income distribution and macroeconomics”, *The Review of Economic Studies,* Vol. 60, No. 1, pp. 35–52.
Hare, P., Naumov, A.I. (2008), “A study of changing income distribution in Kazakhstan using a new social accounting matrix and household survey data”. *The 30th General Conference of The International Association for Research in Income and Wealth.* http://old.iariw.org/papers/2008/hare.pdf
Higgins, M., Williamson, J. (2002), “Explaining inequality, the world round: cohort size, Kuznets curves and openness”, *Southeast Asian Studies*, Vol. 40, No. 3, pp. 268–302.
Howie, P., Atakhanova, Z. (2014), “Resource boom and inequality: Kazakhstan as a case study”, *Resources Policy,* Vol. 39, No. 1, pp. 71-79.
Islyami, A. (2020), “Internal migration in Kazakhstan”, *In* M. Bell, A. Bernard, E. Charles-Edwards, U. Zhu (Eds.), Internal Migration in the Countries of Asia, A Cross-national Comparison. Springer. https://doi.org/10.1007/978-3-030-44010-7_18
Jalles, J.T. (2011), “Growth, poverty, and inequality: Evidence from post-communist economies”, *Journal of Poverty,* Vol. 15, No. 3, pp. 277–308.
Johansson, Å. (2016), “Public finance, economic growth and inequality: A survey of the evidence”, *Economics Department Working Paper* No. 1346, OECD Publishing. https://www.oecd.org/economy/public-finance/Public-finance-economic-growth-and-inequality-a-survey-of-the-evidence.pdf
Kaestner, R., Lubotsky, D. (2016), “Health insurance and income inequality”, *Journal of Economic Perspectives,* Vol. 30, No. 2, pp. 53–78.
Kanseitova, A.K., Kudasheva, T.V., Mukhamediyev, B.M., Zhatkanbaev, E.B. (2012), “Income tax on individuals in the Republic of Kazakhstan: “Fairness and efficiency” compromise”, *African Journal of Business Management,* Vol. 6, No. 27, 8178-8186.
Kudasheva, T., Kunitsa, S., Mukhamediyev, B. (2015), “Effects of access to education and information-communication technology on income inequality in Kazakhstan”, *Procedia-Social and Behavioral Sciences,* Vol. 191, pp. 940–947.
Kuznets, S. (1955), “Economic growth and income inequality”, *The American Economic Review,* Vol. 45, No. 1, pp. 1–28.
Kyriacou, A., Muinelo-Gallo, L., Roca-Sagalés, O. (2016), “On the redistributive efficiency of fiscal policy”, *MPRA*, Paper No. 69045. https://mpra.ub.uni-muenchen.de/69045/
Lucas, R.E. (2002), “The industrial revolution: Past and future”, *Lectures on Economic Growth,* Harvard University Press. https://www.hup.harvard.edu/catalog.php?isbn=9780674016019
Milanovic, B. (1998), “Income, inequality, and poverty during the transition from planned to market economy”, World Bank Regional and Sectoral Studies, Washington, DC. https://documents1.worldbank.org/curated/en/229251468767984676/pdf/multi-page.pdf
Milanovic, B. (2005), “Half a world: Regional inequality in five great federations”, *Journal of the Asia Pacific Economy,* Vol. 10, No. 4, pp. 408–445.
Oshchepkov, A.Y. (2020), “Interregional wage differentials in Russia: Examining the role of long-term factors”, *Voprosy Ekonomiki,* Vol. 11, pp. 86–112.
Parker, R., Morris, K., Hofmeyr, J. (2020), “Education, inequality and innovation in the time of COVID-19”, *JET Education Services*. https://www.jet.org.za/resources/theme-9-final-july-2020-parker-et-al.pdf
Rawls, J. (1971), “A Theory of Justice”, Cambridge, MA: Harvard University Press.
Recepoğlu, M. (2022), “Public expenditures, economic growth and income inequality: Empirical evidence from the Commonwealth of Independent States”, *Journal of Economic Policy Researches,* Vol. 9. No. 2, pp. 293–314.
Rothstein, B., Uslaner, E.M. (2005), “All for all: Equality, corruption, and social trust”, *World Politics,* Vol. 58, No. 1, pp. 41–72.
Sankar, R., Shah, A. (2003), “Bridging the economic divide within countries: A scorecard on the performance of regional policies in reducing regional income disparities”, *World Development,* Vol. 31, No. 8, pp. 1421–1441.

Shahbaz, M., Bhattacharya, M., Mahalik, M.K. (2017), "Finance and income inequality in Kazakhstan: Evidence since transition with policy suggestions", *Applied Economics,* Vol. 49, No. 52, pp. 5337–5351.
Slobodian, Q. (2018), *Globalists: The end of empire and the birth of neoliberalism*, Harvard University Press. https://www.hup.harvard.edu/catalog.php?isbn=9780674979529
Spankulova, L., Karatayev, M., Clarke, M. L. (2020), "Trends in socioeconomic health inequalities in Kazakhstan: National household surveys analysis", *Communist and Post-Communist Studies,* Vol. 53, No. 2, pp. 177-190.
Stiglitz, J. E. (1969), "Distribution of income and wealth among individuals", *Econometrica,* Vol. 37, pp. 382–397.
Turganbayev, Y. (2016), "Regional convergence in Kazakhstan", *Post-Communist Economies,* Vol. 28, No. 3, pp. 314–334.
Uslaner, E.M., Brown, M. (2005), "Inequality, trust, and civic engagement", *American Politics Research,* Vol. 33, No. 6, pp. 868–894.
Wilkinson, R.G., Pickett, K.E. (2009), "Income inequality and social dysfunction", *Annual Review of Sociology,* Vol. 35, pp. 493–511.

APPENDIX

Figure 1A. Gini coefficients by regions

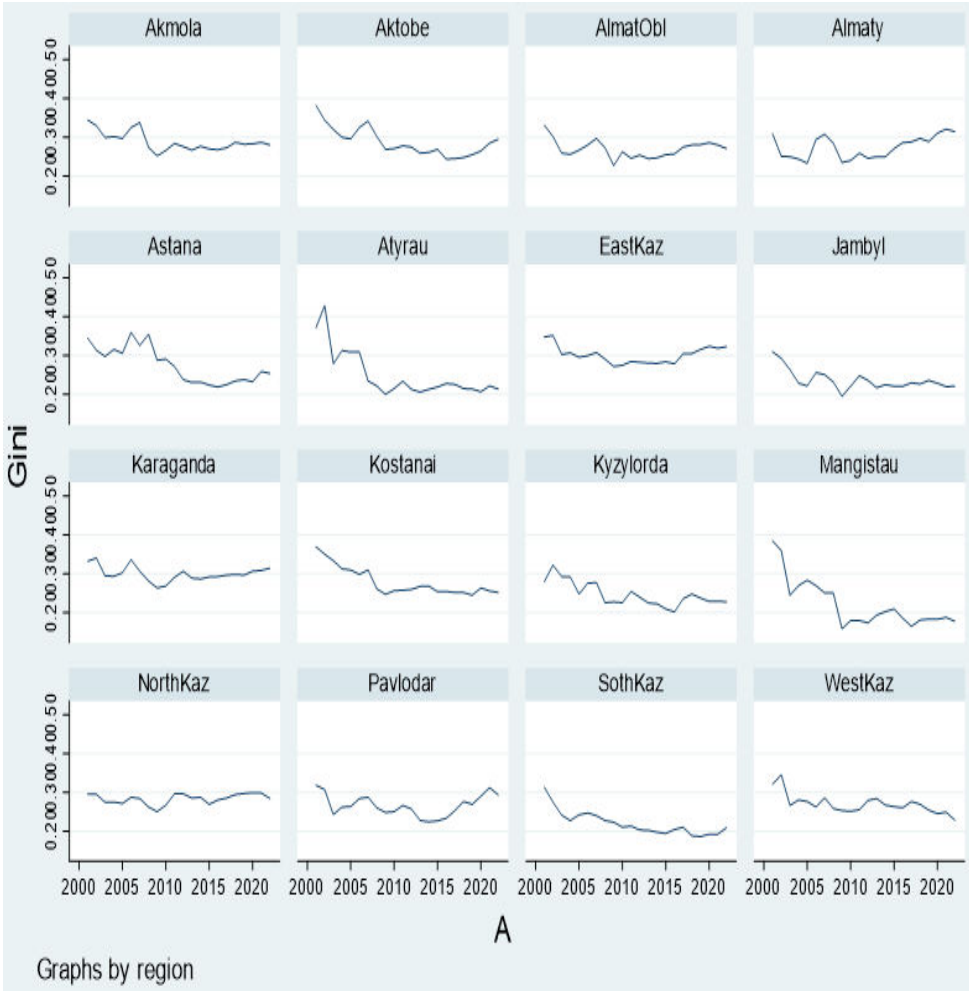


Figure 2A. Funds by regions

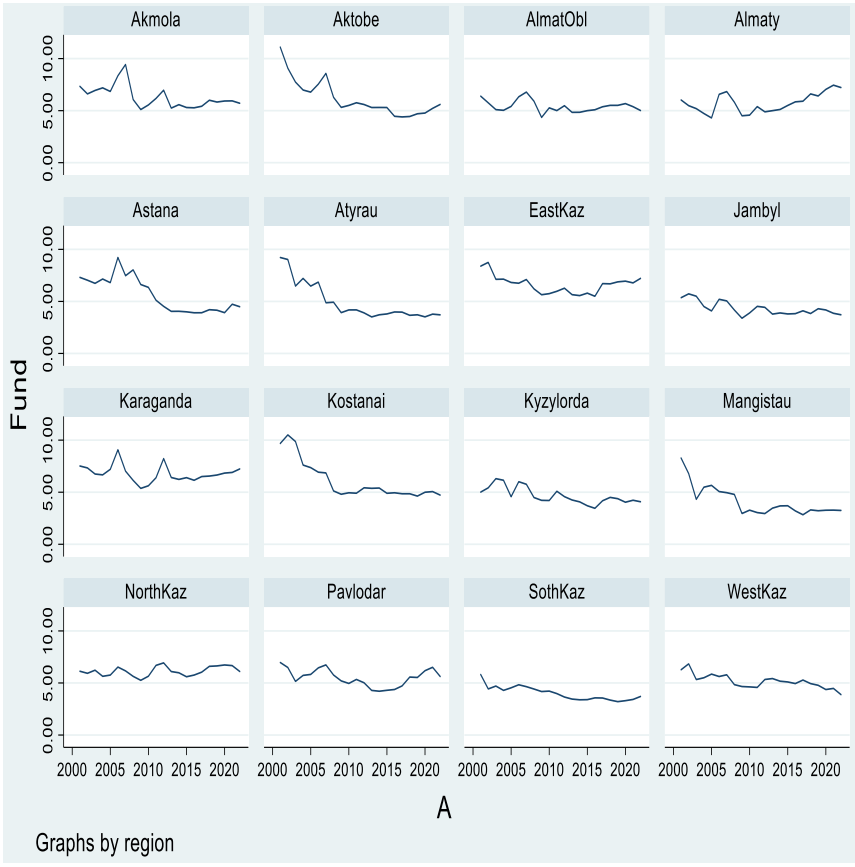


Figure 3A. Household Income by regions

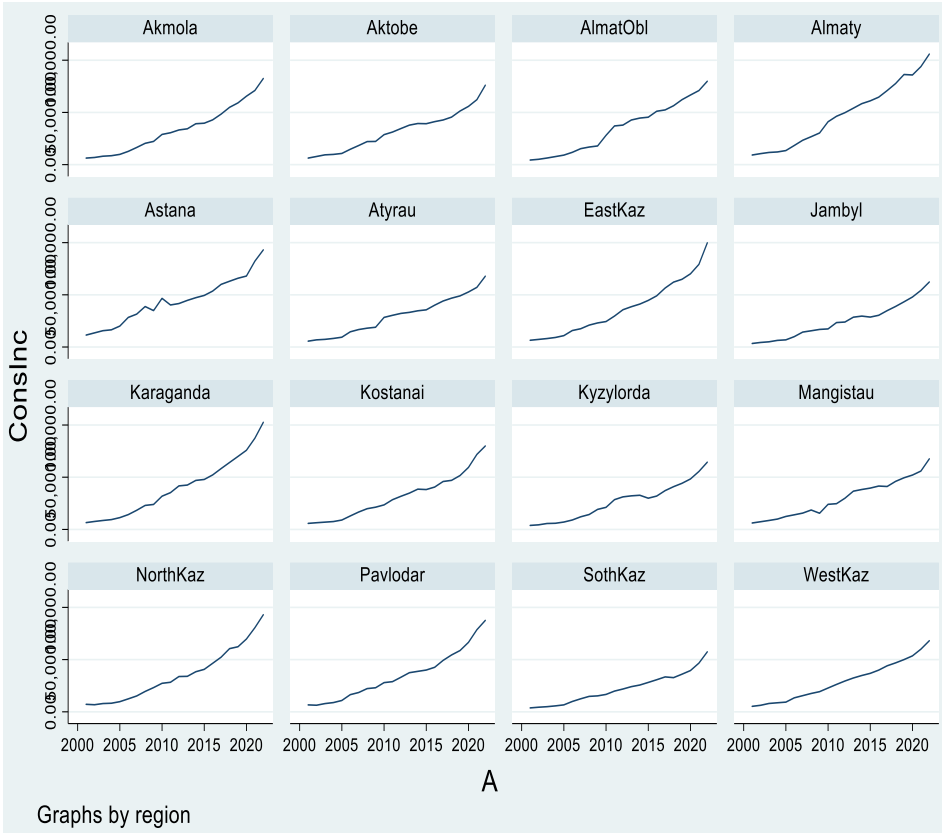


Figure 4A. Inflation rate by regions

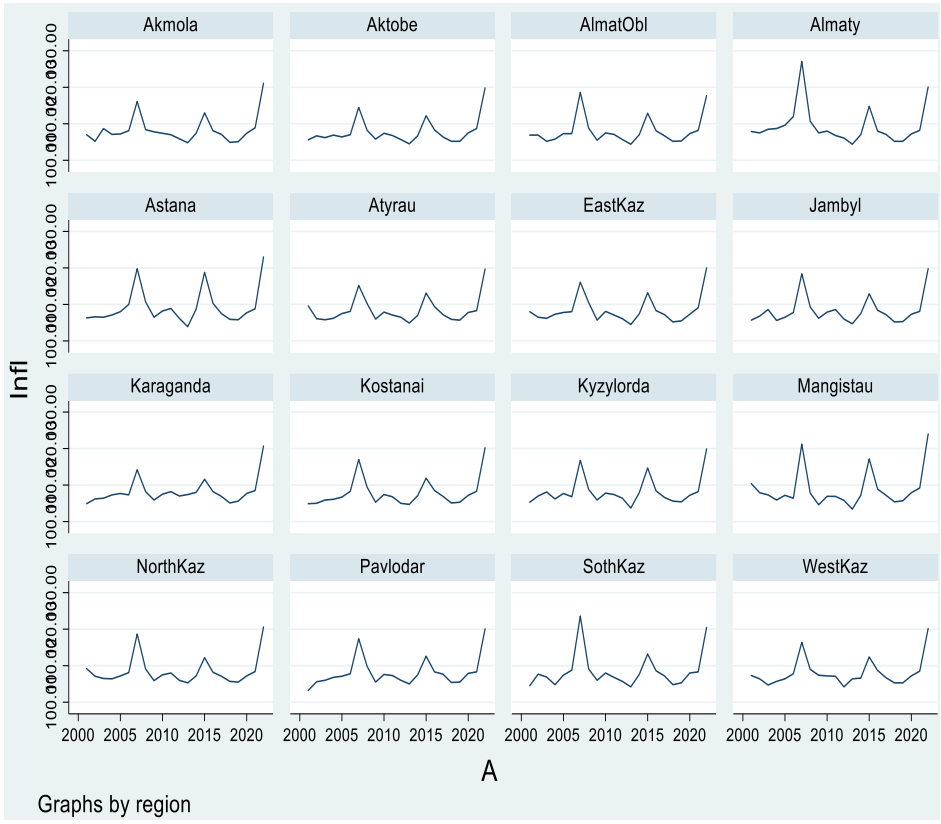
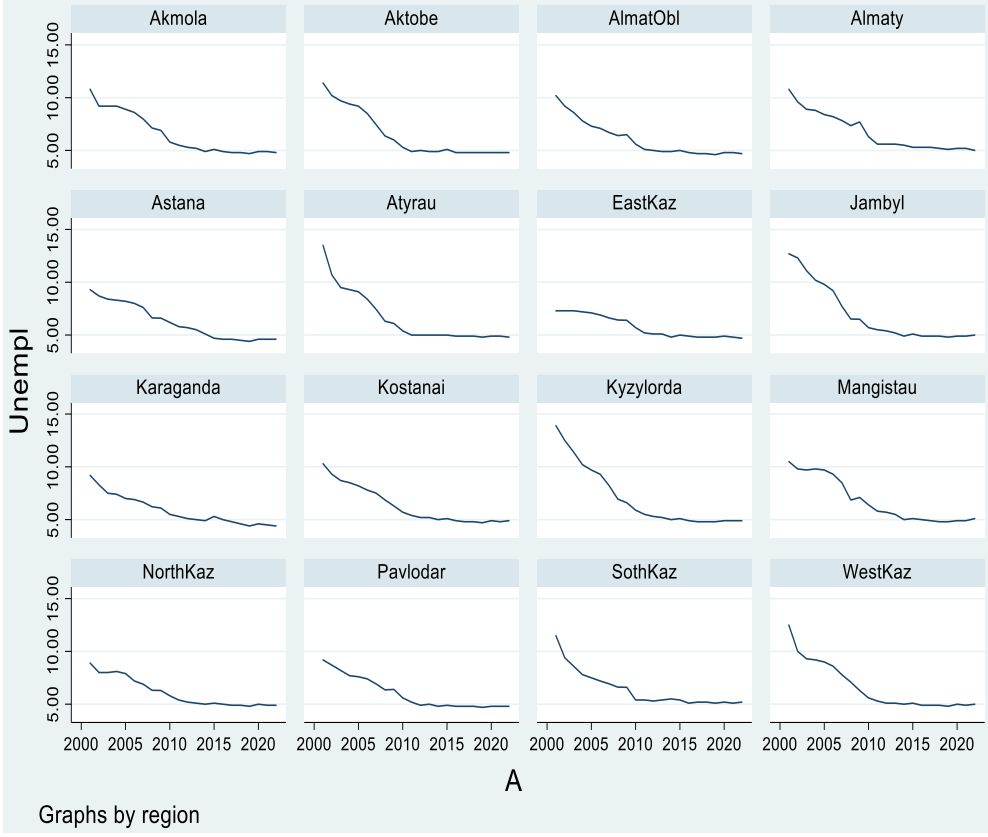


Figure 5A. Unemployment rate by regions



ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Ardianingsih, A., Setiawan, D. Payamta, P., Widarjo, W. (2026), "The Determinant of ESG disclosure: Insight from Indonesia",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 69-78.

The Determinant of ESG Disclosure: Insight from Indonesia

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ARTICLE INFO

Received November 01, 2024
Revised from December 01, 2024
Accepted 20, January 08, 2024
Available online April 15, 2026

JEL classification: G39, M14, M41, Q50

DOI: 10.14254/1800-5845/2026.22-2.6

Keywords:

ESG,
board,
gender,
stakeholder.

ABSTRACT

Sustainability issues have driven the management of social, environmental and governance activities. ESG disclosure is the transparency of a corporation's non-financial information to the stakeholders. Research on this topic still has gaps in the research results. The research was conducted in the context of stakeholder theory. The board of commissioners, board of directors, board gender diversity and CSR committee enable increased interaction between the corporation and its stakeholders. This study aims to provide empirical evidence of the influence of the board of commissioners, board of directors, board gender diversity and CSR committee on ESG disclosure. The research was conducted on corporations included in the 30 indexes on the Indonesia Stock Exchange (IDX) for the 2019-2023 period. The research objects were 18 companies included in index 30. The research data used was 90. The data source is secondary data in the form of sustainability reports. Data was taken using non-probability techniques with certain criteria. The analysis technique uses SEM-PLS. The results of the study show that the board of directors has a significant positive effect on ESG disclosure. The board gender diversity has a significant positive impact on ESG disclosure. This study also obtained empirical evidence that the CSR committee has a significant positive influence on ESG disclosure. The study was unable to provide empirical evidence of a significant positive influence of the board of commissioners towards ESG disclosure.

INTRODUCTION

The concept of corporate value no longer focuses on the interests of shareholders, but also all stakeholders. Corporations need to maintain a balance between creating good corporate value and fulfilling their social responsibilities. Li et al. (2018) state corporations are required to be transparent in carrying out activities related to environmental, social, and governance (ESG) aspects. Sustainable and responsible business practices covering environmental, social and governance aspects are the way to reduce risk and increase the trust of investors and other stakeholders. ESG disclosure also shows the corporation's performance and success in maintaining the sustainability of its business (Du et al., 2023, Chen et al., 2024).

Kerber and Simon (2021) showed that investments taking ESG into account were USD 542 billion in 2020 and USD 285 billion in 2019. Then on November 30, 2021, the fund of 650 billion USD is an ESG-focused investment worldwide (Kerber and Simon, 2021). In Indonesia, Financial Services Authority (FSA) data as of December 2020, there were 14 ESG-based mutual fund products with managed funds reaching 3.062 trillion rupiah (Yoshio, 2020). This figure has increased significantly since the first ESG-based mutual funds were present in Indonesia in 2015 with a managed fund value of only 36 billion rupiah (Yoshio, 2020). In this case, the corporations will continue to increase ESG disclosure to attract investors' attention so that they are willing to invest their funds. The corporation seeks to maintain the sustainability of its business through ESG disclosure to its stakeholders.

Indonesia has regulations governing the implementation of sustainable finance for financial service institutions, issuers and public corporates. Environmental, social, and governance (ESG) is a concept that pays special attention to the sustainability of a corporation's business, which includes 3 factors, namely the environment, social and governance (Li et al., 2018). Research result Junius et al. (2020), provides different evidence that ESG disclosure does not affect corporate performance. ESG disclosures made by corporations require support from corporate organs such as the board of commissioners, board of directors, diversity of the board of directors, and the CSR committee. The board of commissioners ensures the implementation of the corporate strategy, supervises management in managing the corporation, and requires accountability regarding ESG issues. Supervision of the environment, social, and corporate governance is getting tighter as the board of commissioners increases.

A corporate organ that is no less important than the board of commissioners is the board of directors. The duty of the board of directors is to manage and make strategic decisions so that the corporate goals can be achieved. Gender diversity in the board of directors has become a focus for corporations in an effort to create a more conducive and collaborative work environment. The presence of women as board directors is believed to be able to encourage the organizations to make more transparent ESG disclosures. Study Husted and Sousa-Filho (2019) provides empirical evidence that board gender diversity has a significant positive effect on ESG disclosure. Different results were given by the research Nicolo et al. (2023), where board gender diversity cannot influence ESG disclosure.

ESG disclosure is also related to the CSR committee formed by the organization. The corporate social responsibility (CSR) committee is a group or work team within a corporation that is responsible for managing and implementing an organization's corporate social responsibility (CSR) program initiatives. The CSR Committee also plays an important role in addressing sustainable business practices, overseeing sustainable activities, and formulating CSR policies (Radu and Smaili, 2021). According to Arayssi et al. (2020), emphasized that having a committee that handles CSR and/or sustainability issues might be a solution in monitoring business activities. ESG Disclosure influenced by the CSR committee (Nicolo et al., 2023).

Corporations that carry out business activities are required to be environmentally friendly and socially responsible. ESG principles require corporations to carry out their operational and business activities. Environmental criteria are the impact of the corporate operational activities on the environment and the commitment to maintaining environmental sustainability. Social criteria are how much a corporation contributes to its local community and how the corporate profits can be shared fairly. Governance criteria are how a corporation behaves in carrying out operations by paying attention to the dimensions of governance structure, conflicts of interest, effectiveness of risk management processes, and others. ESG disclosure is critical for sustainable business and shows corporate performance. The purpose of this study is to provide empirical evidence of the influence of board characteristics (commissioners and directors) and corporate social responsibility (CSR) committees on ESG disclosure.

1. LITERATURE REVIEW

1.1 Stakeholder Theory

Corporate management carries out business management and has the main objective of improving performance over time. Management pays attention to the interests of its stakeholders in achieving the corporate vision, mission and strategic goals. Stakeholders are starting to change their perspective by not only looking at financial performance, but also at non-financial performance such as environmental, social,

and governance factors. ESG disclosure shows that the corporation has fulfilled stakeholders' rights to obtain information on sustainable aspects of the corporation's operations.

Freeman (2015), stated that stakeholders refer to individuals or specific groups (such as employees, communities, investors, creditors, and government agencies) who have the ability to influence or are influenced by the corporation's activities. Management must identify these stakeholders and design a balanced strategy to meet their needs without negatively influencing each other. The concept of Environmental, Social, and Governance (ESG) disclosure has emerged as a new approach that can be applied across various industry sectors and used by stakeholders to evaluate a corporation's role in carrying out its activities according to their preferences. ESG disclosure becomes a means of dialogue between corporations and stakeholders towards the better (Peng and Isa, 2020; Kubalek et al., 2024).

1.2 Board of Commissioners and ESG Disclosure

The supervisory function is carried out by the board of commissioners over the implementation of strategic plans, corporate operations and ESG-related issues. Supervision is an effort to ensure that social, environmental programs and corporate governance practices are implemented properly. The board of commissioners is an internal mechanism of corporate governance to supervise and provide direction on corporate management. Experience, expertise, knowledge and number of board of commissioners will provide support for supervisory activities more efficiently and effectively.

In the context of stakeholder theory, corporations will meet the needs of their stakeholders. The corporation will also try to align the interests of the corporation and stakeholders. The demand to provide a variety of information has increased the demand for ESG disclosure. The board of commissioners supervises these activities. Research result Ellili (2023), said the board of commissioners will encourage ESG disclosure as a form of transparency regarding the corporate performance that pays attention to social and environmental elements. The first hypothesis proposed is.

H1: The board of commissioners has a positive influence on ESG disclosure.

1.3 Board of Directors and ESG Disclosure

Indonesia adopts a two-tier system in corporate management. The two-tier system separates the supervisory board and the executive board, namely the supervisors (commissioners) and the executives (directors). The board of directors makes strategic decisions and manages the corporate operations and ensures that the corporate goals are achieved. One of the strategic decisions made by the board of directors is to implement ESG principles and disclose ESG in sustainability reports (Knezevic et al., 2023). In the context of stakeholder theory, ESG disclosure is an effort to accommodate the interests of corporate stakeholders.

The board of directors discloses ESG in its annual report as a form of fulfilling its responsibility to stakeholders. Research result Suttipun (2021), stated that a significant number of board directors would increase ESG disclosure. The number of board directors also reflects the diversity of backgrounds, knowledge, and functions performed by the board of directors. This encourages an increase in the level of quality of decision-making, such as disclosure of ESG-related information. The second hypothesis is.

H2: The board of directors has a positive effect on ESG disclosure.

1.4 Board Gender Diversity and ESG Disclosure

ESG disclosure is a form of sustainable performance. Research on corporate governance, particularly board characteristics and ESG disclosure, has grown rapidly (Lagasio and Cucari, 2019). The board of directors has the duty of making strategic decisions within the company. One of the management decisions that the board of directors pays attention to is ESG disclosure (Khemakhem et al., 2022).

Stakeholder theory suggests that increasing the presence of women on boards of directors encourages proactive strategies in responding to stakeholder demands for better ESG disclosure (Ben-Amar et al., 2017). Gender diversity is one of the characteristics of the board of directors that influences ESG disclosure (Manita et al., 2018; Tingbani et al., 2020). The third hypothesis proposed in the study is.

H3: Gender diversity of the board of directors has a positive impact on ESG disclosure.

1.5 Corporate social responsibility (CSR) committee and ESG disclosure

The corporation formed a CSR committee to focus on sustainability issues, managing the corporation's relationship with its stakeholders effectively (Cucari et al., 2018). The corporation activities related to CSR programs are the focus of the CSR committee. The presence of a CSR committee does encourage sustainability (Fuente et al., 2017). CSR implementation can improve corporation performance and provide non-financial information to stakeholders.

Stakeholder theory explains how the role of the CSR committee in disclosing social information to increase the credibility of the corporation to its stakeholders. The corporation credibility is maintained by handling sustainability and business environment issues properly and accountably. The presence of a CSR committee provides guidance for managers in managing CSR issues effectively (Derchi et al., 2020). The description above is a basis for researchers to propose the fourth hypothesis, namely.

H4: CSR committee has a positive influence on ESG disclosure.

2. RESEARCH METHODS

Research using a quantitative approach. According to Sugiyono (2019), states that the quantitative approach is research with data in the form of numbers or qualitative data that is expressed in numbers. The source of research data is observations from secondary data. The research data comes from corporate annual reports and sustainability reports. The research data was taken using a non-probability technique, namely a purposive sampling technique using criteria 1. Corporations listed on IDX30 2019-2023. 2. Corporations listed on IDX30 consecutively during 2019-2023. 3. Corporations listed on IDX30 in 2019-2023 publish annual reports and sustainability reports. This research uses the technique of Partial Least Squares Structural Equation Modeling (SEM PLS - Hair et al., 2022).

This study has dependent and independent variables. The dependent variable in the study is ESG disclosure as measured by the ESG Reporting Guide 2.0 indicator, issued by Nasdaq in 2019, totaling 30 items, namely 10 environmental items, 10 social items, and 10 governance indicator items (Zuhrotun and Triana, 2023). The independent variables in this study consist of 1. The board of commissioners is proxied by the number of members of the board of commissioners (Nicolo et al., 2023). 2. The board of directors is measured by the number of members of the board of directors (Nicolo et el., 2023). 3. Gender diversity in the board of directors is measured by the percentage of female directors in the board of directors (Shakil et al., 2021). 4. CSR Committee is measured by a dummy variable that has a value of 1 if the company has a CSR committee, or 0 if it does not (Radu and Smaili, 2022).

3. RESULTS AND DISCUSSION

Research data was taken from annual reports and sustainability reports. The research uses SEM PLS to process research data. Research data came from 18 companies in 5 years of research observation. Test results using SEM PLS obtained the following things: *Average path coefficient* (APC) of 0.226, the value of 0.437 for *Average R-square* (ARS), *Average Adjusted R-square* (AARS) which is 0.411, *Average Variance inflation factor* (AVIF) is 1.679, *Average Full Collinearity VIF* (AFVIF) namely 1.506 and *TenenhausGoF (GoF)* is 0.661. The research is stated in the fit model (figure 1) and (table 1). The results of the hypothesis test of each variable are presented in (figure 2), (table 2) and multiple linear regression (figure 3).

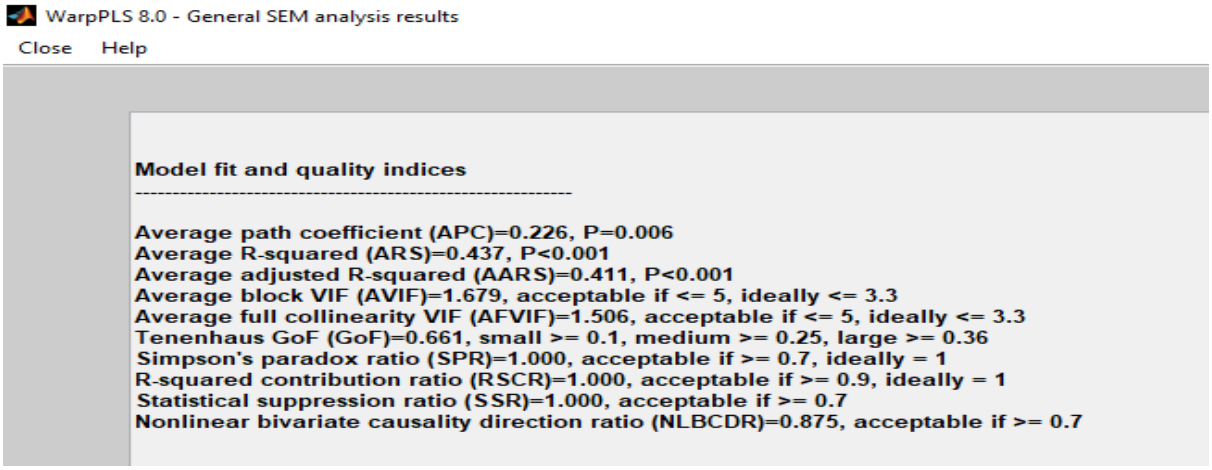

Figure 1. Output of the fit model
Source: own

Table 1. Model fit test results

Model Fit	*Value*	*Significance*	*Rule Of Thumb*	*Explanation*
Average path coefficient (APC)	0,223	P=0,020	P<0,05	Fulfil
Average R-square (ARS)	0,421	P= <0,001	P<0,05	Fulfil
Average Adjusted R-square (AARS)	0,373	P= <0,001	P<0,05	Fulfil
Average Variance inflation factor (AVIF)	1,779		≤5 better ≤3,3	Fulfil
Average Full Collinearity VIF (AFVIF)	1,504		≤5 better ≤3,3	Fulfil
TenenhausGoF (GoF)	0,649		Small ≥0,1 Medium ≥ 0,25 Large ≥ 0,36	Large

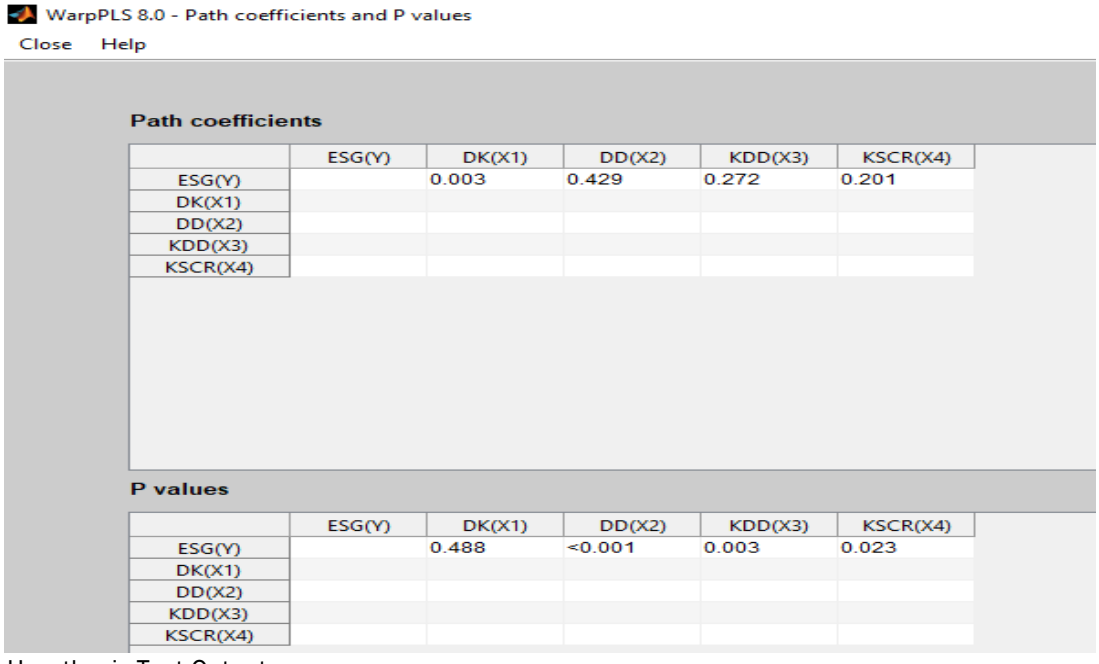

Figure 2. Hypothesis Test Output
Source: Own

Table 2. Hypothesis Test Results

Variabel	*Path coefficient*	*P-value*	*Rule of Thumb*	*Conclusion*
X1 (Board of Commissioners)	0,003	0,488	P>0,05	*Rejected*
X2 (Board of Directors)	0,429	<0,001	P<0,05	*Be accepted*
X3 (Board of Gender)	0,272	0,003	P<0,05	*Be accepted*
X4 (CSR Committee)	0,201	0,023	P<0,05	*Be accepted*

Source: own

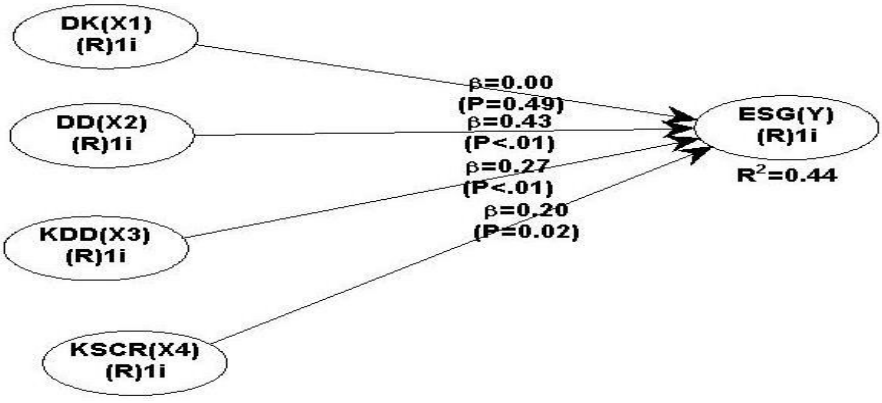

Figure 3. Multiple Linear Regression Results

The test results obtained the first empirical evidence that the board of directors has a significant positive effect on ESG disclosure. Second, board gender has a significant positive influence on ESG disclosure. Then, the CSR committee has a significant positive impact on ESG disclosure. This study did not find a positive influence of the board of commissioners on ESG disclosure.

3.1 The influence of the board of commissioners on ESG disclosure

Statistical testing obtained a significance value of 0.488 and a path coefficient of 0.003. The form of communication carried out by the corporations regarding their social, environmental, and sustainability performance is to provide information to stakeholders through ESG disclosure. The board of commissioners, with its duties and responsibilities to oversee the corporate activities, is certainly expected to be able to encourage the corporation to make ESG disclosures. In the context of stakeholder theory, ESG disclosure is a form of transparency of a corporation's non-financial information to its stakeholders.

The board of commissioners supervises ESG disclosure to ensure the corporation accommodates the interests of its stakeholders. The test results in this study are that the board of commissioners does not have a significant positive influence on ESG disclosure. The board of commissioners supervises the implementation of the corporate operations but is not directly involved in operations and strategic decision-making. The board of commissioners is unable to encourage ESG disclosure by the corporation.

3.2 The impact of the board of directors on ESG disclosure

The results of statistical testing obtained a significance value of 0.001 and a path coefficient of 0.429. Because the board of directors has duties and responsibilities in managing the corporate operations, taking strategic policies, and providing accountable and transparent reporting to its stakeholders. The Corporations have an obligation to comply with regulations and be transparent about the performance they achieve over a certain period of time. Disclosure of ESG information is useful to meet the needs of

corporation stakeholders to help make appropriate economic decisions, manage risk management well, and increase the corporation's credibility (El-Deeb et al., 2023).

Corporates disclose ESG information to increase credibility to stakeholders. The board of directors as policy makers for corporate operations must be transparent and accountable to its stakeholders. The Board size is the total number of board members, and larger boards have different viewpoints, making them more efficient in environmental and social disclosure (Campanella et al., 2021). ESG disclosure also provides information especially for investors to decide whether to invest or not (El-Deeb et al., 2023). The results of this study are in line with research Nicolo et al. (2023), namely that ESG disclosure is influenced by the size of the corporation's board of directors.

3.3 The Impact of Board of Directors Gender Diversity on ESG Disclosure

The significance value of board gender diversity is 0.003 and the path coefficient value is 0.272. The gender diversity of the board is reflected by the presence of women on the board of directors, to participate in the management and policy making of the organization. The results of this study provide empirical evidence of a significant positive influence of gender diversity on the board of directors on ESG disclosure (Arayssi et al., 2020; Suttipun, 2021). Gender diversity aligns the interests of the corporation with its stakeholders. Gender diversity is important in corporate governance (Nicolo et al., 2022).

The Boards with gender diversity are more likely to represent stakeholders because they pay more attention to corporate performance (Pareek et al., 2021). Gender diversity of the board of directors will make corporate decisions and policies more diverse (Adams and Ferreira, 2009). The presence of women in the composition of the board of directors will be able to improve environmental, social, and corporate governance performance as well as financial performance (Bear et al., 2010).

3.4 The effect of CSR committees on ESG disclosure

The significance value of the CSR committee is 0.023 and the path coefficient value is 0.201. The formation of a CSR committee is a signal that the organization is accommodating the interests of stakeholders regarding social, environmental and governance issues. CSR committees tend to be sensitive to stakeholder demands (Radu and Smaili, 2021). Helfaya and Moussa (2017), State CSR committee can promote the corporation's relationship with stakeholders.

The CSR Committee has the duty of overseeing the implementation of social programs run by the organization. The corporation's social programs can be an indicator of the success of the corporate performance. The CSR Committee encourages corporations to provide transparency in non-financial information through disclosure of accountability for environmental, social, and governance (ESG) activities. CSR committees help improve the corporation’s image in social and environmental aspects.

CONCLUSION

ESG is an environmental, social, and governance concept implemented by corporations to maintain business sustainability. ESG disclosure provides easy access to information for stakeholders. Board size, board gender diversity, CSR committee can create better interactions between corporations and stakeholders. The organization has an obligation to provide financial and non-financial reports and information to its stakeholders. Non-financial information, one of which is in the form of ESG disclosure, is used by stakeholders as a basis for strategic decision making. The results of this study provide empirical evidence that the board of commissioners does not have a significant positive influence on ESG disclosures made by corporations.

The board of commissioners has the main task of supervising the operational activities of the corporation. The board of commissioners does not have direct authority to make decisions or policies related to the corporate operations. ESG disclosure is a policy taken by corporations to meet the needs of their stakeholders. ESG disclosure is a policy adopted by the board of directors. ESG disclosure aims to balance three things, namely social, environmental, and governance towards the sustainability of the corporation's

business. ESG disclosure is more influenced by the board of directors, board gender diversity, and CSR committee.

The results of this study indicate that the board of directors, board gender diversity and CSR committee have a significant positive influence on ESG disclosure. This can be explained that the board of directors has an active role in operational management and the corporation's policy makers will understand that information related to the environment, social, and governance is important for stakeholders. The presence of women on boards of directors encourages proactive strategies that respond to stakeholder demands for greater sustainability disclosure (Ben-Amar et al., 2017). The presence of women on the board of directors also adds other atmosphere to the corporation's strategic decision-making. Women are more cautious and have feminine traits, so they pay more attention to ESG-related issues. Meanwhile, the CSR committee is a committee formed by the corporation with a focus on social and environmental programs run by the corporation. So that the organization will always strive to improve performance in social, environmental and governance aspects.

REFERENCES

Adams, R.B., Ferreira, D. (2009), "Women in the boardroom and their impact on governance and performance", *Journal of Financial Economics",* Vol. 94, No. 2, pp. 291–309, https://doi.org/10.1016/j.jfineco.2008.10.007

Arayssi, M., Jizi, M., Tabaja, H. H. (2020), "The impact of board composition on the level of ESG disclosures in GCC countries", *Sustainability Accounting, Management and Policy Journal,* Vol. 11, No. 1, pp. 137–161, https://doi.org/10.1108/SAMPJ-05-2018-0136

Bear, S., Rahman, N., Post, C. (2010), "The Impact of Board Diversity and Gender Composition on Corporate Social Responsibility and Firm Reputation", *Journal of Business Ethics,* Vol. 97, No. 2, pp. 207–221, https://link.springer.com/article/10.1007/s10551-010-0505-2

Ben-Amar, W., Chang, M., McIlkenny, P. (2017), "Board gender diversity and corporate response to sustainability initiatives: Evidence from the carbon disclosure project", *Journal of Business Ethics,* Vol. 142, No. 2, pp. 369–383, https://doi.org/10.1007/s10551-015-2759-1

Campanella, F., Serino, L., Crisci, A., D'Ambra, A. (2020), "The role of corporate governance in environmental policy disclosure and sustainable development", *Corporate Social Responsibility and Environmental Management,* Vol. 28, No. 1, pp. 474-484, https://doi.org/10.1002/csr.2062

Chen, L., Johari, J., Mohd Said, R. (2024), "Do Green Funds Contribute to Corporate Environmental Performance? Empirical Evidence from China", *Transformations in Business & Economics*, Vol. 23, No 1 (61), pp. 259-280.

Cucari, N., de Falco, S. E., Orlando, B. (2018), "Diversity of board of directors and environmental social governance: evidence from Italian listed companies", *Corporate Social Responsibility and Environmental Management,* Vol. 25, No. 3, pp. 250-266, https://doi.org/10.1002/csr.1452

Derchi, G.-B., Zoni, L., Dossi, A. (2020), "Corporate social responsibility performance, incentives, and learning effects", *Journal of Business Ethics,* Vol. 173, No. 3, pp. 617-641, https://doi.org/10.1007/s10551-020-04556-8

Du Y.C., Zhang J.D., Deng H.Y. (2023), "Environmental, Social and Governance (ESG), Financing Constraints, and Enterprise Value", *Transformations in Business & Economics*, Vol. 22, No 3A (60A), pp. 1039-1059.

El-Deeb, M.S., Ismail, T.H., El Banna, A.A. (2023), "Does audit quality moderate the impact of environmental, social and governance disclosure on firm value? Further evidence from Egypt", *Journal of Humanities and Applied Social Sciences,* Vol. 5, No. 4, pp. 293–322, https://doi.org/10.1108/jhass-11-2022-0155

Ellili, N.O.D. (2023), "Impact of corporate governance on environmental, social, and governance disclosure: Any difference between financial and non-financial companies?", *Corporate Social Responsibility and Environmental Management,* Vol. 30, No. 2, pp. 858–873, https://doi.org/10.1002/csr.2393

Freeman, R.E. (2015), "Stakeholder Theory"in *Wiley Encyclopedia of Management*, Professor Sir Cary L Cooper (Ed.), John Wiley & Sons, pp. 1–6, https://doi.org/10.1002/9781118785317.weom020179

Fuente, J.A., García-Sánchez, I.M., Lozano, M.B. (2017), "The role of the board of directors in the adoption of GRI guidelines for the disclosure of CSR information", *Journal of Cleaner Production,* Vol. 141*,* pp. 737–750, https://doi.org/10.1016/j.jclepro.2016.09.155

Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M. (2022), *A Primer on Partial Least Square Structural Equation Modeling* (PLS-SEM), SAGE Publication, Inc., California.

Helfaya, A., Moussa, T. (2017), "Do board's corporate social responsibility strategy and orientation influence environmental sustainability disclosure? UK evidence", *Business Strategy and the Environment,* Vol. 26, No. 8, pp. 1061–1077, https://doi.org/10.1002/bse.1960

Husted, B. W., Sousa-Filho, J.M. de. (2019), "Board structure and environmental, social, and governance disclosure in Latin America", *Journal of Business Research*, Vol. 102, pp. 220–227, https://doi.org/10.1016/j.jbusres.2018.01.017

Junius, D., Adisurjo, A., Rijanto, Y.A., Adelina, Y.E. (2020), "The Impact of ESG Performance to Firm Performance", *Jurnal Aplikasi Akuntansi,* Vol. 5, No. 1, pp. 21–41, https://jaa.unram.ac.id/index.php/jaa/article/view/84

Kerber, R., Simon, J. (2021), "Analysis: How 2021 became the year of ESG investing", https://www.reuters.com/markets/us/how-2021-became-year-esg-investing-2021-12-23/ (Accessed 26 November, 2023).

Khemakhem, H., Arroyo, P., Montecinos, J. (2022), "Gender diversity on board committees and ESG disclosure: evidence from Canada", *Journal of Management and Governance,* Vol. 27, No. 4, pp. 1397–1422, https://doi.org/10.1007/s10997-022-09658-1

Knezevic,G., Pavlovic, V.,, Bojicic, R. (2023), "Does gender diversity improve CSR reporting? Evidence from the Central and West Balkan banking sector", *Economics and Sociology*, Vol. 16, No. 3, pp. 261-280. doi:10.14254/2071-789X.2023/16-3/14

Kubalek, J., Erben, E., Kudej, M. (2024), "Impact of the environmental ESG pillar on firm sustainability: Empirical research in the V4 countries", *Journal of International Studies*, Vol. 17, No. 3, pp. 148-163. doi:10.14254/2071-8330.2024/17-3/8

Lagasio, V., Cucari, N. (2019), "Corporate governance and environmental social governance disclosure: A meta-analytical review", *Corporate Social Responsibility and Environmental Management,* Vol. 26, No. 4, pp. 701–711, https://doi.org/10.1002/csr.1716

Li, Y., Gong, M., Zhang, X.-Y., Koh, L. (2018), "The impact of environmental, social, and governance disclosure on firm value: The role of CEO power", *The British Accounting Review,* Vol. 50, No. 1, pp. 60–75, https://doi.org/10.1016/j.bar.2017.09.007

Manita, R., Giuseppina, M., Dang, R., Houanti, L. (2018), "Board Gender Diversity and ESG Disclosure: Evidence from the USA", *Journal of Applied Accounting Research,* Vol. 19, No. 2, pp. 206–224, https://doi.org/10.1108/JAAR-01-2017-0024

Nicolò, G., Zampone, G., Sannino, G., De Iorio, S. (2022), "Sustainable corporate governance and non-financial disclosure in Europe: does the gender diversity matter?", *Journal of Applied Accounting Research,* Vol. 23, No. 1, pp. 227–249, https://doi.org/10.1108/JAAR-04-2021-0100

Nicolo, G., Zampone, G., Sannino, G., Tiron-Tudor, A. (2023), "Worldwide evidence of corporate governance influence on ESG disclosure in the utilities sector", *Utilities Policy*, Vol. 82 (March), 101549. https://doi.org/10.1016/j.jup.2023.101549

Pareek, R., Sahu, T. N., Gupta, A. (2021), "Gender diversity and corporate sustainability performance: empirical evidence from India", *Vilakshan-XIMB Journal of Management,* Vol. 20, No. 1, pp. 140-153, https://doi.org/10.1108/XJM-10-2020-0183

Peng, L. S., Isa, M. (2020), "Environmental, social and governance (ESG) practices and performance in shariah firms: Agency or stakeholder theory?", *Asian Academy of Management Journal of Accounting and Finance,* Vol. 16, No. 1, pp. 1–34, https://doi.org/10.21315/aamjaf2020.16. 1.1

Radu, C., Smaili, N. (2021), "Alignment Versus Monitoring: An Examination of the Effect of the CSR Committee and CSR-Linked Executive Compensation on CSR Performance", *Journal of Business Ethics,* Vol. 180, No. 1, pp. 145-163, https://doi.org/10.1007/s10551-021-04904-2

Shakil, M. H., Tasnia, M., Mostafiz, M. I. (2021), "Board gender diversity and environmental, social and governance performance of US banks : moderating role of environmental, social and corporate governance controversies", *International Journal of Bank Marketing*, Vol. 39, No. 4, pp. 661–677, https://doi.org/10.1108/IJBM-04-2020-0210

Sugiyono. (2019), *Statistics for Research*, CV Alfabeta, Bandung.
Suttipun, M. (2021), "The influence of board composition on environmental, social and governance (ESG) disclosure of Thai listed companies", *International Journal of Disclosure and Governance,* Vol. 18, No. 4, pp. 391–402, https://doi.org/10.1057/s41310-021-00120-6
Tingbani, I., Chithambo, L., Tauringana, V., Papanikolaou, N. (2020), "Board gender diversity, environmental committee and greenhouse gas voluntary disclosures", *Business Strategy and the Environment,* Vol. 29, No. 6, pp. 2194–2210, https://doi.org/10.1002/bse.2495
Yoshio, A. (2020), "The Rising Trend of ESG Investment in Indonesia", Databoks, Katadata.co.Id. https://databoks.katadata.co.id/datapublish/2021/06/04/tren-menanjak-investasi-esg-di-indonesia
Zuhrotun, Triana, E. (2023), "The Influence of Environmental Social and Governance, Return on Equity and Earning Per Share on Stock Prices", *Buletin Studi Ekonomi,* Vol. 28, No. 2, pp. 206-219, https://ojs.unud.ac.id/index.php/bse/article/view/101210

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Nasania, J.K. (2026), "Exploring the Dynamic Relationship Between Regional Exports and Economic Growth: A Panel Autoregressive Analysis of Kenya and Tanzania", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 79-90.

Exploring the Dynamic Relationship Between Regional Exports and Economic Growth: A Panel Autoregressive Analysis of Kenya and Tanzania

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ARTICLE INFO

Received October 11, 2024
Revised from November 11, 2024
Accepted 20, December 11, 2024
Available online April 15, 2026

JEL classification: F11, F41, F43

DOI: 10.14254/1800-5845/2026.22-2.7

Keywords:
Economic growth,
Export trade,
Panel Autoregressive analysis,
Regional exports,
Panel-ARDL-PMG.

ABSTRACT

Export led growth hypothesis and endogenous growth theory asserting that exports of goods and services and imports of capital goods can influence the economic growth. This paper investigates the dynamic relationship betwixt regional exports and growth of economy in East African countries particularly Kenya and Tanzania, grounded in the export-led growth hypothesis and endogenous growth theory. Utilizing a panel dataset from the World Development Indicators spanning 1970 to 2023, we analyze economic growth, proxied by GDP in current US dollars, alongside regional exports from Sub-Saharan Africa, South Asia, East Asia and Pacific, the Arab World and Imports. We utilize the Levin-Lin-Chu (LLC) test for assessing unit roots, as well as the Kao cointegration test to evaluate cointegration relationships. Thereafter panel ARDL-Pooled Mean Group (Panel-ARDL-PMG) was estimated. Empirical findings reveal that all variables are non-stationary at level and once differenced becomes stationary. Again, variables have long run relationship means are cointegrated. Employing the panel ARDL-Pooled Mean Group methodology, our findings indicate that exports from South Asia and East Asia and Pacific, along with imports, significantly contribute to economic growth, while exports from Sub-Saharan Africa and the Arab World adversely impact growth in the long run. In the short run, only imports and exports from the Arab World positively influence economic growth, whereas other regions hinder growth. These results suggest that policymakers should enhance international trade policies to boost export contributions to economic growth, particularly by focusing on improving export quality and diversifying trade partnerships. Strengthening these aspects can foster sustainable economic development in Kenya and Tanzania.

INTRODUCTION

The relationship betwixt export trade and growth of economy has been a long-standing subject of economic debate and research. Export trade, as a core component of international trade, involves the trading of goods and services across borders and is recognized as a vital driver of the development of the economy. As Uddin and Khanam (2017) highlight, international trade has contributed significantly to global economic growth, facilitating the efficient allocation of resources and promoting the specialization of production. For many countries, including Kenya and Tanzania, foreign trade provides access to essential goods and

services, while enabling the export of domestic agricultural and industrial products (Worku, 2021; Gatimu, 2020).

While much research has explored the function of trade in the development of the economy, gaps remain in our understanding of the specific impact of exports and imports in the growth of economy across different regions. Previous studies have focused primarily on trade dynamics within SSA, SADC, and the ECOWAS, and the European Union, but limited attention has been given to the trade relationships between East African nations and regions such as South Asia, East Asia and the Pacific, and the Arab world (Okoli et.al, 2024; Worku, 2021). This research seeks to fill that gap by examining how regional exports and imports influence the growth of economy in selected East African countries, particularly Kenya and Tanzania.

International trade theory provides the foundation for understanding how trade contributes to growth. The theories of absolute advantage and comparative advantage emphasize that countries should go for in producing goods in which they possess a comparative advantage, meanwhile importing goods they have a comparative disadvantage. The Heckscher-Ohlin theory further posits that countries should export products based on their plentiful factors of production, like capital or labor. For Kenya and Tanzania, both of which are labor-abundant, this suggests a focus on exporting labor-intensive products, particularly from the agricultural sector, while importing capital goods that enhance production capacity (Ali et al., 2021Aluko; Adeyeye, 2020). However, the applicability of these theories must be assessed within the context of contemporary trade patterns and economic policies.

Trade openness, characterized by increased exports and imports, has been recognized as a main engine for economic growth, with the ELG model playing a central role in many countries' economic strategies. Moreover, the importation of capital goods, which facilitates technological advancement and enhances production efficiency, has been shown to contribute to growth (Espoir et al., 2024). The current study seeks to analyze how exports and imports, particularly the importation of capital goods, affect growth of economy in Kenya and Tanzania's trade with regions such as Sub-Saharan Africa, South Asia, East Asia and the Pacific, and the Arab world.

The gist of this paper lies in its contribution to both academic research and policymaking. First, it offers new insights into the effect of regional exports on growth of economy, especially in East Africa, and highlights indispensable role of capital goods imports in enhancing this growth. Second, it provides practical policy recommendations, offering valuable guidance for policymakers in Kenya and Tanzania on how to optimize foreign trade strategies to align with global trade dynamics. Third, by focusing on relatively underresearched regions, this study broadens the scope of existing literature on foreign trade and its implications for economic development. Understanding the trade patterns between East Africa and regions such as South Asia and the Arab world is critical, as these regions are becoming increasingly important trading partners for Kenya and Tanzania.

This research employs modern econometric techniques to investigate long-run and short-run association ship between exports, imports, and growth of economy. Specifically, the study utilizes the Panel Autoregressive Distributed Lag (panel-ARDL-PMG) model, that permit for the analysis of both long- and short-term dynamics between these variables. This method provides a thorough view the extent exports and imports determine growth of economy, while also identifying individual short-term effects for each country. The panel-ARDL-PMG approach is particularly well-suited to this analysis as it allows the assessment of long-run equilibrium and short-run adjustments, thereby offering a more holistic understanding of trade's impact on growth.

The findings will provide a clearer picture of how exports from Kenya and Tanzania to regions such as South Asia and the Arab world contribute to their economic growth, while also offering insights into the role of capital goods imports in boosting production efficiency. The results will not only inform policymakers but also shape future research directions on foreign trade and economic development in the region.

This paper is arranged as follows: Section One presents the review of literature; Section Two details the research methodology and data; Section Three provides the empirical results; and the final section offers conclusions.

1. LITERATURE REVIEW

1.1 Theoretical Literature Review

This study is grounded in classical and modern economic theories of trade, including comparative advantage, the Heckscher-Ohlin (H-O) model, and endogenous growth theory, while also considering insights from contemporary trade theories. These structures are essential in knowing the association betwixt regional exports and growth in Kenya and Tanzania.

The comparative advantage theory, pioneered by David Ricardo, argues that countries should go for in the production as well as export of goods they possess a relative efficiency advantage compared to other nations. This concept remains central to trade theory, as it provides a rationale for the international division of labour and resource allocation. As explained by Worku (2021), specialization according to comparative advantage enables countries to maximise their productivity and economic welfare. However, comparative advantage has its limitations, particularly in explaining intra-industry trade and trade in services, which are significantly important in the global economy. For developing countries like Kenya and Tanzania, these limitations necessitate an exploration of how comparative advantage interacts with more structural factors like government policies and trade agreements.

Building on comparative advantage, the Heckscher-Ohlin (H-O) theory extends the discussion by focusing on factor endowments. The H-O theory put forward that a country can export goods that intensive use its plentiful resources. Thus, capital-rich countries can export capital-intensive products, while labour-rich countries can export labor-intensive goods (Espoir et al., 2024; Ali et al., 2021; Aluko & Adeyeye, 2020). In the context of Kenya and Tanzania, both nations are endowed with substantial arable land and natural resources, which positions them to export primarily agricultural products. This alignment with the H-O theory is evident in their export profiles, which feature traditional goods such as cashew nuts, coffee, tea, sisal, cotton, and pyrethrum, as well as non-traditional exports like iron ore, gold, diamonds, and Tanzanite (Moshi et.al, 2024). However, the H-O model has been critiqued for its inability to explain trade patterns in economies that rely on increasing returns to scale or where technology plays a dominant role in determining trade flows.

To address these gaps, the study incorporates endogenous growth theory, that highlights the capacity of capital formation and technological innovation in promoting long-term economic growth. According to endogenous growth theory, international trade can stimulate economic development by facilitating the importation of capital goods and technology, which enhances a country's productive capacity (Okyere & Jilu, 2020; Dudzeviciūtė et al., 2017). This theory is particularly relevant for Kenya and Tanzania, as both nations have focused on expanding their industrial base and modernizing their agricultural sectors through imported technology and machinery. Endogenous growth theory recognises that increased investment in human capital and technological innovation is critical for sustaining productivity and boosting exports. The theory also challenges the traditional notion of exogenous factors driving growth, suggesting that internal factors such as innovation policies and capital investment strategies can be powerful growth engines.

In addition to these classical and endogenous frameworks, contemporary trade theories like “new trade theory” and “new-new trade theory” provide valuable insights for understanding the export dynamics in developing economies. New trade theory, for instance, emphasises the economies of scale’s role and network effects in explaining why some countries dominate global trade in certain sectors, even in the absence of clear comparative advantage. Moreover, the new trade theory, which focuses on firm-level heterogeneity, highlights how differences in firm productivity within the same industry can drive trade patterns. These modern theories suggest that the export performance of Kenya and Tanzania may not only be determined by factor endowments but also by the productivity and competitiveness of individual firms, particularly in industries like manufacturing and services.

By integrating these various theoretical perspectives, this study provides an insight of the factors driving regional exports and economic growth in Kenya and Tanzania. It underscores the importance of combining traditional theories of comparative advantage and factor endowments with contemporary insights into innovation, capital formation, and firm-level competitiveness. This integrated approach allows for a more comprehensive analysis of how both exports and imports impact economic growth in these East African nations.

1.2 Empirical Literature

The association betwixt exports, imports, and growth of economy has generated mixed results across different studies, reflecting the complex dynamics of international trade and its diverse impact on economic development. Some studies have found a positive interrelation betwixt exports and growth of economy (Okyere & Jilu, 2020; Dudzevičiūtė et al., 2017; Hodey et al., 2015), while others have reported negative effects, highlighting the need for further investigation, particularly in East African countries. This paper seeks to fill up this gap by contributing to the ongoing debate on the involvement of exports and imports in the growth of economy, with a specific focus in Kenya and Tanzania by providing insights into how exports and imports drive the economy.

Numerous empirical studies support the idea that exports positively influence growth of the economy. For instance, Hodey et al. (2015) found that export influenced the economic growth positively Sub-Saharan Africa (SSA), providing evidence that exports are crucial for the development of economies in this region. Similarly, Dudzeviciūtė et al. (2017) reported a positive association ship between exports and growth of economy in European Union countries, which further strengthens the argument that exports increase economic expansion significantly. Okyere and Jilu (2020) also supported the export-led growth hypothesis, showing that exports had advantageous role on growth of economy in Ghana.

However, the influence of exports is not universally positive. In some countries, exports have been found to reduce economic growth. Wabiga and Nakijoba (2018) reported that exports negatively affected the economic growth in Uganda, indicating that the structure and composition of exports could affect economic outcomes differently depending on the country. Similarly, Ali et al. (2021) found that exports reduced the Bahrain's economic growth, suggesting that the benefits of trade are not automatic and may depend on a range of factors, including the country's infrastructure, industrial base, and institutional frameworks. Also, imports play a complex task in economic growth, with findings that are similarly mixed. In some cases, imports affected economic growth positively. Bakari (2017) found that imports influenced the economic growth positively in Egypt, a result echoed by Mwangi et al. (2020), who observed a similar positive effect in Sub-Saharan Africa. Aluko and Adeyeye (2020) also confirmed the significant effect of imports on economic growth in African countries, suggesting that imports, particularly of capital goods and technology, can stimulate productivity and economic development.

On the other hand, imports have been found to hinder economic growth in certain countries. Uddin and Khanam (2017) reported that imports negatively affected economic growth in Bangladesh, attributing this to the excessive reliance on imported goods that suppress domestic production. Okyere and Jilu (2020) also found that imports affecting economic growth negatively in Ghana, while Ali et al. (2021) observed a similar effect in Bahrain. These studies indicate that the correlation betwixt imports and economic growth is not straightforward and can depend on aspects like the composition of imports, domestic industrial capacity, and trade policies.

The conflicting findings on the role of both exports and imports in the growth of economy highlight the complexity of trade's influence on economies. In the case of Kenya and Tanzania, it is essential to examine how their specific trade structures, institutional frameworks, and levels of economic development interact with global trade dynamics. While the literature presents mixed results regarding the function of exports and imports on growth of economy, it is evident that these relationships are influenced by country-specific factors such as infrastructure, institutional quality, and trade policies.

2. METHOD AND DATA

This study employs panel autoregressive techniques to investigate the dynamic interconnection betwixt regional exports and growth of economy. Panel autoregressive models are advantageous because they facilitate the estimation of coefficients in long-run and short-run, thus providing a more nuanced understanding of the interactions among the variables. This technique also allows for the assessment of individual effects for each variable, a capability that static panel regressions lack (Abille and Meçik, 2023).

The data utilized in this analysis is gathered from the World Bank database, covering the period from 1970 - 2023. Periodization was chosen based on the availability and completeness of data on exports and economic indicators. Before 1970, many export regions had significant gaps in export values, which could hinder the robustness of the analysis. The main dependent variable in this study is GDP, while the independent variables are ESSA, ESA, EEAP, EAW and IMP. The selection of these regions is grounded in their economic relevance and trade relationships with Kenya and Tanzania.

A detailed variables' description and their operational definitions is provided in Table 1. The table outlines the measurement criteria for each variable, ensuring clarity and transparency in the analysis. The selection of the study variables is theoretically supported by the premise that export activities can stimulate economic growth through enhanced production capabilities, job creation, and improved foreign exchange earnings. Conversely, imports may impact economic growth differently relying on the economic context and the nature of the imported goods. Variables under study and measurements are given out in Table 1.

Table 1. Variable Descriptions

Variables	*Measurement*	*Sources*
Gross Domestic Product (GDP)	"GDP (current US$)"	WDI (2024)
Export in Sub Saharan Africa (ESSA)	"Merchandise exports to low- and middle-income economies in Sub-Saharan Africa (% of total merchandise exports)"	WDI (2024)
Export in South Asia (ESA)	"Merchandise exports to low- and middle-income economies in South Asia (% of total merchandise exports)"	WDI (2024)
Export in East Asia and Pacific (EEAP)	"Merchandise exports to low- and middle-income economies in East Asia & Pacific (% of total merchandise exports)"	WDI (2024)
Export in Arab World (EAW)	"Merchandise exports to economies in the Arab World (% of total merchandise exports)"	WDI (2024)
Merchandise Imports (IMP)	"Merchandise imports (current US$)"	WDI (2024)

Source: Researcher's compilation, 2024. Note: Data were sourced from WDI - "World Development Indicators"

2.1 Model Specification

The present study employs the ELG-hypothesis and the endogenous economic growth model to formulate the study's analytical framework. The ELG- hypothesis posits that increases in exports can stimulate economic growth, particularly by enhancing domestic productivity and generating foreign exchange. The endogenous growth model, on the other hand, stresses the function of internal factors like human capital and technological innovation in spurring economic growth. Together, these theories suggest that both exports and internal factors are pivotal economic drivers.

To develop the model, this study follows the methodological approach established by Etensa et al. (2022), which offers a robust framework for analyzing the dynamic relationship betwixt exports and growth of economy. The analysis includes essential pre-estimation tests, namely panel unit root and panel cointegration tests. These tests are crucial for determining the stationarity of the data and long-term association ship betwixt the variables. Specifically, we utilize the Levin-Lin-Chu (LLC) test for assessing unit roots, as well as the Kao cointegration test to evaluate cointegration relationships.

2.1.1 Panel Unit Root

The study employed the LLC to determine the unit root amongst the variables. See equation 1.

$$Y_{it} = pY_{it-1} + \alpha_{0i} + \alpha_{1i}t + u_{it} \quad 1$$

Where i for individual 1 to N at time 1 to T.
$\alpha_{1i}t$ represent time trend, while α_i is an individual effect and u_{it} stands for an error term.

$$u_{it} = \sum_{j=1}^{\infty} \phi_{ij}\, u_{it-j} + \varepsilon_{it} \quad 2$$

2.1.2 Panel Cointegration

Kao (1999) cointegration test was employed to determine the long-run interrelationship between GDP and export from SSA, exports from South Asia, exports from East Asia and Pacific, export from Arab World and imports in selected countries. The merit of this technique tends to estimate the homogeneous association ship via pooling regression and allowing the individual fixed effects. See equation 3 below.

$$Yit = \alpha i + \beta Xit + u_{it} \quad 3$$

Where β and X_{it} are vectors of row and column respectively whereas u_{it} is a regression error term. Testing for cointegration is imperative in this study since it will provide clues in future predictions or forecasting once variables are cointegrated.

$$lnGDP_{it} = \sum_{j=1}^{p} \delta_i lnGDP_{i,t-j} + \sum_{j=0}^{q} \beta_{ij} X_{i,t-j} + \gamma_i + \varepsilon_{it} \quad 4$$

Where $lnGDP_{it}$ is a natural logarithm of gross domestic product stands for dependent variable, X_{it} stands for vectors for independent study variables, δ_i present coefficient of lagged dependent variable, β_{ij} are independent variable's coefficients γ_i stands for unit fixed effect while ε_{it} is the error term.

2.1.3 Panel Autoregressive Distributed Lag Model

The study re-formulated the panel-ARDL model (p,...q) for lagging and differenced variables and inserting error correction term as shown in equation 5. This equation presenting the long run and short run coefficients as well as error correction term (EC_{it-1}).

$$\begin{aligned} lnGDP_t = {} & \Phi_0 + \gamma_1 lnGDP_{t-1} + \gamma_2 ESSA_{it-1} + \gamma_3 ESA_{it-1} + \gamma_4 EEAP_{it-1} + \gamma_4 EAW_{it-1} + \gamma_5 lnIMP_{it-1} \\ & + \sum_{i=1}^{p} \alpha_1 \Delta lnGDP_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta ESSA_{t-i} + \sum_{i=0}^{q} \alpha_3 \Delta ESA_{t-i} + \sum_{i=0}^{q} \alpha_4 \Delta EEAP_{t-i} \\ & + \sum_{i=0}^{q} \alpha_5 \Delta EAW_{t-i} + \sum_{i=0}^{q} \alpha_6 \Delta lnIMP_{t-i} + \lambda ECT_{t-1} + \mu_{it-i} \end{aligned} \quad 5$$

This study employs the semi-log model where GDP and IMP are instituted the natural logarithm whereas other variables are without logarithm. The dependent variable remains the same as in equation 1 while independent variables are expressed as follows: ESSA stands for export from Sub-Saharan Africa, ESA is export from South Asia, EEAP is export from East Asia and Pacific, EAW is export from Arab World, lnIMP represent natural logarithm of Imports and ECT_{t-1} is error correction term as well μ is the error term. ϕ_0 is the constant term, γ_1 to γ_5 are the coefficient of changes of independent variables, α_1 to α_6 are independent variable's coefficients in the short run and λ is error correction term's coefficient. Δ present the difference operator. DGP and Imports are in current US dollar while all other variables are in percentage of total merchandise exports.

3. EMPIRICAL RESULTS

3.1 Descriptive Statistics

Descriptive statistics in table 2 presents the main variables of the study. The mean value of LNGDP is 23.41, indicating a relatively high level of economic output during the sample period. A standard deviation of 1.06 indicating moderate change in GDP across observations, with maximum and minimum values of 21.20 and 25.45, respectively, reflecting fluctuations in the economies of Kenya and Tanzania while maintaining robustness. ESSA exhibits substantial variation, with a mean of 26.46 and a standard deviation of 12.31, highlighting significant disparities in export performance among countries in the region. In contrast, ESA has a mean of 8.75 and a standard deviation of 4.99, suggesting lower export levels. EEAP's mean of 4.62 indicates limited engagement, while EAW's mean of 7.33 reveals potential opportunities for growth in export relationships with Arab nations. The mean value of LNIMP is 21.76, suggesting consistent import levels across the study countries.

Table 2. Descriptive statistics

Variable	*Obs*	*Mean*	*Std. dev*	*Min*	*Max*
LNGDP	108	23.41164	1.061246	21.19542	25.45436
ESSA	108	26.46396	12.3135	.1145155	43.2076
ESA	108	8.74676	4.992399	1.837496	24.08172
EEAP	108	4.61663	4.429142	.2610577	18.28178
EAW	108	7.328722	5.116074	.9075892	27.23149
LNIMP	108	21.76387	1.136115	19.57756	23.77566

Source: Researcher's computation, 2024.

3.2 Correlation Analysis Results

Table 3 show the correlation coefficients. A notable strong positive correlation is observed between LNGDP and LNIMP (0.9346), indicating that higher levels of imports are associated with increased economic growth in Kenya and Tanzania. This implies that imports may play a significant role in stimulating the economies of the two countries. Additionally, LNGDP shows significant positive correlations with other export variables: ESSA (0.4669), ESA (0.5056), and EAW (0.5626). These correlations imply that higher export levels in SSA, EA, and the Arab World are positively linked to the growth of economy, supporting the ELG -hypothesis.

Conversely, EEAP demonstrates weaker correlations with LNGDP (0.2653) and other variables, indicating that exports in EAP may have a limited influence on economic growth. Overall, the correlation analysis highlights the interconnectedness of exports and economic growth, suggesting areas for further investigation in the dynamic relationships among these variables.

Table 3. Correlation Coefficients

Variables	*LNGDP*	*ESSA*	*ESA*	*ESAP*	*EAW*	*LNIMP*
LNGDP	1.0000					
ESSA	0.4669	1.0000				
ESA	0.5056	0.2132	1.0000			
EEAP	0.2653	0.0243	0.3440	1.0000		
EAW	0.5626	0.4795	0.0857	-0.3232	1.0000	
LNIMP	0.9346	0.6747	0.4406	0.1798	0.6407	1.0000

Source: Researcher's computation, 2024.

3.3 Panel Unit Root Results

Table 4 elucidate the findings of the LLC unit-root results, indicating that all variables—gross domestic product (LNGDP), export from SSA, exports from SA, exports from EAP, exports from the Arab World (EAW), and imports (LNIMP)—are non-stationary at the level. However, after differencing once, all variables become stationary.

These findings are in line with with previous studies, like Daniel et al. (2023) and Terefe and Teera (2018), which report similar integration orders among variables in East African countries. The results suggest that the variables share the same order of integration, reinforcing the appropriateness of the model specification used in this study.

Table 4. Levin–Lin–Chu Unit-Root Test Results

LR variance: Bartlett kernel-Without trend		
Variables	*At Level*	*At First Difference*
LNGDP	Non-stationary	Stationary
ESSA	Non-stationary	Stationary
ESA	Non-stationary	Stationary
EEAP	Non-stationary	Stationary
EAW	Non-stationary	Stationary
LNIMP	Non-stationary	Stationary

Source: Researcher's computation, 2024.

3.4 Panel Cointegration Results

Table 5 presents the findings of the Kao test for cointegration, indicating a significant association ship between gross domestic product, exports from SSA, exports from SA, exports from EAP, exports from AW, and imports. All reported p-values are below the 5% significance level, confirming the presence of cointegration among these variables.

This finding is consistent with studies by Okoli et al. (2024), Daniel et al. (2023), Etensa et al. (2022), and Yussuf (2022), which also reported similar results within the East African Community. Moreover, Espoir et al. (2024) corroborated that variables have long-run association ship across 54 African countries. These results suggest that enhancements in exports could significantly influence economic growth in Kenya and Tanzania.

Table 5. Kao Test Cointegration Results

Cointegrating vector	Statistic	p-value
Modified Dickey-Fuller t	-5.8974	0.0000
Dickey-Fuller t	-2.2979	0.0108
Augmented Dickey-Fuller t	-2.6548	0.0040
Unadjusted modified Dickey-Fuller t	-4.0646	0.0000
Unadjusted Dickey-Fuller t	-2.1475	0.0159

Source: Researcher's computation, 2024.

3.5 Pooled Mean Group Regression Results

Table 6 outlines the PMG regression results, illustrating the long-run coefficients and short-run effect of export and import variables on growth of economy in Kenya and Tanzania.

In the long run, exports from South Asia (SA) and East Asia and the Pacific (EAP) significantly enhance economic growth, with increases in ESA and EEAP contributing positively by 0.0393% and 0.1159%, respectively. Conversely, exports from Sub-Saharan Africa (SSA) and the Arab World (AW) negatively influence GDP, with ESSA reducing GDP by 0.0037%, although this effect is statistically insignificant. Imports demonstrate a strong positive relationship with economic growth, showing a significant increase of 1.0547% for every 1% rise in imports.

In the short run, all regional exports, including SSA, SA, and EAP, negatively impact growth, while the Arab World and imports show positive effects. The error correction term, although not statistically significant, indicates that the system adjusts towards long-run association at a rate of 24.5% per annum, confirming the findings from the cointegration analysis. Overall, this suggests that strategic emphasis on improving exports in South Asia and East Asia, alongside enhancing imports, could significantly bolster economic growth in the region.

Table 6. Panel ARDL -PMG Results

D.lngdp	*Coefficient*	*Std. err.*	*z*	*P>|z|*	*[95% conf.*	*interval]*
Long run						
ESSA	-.0036867	.0034765	-1.06	0.289	-.0105004	.0031271
ESA	.039264	.0130971	3.00	0.003	.0135941	.0649338
EEAP	.1158821	.0265321	4.37	0.000	.0638801	.1678842
EAW	-.0376751	.0107786	-3.50	0.000	-.0588007	-.0165494
LNIMP	1.054718	.0471856	22.35	0.000	.9622359	1.1472
Short run						
EC_{it-1}	-.2451063	.1968364	-1.25	0.213	-.6308985	.1406859
DESSA	-.0024466	.0015812	-1.55	0.122	-.0055456	.0006525
DESA	-.0093115	.0042233	-2.20	0.027	-.0175891	-.0010339
DEEAP	-.0221234	.0210105	-1.05	0.292	-.0633032	.0190564
DEAW	.0035477	.0101125	0.35	0.726	-.0162725	.0233679
DLNIMP	.0513896	.1524087	0.34	0.736	-.2473259	.3501052
Cons	.0914036	.0587009	1.56	0.119	-.0236481	.2064553

Source: Researcher's computation, 2024.

3.6 Panel ARDL-PMG and Individual Effect Results

Table 7 presents the Panel ARDL-PMG results, highlighting both long-run coefficients and short-run individual effects on economic growth in Kenya and Tanzania. The long-run results align with those from Table 6, indicating that exports from South Asia and East Asia and Pacific significantly enhance GDP, while exports from Sub-Saharan Africa and the Arab World negatively impact growth.

In the short run, exports from SSA, SA, EAP, and the Arab World (AW) exhibit negative effects on GDP for Tanzania, with coefficients of -0.0040, -0.0051, -0.0011, and -0.0066, respectively. Notably, these effects are statistically insignificant at the 5% level, suggesting that exporting in these regions does not enhance growth of economy in the short run. Conversely, imports have a positive and significant influence, where a 1% increase results in a 0.2038% rise in GDP, emphasizing the importance of capital goods for short-term growth.

In Kenya, the short-run effects are similarly negative for ESSA, ESA, Imports and EEAP, with only EEAP being statistically significant ($p = 0.032$). However, export from the Arab World positively affects GDP, with a coefficient of 0.0137, indicating that trade with this region could stimulate economic growth.

The error correction terms for both countries support the existence of a long-run association ship. In Tanzania, the adjustment speed is 48.3% per annum, while in Kenya, it is 44.2%, indicating that any economic shocks will gradually restore equilibrium. Overall, these findings highlight the nuanced impact of regional exports and imports on growth, with imports playing a crucial role in both countries, while the effectiveness of exports varies significantly by region.

Table 7. Panel ARDL-PMG and Individual Effect Results

D.lngdp	*Coefficient*	*Std. err.*	*z*	*P>|z|*	*[95% conf.*	*interval]*
Long run						
ESSA	-.0036867	.0034765	-1.06	0.289	-.0105004	.0031271
ESA	.039264	.0130971	3.00	0.003	.0135941	.0649338
EEAP	.1158821	.0265321	4.37	0.000	.0638801	.1678842
EAW	-.0376751	.0107786	-3.50	0.000	-.0588007	-.0165494
LNIMP	1.054718	.0471856	22.35	0.000	.9622359	1.1472
Short run						
Tanzania						
EC_{it-1}	-.0482699	.0149502	-3.23	0.001	-.0775717	-.018968
DESSA	-.0040277	.0034191	-1.18	0.239	-.010729	.0026735
DESA	-.0050881	.003337	-1.52	0.127	-.0116285	.0014522
DEEAP	-.0011129	.0038888	-0.29	0.775	-.0087348	.006509
DEAW	-.0065649	.005648	-1.16	0.245	-.0176347	.004505
DLNIMP	.2037983	.0662035	3.08	0.002	.0740419	.3335548
Cons	.0327027	.044288	0.74	0.460	-.0541001	.1195055
Kenya						
EC_{it-1}	-.4419426	.0824128	-5.36	0.000	-.6034687	-.2804166
DESSA	-.0008654	.0020834	-0.42	0.678	-.0049487	.0032179
DESA	-.0135348	.0075838	-1.78	0.074	-.0283988	.0013291
DEEAP	-.0431339	.0200806	-2.15	0.032	-.0824911	-.0037767
DEAW	.0136602	.0031042	4.40	0.000	.007576	.0197443
DLNIMP	-.101019	.0925325	-1.09	0.275	-.2823794	.0803413
Cons	.1501045	.4150206	0.36	0.718	-.6633208	.9635299

Source: Researcher's computation, 2024.

4. DISCUSSION

The empirical analysis reveals complex interrelationship between regional exports and growth of economy in Kenya and Tanzania. While exports in specific regions positively contribute to growth, those from Sub-Saharan Africa (SSA) exhibit a statistically insignificant negative impact. This finding contrasts with Dudzeviciūtė et al. (2017) and Hodey et al. (2015), highlighting a need for SSA countries to focus on product differentiation to enhance competitiveness. Conversely, exports from South Asia and East Asia show significant positive correlations, reinforcing the Heckscher-Ohlin theorem, which asserts that nations export goods in which they hold a comparative advantage. However, exports from the Arab World adversely affect growth, suggesting that East African countries must prioritize quality and diversification in their export strategies. The analysis supports the import-led growth hypothesis, revealing a significant positive correlation betwixt imports and growth of economy, consistent with Mwangi et al. (2020) and Bakari (2017). This emphasizes the necessity of importing capital goods to bolster economic performance, a point echoed by Aluko and Adeyeye (2020).

In the short run, SSA, East Asia, and South Asia exports do not significantly drive growth, challenging the comparative advantage theory (Ali et al., 2021). However, the positive effects of imports affirm their role as crucial economic stimulants, supporting the export-led growth and trade liberalization theories. Long-run relationships confirmed by error correction terms suggest that GDP and exports inform future policymaking, consistent with Moshi et.al (2024). Therefore, policymakers must enhance the quantity and quality of exports while strategically importing to ensure sustainable growth.

CONCLUSION

This study analyzed the interplay between regional exports and growth of economy in Kenya and Tanzania from 1970 to 2023, utilizing a panel dataset and Panel-ARDL-PMG methodology. The analysis revealed significant long-run relationships between GDP and exports from South Asia and East Asia and Pacific, which positively impact economic growth. Conversely, exports from SSA and the Arab World were found to negatively affect growth, albeit with varying statistical significance.

These findings suggest that policymakers should prioritize enhancing the quality and quantity of exports, particularly to South Asia and East Asia, to stimulate long-term economic growth. In contrast, efforts should be made to improve the quality of agricultural exports and reduce reliance on raw product exports. Furthermore, the importation of capital goods is crucial, as it stimulates production capacity and contributes positively to economic growth.

In light of these results, policymakers are encouraged to focus on value-added production before exporting, especially in the agricultural sector. Additionally, the importation of advanced technologies and machinery should be prioritized to enhance productivity and export capabilities.

Future research should delve into the dynamics of intra-industry trade in East Africa, investigating its implications for economic growth and trade policy. By exploring these dynamics, researchers can provide valuable insights that could inform policy development in the region.

REFERENCES

Abille, A.B., Meçik, O. (2023), "The exchange rate, income, trade openness and the trade balance: Longitudinal panel analysis for selected SSA countries", *International Trade, Politics and Development*, Vol. 7, No. *2*, pp. 138-153.

Ali, B.J., Hasan, H., Oudat, M.S. (2021), "Relationship among export, import, and economic growth: Using co-integration analysis", *Psychology and Education Journal*, Vol. 58, No. 1, pp. 5126-5134.

Aluko, O.A., Adeyeye, P.O. (2020), "Imports and economic growth in Africa: Testing for Granger causality in the frequency domain", *The Journal of International Trade & Economic Development*, Vol. 29, No. 7, pp. 850-864.

Daniel, O.J., Fredrick, O.S., Michael, J.N. (2023), "The effect of agricultural trade openness on economic growth in the East African Community", *Cogent Economics & Finance*, Vol. 11, No. 2, pp. 1-13. https://doi.org/10.1080/23322039.2023.2250632.

Dudzeviciūtė, G., Simelytė, A., Antanavicienė, J. (2017), "Causal nexus between export and economic growth in the European Union countries", *Montenegrin Journal of Economics*, Vol. 13, No. 2, pp. 107-120.

Esaku, S. (2021), "The long-and short-run relationship between the shadow economy and trade openness in Uganda", *Cogent Economics & Finance,* Vol. 9, No. 1, pp. 1-19. https://doi.org/10.1080/23322039.2021.1930886

Espoir, D.K., Bannor, F., Sunge, R. (2024), "Intra-Africa agricultural trade, governance quality, and agricultural total factor productivity: Evidence from a panel vector autoregressive model", *The European Journal of Development Research*, Vol. 1, pp. 1-32.

Etensa, T., Taye, L., Bersisa, M. (2022), "Infrastructure development and economic growth in East Africa: Quantity versus quality dimensions using the panel-ARDL approach", *International Journal of Empirical Economics,* Vol. 1, No. 4, pp. 1-28.

Fayisa, T.F. (2021), "Determinants of export in East Africa: Heterogeneous panel data analysis", *Journal of Finance and Economics*, Vol. 9, No. 1, pp. 16-33.

Gatimu, E.W., 2020, "*Foreign direct investment, export and economic growth*: *Evidence from East African community countries*", Doctoral dissertation, University of Nairobi.

Hodey, L.S., Oduro, A.D., Senadza, B. (2015), "Export diversification and economic growth in Sub-Saharan Africa", *Journal of African Development*, Vol. 17, No. 2, pp. 67-81.

Moshi, A., Lufuke, M., Baha, M. (2024), "Imports in East Africa: Boosting manufacturing performance or impeding domestic growth?", *Journal of African Economic Perspectives*, Vol. 2*,* No. 1, pp. 21-30.

Mwangi, E.N., Chen, F., Njoroge, D.M. (2020), "Agricultural imports, agriculture productivity, and economic growth in Sub-Saharan Africa", *Journal of African Trade*, Vol. 7, No. 1, pp. 15-28.

Okoli, U.V., Okolie, D.O., Okolie, J.I. (2024), "Marginal propensity to import and terms of trade: Panel Granger causality evidence from the East African Community (EAC)", *Economic and Regional Studies*, Vol. 17, No. 2, pp. 251-269.

Okyere, I., Jilu, L. (2020), "The impact of export and import on economic growth in Ghana", *European Journal of Business and Management*, Vol. 12, No. 21, pp. 130-138.

Terefe, K.D., Teera, J. (2018), "Determinants of tax revenue in East African countries: An application of multivariate panel data cointegration analysis", *Journal of Economics and International Finance*, Vol. 10, No. 11, pp. 134-155.
Uddin, H., Khanam, M.J. (2017), "Import, export, and economic growth: The case of lower-income countries", *Journal of Business and Management*, Vol.19, No. 1, pp.37-42.
Wabiga, P., Nakijoba, S. (2018), "High technology exports, gross capital formation, and economic growth in Uganda: A vector autoregressive approach", *International Journal of Business and Economics Research*, Vol. 7, No. 6, pp. 191-202.
Worku, U.R. (2021), "The determinants of GDP growth rate in East Africa", *China-USA Business Review*, Vol. 20, pp. 1537-1514. https://doi.org/10.17265/1537-1514/2021.01.002
Yussuf, Y.C. (2022), "Cointegration test for the long-run economic relationships of East Africa community: Evidence from a meta-analysis", *Asian Journal of Economics and Banking*, Vol. 6, No. 3, pp. 314-336.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Zou, Y., Tong, Y., Serrasqueiro, Z. (2026), "Bank Credit and Trade Credit during Crisis", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 91-100.

Bank Credit and Trade Credit during Crisis

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ARTICLE INFO

Received October 01, 2024
Revised from November 01, 2024
Accepted 20, December 01, 2024
Available online April 15, 2026

JEL classification: G21, G30, M13, M41

DOI: 10.14254/1800-5845/2026.22-2.8

Keywords:

Bank loans,
trade credit,
Covid crisis,
global financial crisis,
start-up firms.

ABSTRACT

Using the logit model, this paper investigates the relationship between bank credit and trade credit. In particular the impacts of trade credit factors on obtaining bank loans are studied in depth with comparing the global financial crisis and the Covid crisis (as the two most serious crises since the 21st century). Considering the importance of bank credit and trade credit for start-up firms, this paper uses the financial data of Portuguese manufacturing firms in their founding year during the crisis and pre-crisis periods. The findings generally support a substitute relationship between bank credit and trade credit for start-up firms. A special finding is that during the Covid crisis period trade credit factors cannot influence access to bank loans for start-up firms compared to during the global financial crisis period, while a positive effect of profitability on obtaining bank loans is highlighted during the Covid crisis period. One reason may be the effect of the European sovereign debt crisis making banks tighten granting loans in hard economic situations since then, which increases the importance of profitability. Another reason may be that the Covid pandemic broke out and diffused worldwide in a quite short time, which swiftly caused lock-down policy and then dramatic economic downturn in 2020 with the feature of being unable to be forecasted previously. The global financial crisis started in September 2008, which immediately triggered a pessimistic opinion about economic expectation in the following year; this means that banks had time to adjust their policy in granting loans to suit the upcoming market situation during this traditional crisis. Therefore, the findings confirm a failure of trade credit factors to influence obtaining bank credit for start-up firms during the Covid crisis that is unpredictable and untraditional.

INTRODUCTION

Trade credit is an important short-run financial resource (Del Gaudio et al., 2018). It is of importance to help financially constrained firms especially during economic downturn periods, which is because more information can be assessed by suppliers than by financial institutions and banks (Love, 2011). As pointed out by Milosevic et al. (2020), based on the data from Eurostat, trade credit as a crucial financing source for small and medium-sized enterprises had increased steadily from 2016 to 2018 in the European Union. In fact, from the perspective of financing, the importance of trade credit is similar to bank credit but is much higher than venture capital or other financing sources (Rodríguez-Rodríguez, 2008).

Bank credit is usually studied hand in hand with trade credit, particularly with regard to revealing the relationship between trade credit and bank credit. The relationship between trade credit and bank credit can be substitutive or complementary (Rahman et al., 2018). According to Andrieu et al. (2018), a complementary relationship between trade credit and bank credit is based on the assumption that receiving trade credit can pass a positive signal to banks as potential lenders to borrowers. On the other hand, some scholars point out that trade credit shows a substitute relationship with bank credit (Canto-Cuevas et al., 2019), mainly due to higher financial pressure for the firms with more trade credit.

The relationship between trade credit and bank credit could be impacted much by crisis, as during crisis bank credit tends to be constrained (Carbó-Valverde et al., 2016). According to Agostino and Trivieri (2014), because new firms usually lack of reputation on the credit market, they need to use trade credit as a signal of good quality in order to mitigate information asymmetries and then to obtain bank credit. Hence, trade credit is especially suitable for younger firms without sufficient reputation, credit worthiness, and then with low debt capacity and a lack of financial resources (Canto-Cuevas et al., 2019). In fact, start-up firms tend to invest more in trade credit in order to attract new customers and drive sales for counteracting the negative impact of crisis (Baños-Caballero and García-Teruel, 2023).

This paper investigates the relationship between trade credit and bank credit, and especially focuses on the impacts of trade credit factors on obtaining short-term bank loans for start-up firms during crisis periods in order to find the differences between the global financial crisis in 2009 and the 2020 Covid crisis. We explore the financing behavior of the start-up firms founded in manufacturing sectors in Portugal that was negatively impacted by a series of crises in the past two decades. Thus, the most important contribution of this paper is to recognize the relationship between trade credit and bank credit during the most important two crises since the 21st century.

1. RESEARCH METHODS

Our sample includes the firms that incorporated in 2008, 2009, 2019 and 2020 in Portugal from Iberian Balance sheet Analysis System (SABI) database which is developed by Bureau Van Dijk. We focus on their founding year data, and the firms with missing data and outliers are excluded from the sample. Finally, the sample consists of 1274 firms incorporated in 2008, 868 firms incorporated in 2009, 871 firms incorporated in 2019, and 626 firms incorporated in 2020 in manufacturing sectors in Portugal.

Following the studies of Deloof and La Rocca (2015) and Baños-Caballero and García-Teruel (2023), we use receivables (accounts receivable to total assets), payables (accounts payable to total assets), and net trade credit (the difference between accounts receivable and accounts payable to total assets) as independent variables for testing their impacts on access to bank loans respectively. Bank credit as the dependent variable, we refer to the research method of Adilkhanova et al. (2022) to use a dummy variable to identify whether obtaining short-term bank loans, which takes the value of 1 for the firm with access to short-term bank loans and 0 otherwise.

In addition to the above mentioned variables, there are also several control variables that are defined as follows. Firm size is measured as the natural logarithm of total assets. Profitability captures self-financing, which is calculated as the ratio between earnings before interests and tax (EBIT) and sales. Leverage is calculated as the ratio of total liabilities to total assets. Tangibility is defined as the ratio between tangible fixed assets and total assets. Stock is used to measure the ratio of stocks to total assets. Group is a dummy variable that takes the value of 1 for the firm with a parent company and 0 otherwise.

Here logistic model is employed to explore the targeted relationships. According to Horváthová and Mokrisová (2020), Kitowski et al. (2022), and Brygała (2022), the logistic model is a binary model with the dependent variable taking only two values and the logistic regression equation (that is estimated by maximum-likelihood) can be written as follows:

$$\pi = \exp(\alpha + \beta_1 X_1 + \cdots + \beta_n X_n)/(1+ \exp(\alpha + \beta_1 X_1 + \cdots + \beta_n X_n))$$

and $$\text{logit} = \ln(\pi/(1-\pi)) = \alpha + \beta_1 X_1 + \cdots + \beta_n X_n$$

where π represents the probability, α is the intercept, β represents the estimated parameters, and X represents the selected predictors. Logistic regression aims to calculate the odds ratio π/(1-π).

2. RESULTS

Table 1 and 2 show the results of logistic regression for the start-up firms founded respectively in 2008, 2009, 2019, and 2020. Receivables, payables, and net trade credit are statistically significant in the 2008, 2009 and 2019 regressions, whereas all of these are non-significant in the 2020 regressions. In the 2008 and 2009 regressions, the coefficients of receivables and net trade credit are positive at the 1 percent level while the coefficient of payables is negative at the 1 percent level. In the 2019 regressions, the coefficients of receivables and payables are negative at the 1 percent level, whereas the coefficient of net trade credit is positive at the 5 percent level. Therefore, similar to the research results of Santos and Silva (2014) for Portuguese industrial companies, our findings generally endorse the existence of a negative relationship between bank credit and trade credit, indicating a substitute relationship between bank credit and trade credit; in 2008 and 2009, investments in trade credit and shrinkage in trade credit finance can help start-up firms gain bank loans.

Profitability is statistically significant at the 5 percent level and positively associated with obtaining bank loans in the 2008 and 2020 regressions. According to Niskanen and Niskanen (2006), profit-related variables can be used to measure a firm's ability to generate internal cash flows. Therefore, the positive effect of profitability on access to bank loans goes against the pecking order theory where internally accumulated profits as a financing source is prior to external bank loans.

Firm size and leverage are statistically significant and positively related to obtaining bank loans in the 2008, 2009, 2019 and 2020 regressions. The positive relationship between firm size and access to bank loans is in line with Andrieu et al. (2018), Agostino and Trivieri (2014), and Arslan and Umutlu (2009). Psillaki and Eleftheriou (2015) also find that larger firms, ceteris paribus, tend to receive more bank credit than smaller firms during the credit crunch period (2007 to 2009). As explained by Masiak et al. (2019), compared to large firms, from the supply side banks would bear higher monitoring and risk management costs when providing loans to small firms; and from the demand side small firms would bear high financing costs when obtaining bank loans, thus tending to rely less on bank loans.

For the effect of leverage, according to Drakos (2013) and Hernández-Cánovas and Martínez-Solano (2010), leverage usually represents the borrower's credit risk in that more levered firms usually are more likely to be of insolvency. Therefore, we have an untraditional result about a positive impact of leverage on obtaining bank loans. A possible explanation may be that, for start-up firms, high leverage means more financial intermediaries offering funds and then signals positive information to banks.

The relationship between tangibles and gaining bank loans is positive and its statistical significance is mainly shown in the 2008 and 2009 regressions at the 1 percent level. The association between stocks and access to bank loans is also significantly positive in the 2008 and 2009 regressions at the 1 percent level. The positive effects of tangibles and stocks on access to bank loans are coherent with the most frequent results in the literature, that is, pledgeable assets are positively related to short-term bank debt (Agostino and Trivieri, 2014). As noted by Peón and Guntín (2021), because fixed tangible assets can work as collateral and then reduce the problems of asymmetric information and agency costs as well as the costs for external financing, asset tangibility can help to obtain external finance. Therefore, the firms having more collaterals (tangible assets and stocks) are estimated to be more likely to have access to bank loans.

Group background only shows statistical significance in the 2019 regression with a negative impact on obtaining bank loans. The group dummy generally fails to significantly explain access to bank loans, which consists to the finding of Agostino and Trivieri (2014) that whether belonging to a group or a consortium is not significantly linked to short-term bank debt.

Table 1. The results of year-by-year regressions with receivables and payables as independent variables

2008 year (1274 samples)				*2009 year (868 samples)*			
Classification accuracy: 66.9%				*Classification accuracy: 66.2%*			
	Beta Coefficient	*Wald*	*Significance*		*Beta Coefficient*	*Wald*	*Significance*
Receivables	1.601***	26.526	0.000	Receivables	1.869***	27.747	0.000

Payables	-1.319***	50.284	0.000	Payables	-1.080***	24.165	0.000
Profitability	0.111**	5.633	0.018	Profitability	0.044	0.104	0.747
Size	0.442***	99.230	0.000	Size	0.387***	50.698	0.000
Leverage	1.461***	61.411	0.000	Leverage	1.205***	25.357	0.000
Tangibles	1.979***	36.526	0.000	Tangibles	2.533***	43.886	0.000
Stocks	1.988***	27.029	0.000	Stocks	2.272***	29.061	0.000
Group	0.065	0.408	0.523	Group	-0.130	1.209	0.271
Constant	-4.197***	165.414	0.000	Constant	-3.942***	106.902	0.000
2019 year (871 samples)				*2020 year (626 samples)*			
Classification accuracy: 60.7%				*Classification accuracy: 62.3%*			
	Beta Coefficient	*Wald*	*Significance*		*Beta Coefficient*	*Wald*	*Significance*
Receivables	-0.743***	6.596	0.010	Receivables	-0.186	0.331	0.565
Payables	-1.040***	21.913	0.000	Payables	-0.348	1.771	0.183
Profitability	0.011	0.017	0.897	Profitability	0.313**	6.220	0.013
Size	0.497***	99.718	0.000	Size	0.427***	68.248	0.000
Leverage	0.950***	45.115	0.000	Leverage	0.551***	6.730	0.009
Tangibles	-0.212	0.525	0.469	Tangibles	0.479	1.968	0.161
Stocks	-0.345	0.740	0.390	Stocks	-0.288	0.431	0.511
Group	-0.216*	3.337	0.068	Group	-0.042	0.089	0.765
Constant	-2.068***	52.819	0.000	Constant	-2.097***	38.545	0.000

Note: dependent variable is the bank loan dummy variable.
Source: authors' own calculation.

Table 2. The results of year-by-year regressions with net trade credit as independent variable

2008 year (1274 samples)				*2009 year (868 samples)*			
Classification accuracy: 66.7%				*Classification accuracy: 65.4%*			
	Beta Coefficient	*Wald*	*Significance*		*Beta Coefficient*	*Wald*	*Significance*
Net trade credit	1.384***	66.866	0.000	Net trade credit	1.286***	43.543	0.000
Profitability	0.115**	5.989	0.014	Profitability	0.066	0.235	0.628
Size	0.448***	104.678	0.000	Size	0.405***	57.102	0.000
Leverage	1.498***	68.052	0.000	Leverage	1.341***	33.926	0.000
Tangibles	1.795***	55.399	0.000	Tangibles	2.065***	48.530	0.000
Stocks	1.851***	28.835	0.000	Stocks	1.909***	25.646	0.000
Group	0.070	0.472	0.492	Group	-0.117	0.978	0.323
Constant	-4.075***	197.772	0.000	Constant	-3.641***	112.156	0.000
2019 year (871 samples)				*2020 year (626 samples)*			
Classification accuracy: 61.1%				*Classification accuracy: 62.3%*			
	Beta Coefficient	*Wald*	*Significance*		*Beta Coefficient*	*Wald*	*Significance*

Net trade credit	0.421**	5.267	0.022	Net trade credit	0.150	0.461	0.497
Profitability	-0.066	0.686	0.407	Profitability	0.282**	5.394	0.020
Size	0.479***	96.226	0.000	Size	0.419***	67.181	0.000
Leverage	0.771***	31.983	0.000	Leverage	0.447**	5.067	0.024
Tangibles	0.397	2.250	0.134	Tangibles	0.685**	4.917	0.027
Stocks	-0.011	0.001	0.978	Stocks	-0.223	0.260	0.610
Group	-0.277**	5.669	0.017	Group	-0.052	0.137	0.711
Constant	-2.536***	88.050	0.000	Constant	-2.183***	43.342	0.000

Note: dependent variable is the bank loan dummy variable.
Source: authors' own calculation.

3. ROBUSTNESS CHECKS

For checking the robustness of the previous regression results, the start-up firms founded in 2008 and 2009 and in 2019 and 2020 are respectively combined to regress with year dummy created here. The purpose of this design is to find the differences of the financing behavior of start-up firms when coming into the crisis periods separately from 2008 to 2009 and from 2019 to 2020. According to our estimates (shown in Table 3), all the interaction variables are not statistically significant in the regressions describing the interaction effects between 2008 and 2009. The results here to a large extent are in line with the comparison of the regression results separately in 2008 and 2009, since the statistically significant levels of all the variables are kept unchanged from the 2008 to the 2009 regressions except for profitability.

In the regressions describing the interaction effects between 2019 and 2020 (shown in Table 3), the interaction variables of payables and leverage are statistically significant and their signs are different to their original variables. Therefore, the negative effect of payables and the positive effect of leverage are reduced from 2019 to 2020. In addition, we also find the effect of profitability tends to become positive from 2019 to 2020. However, the changes of the significant level of receivables, net trade credit, group and tangibles are not presented here in the cross-effect regressions. Therefore, the robustness checks partially support the previous findings between 2019 and 2020.

Table 3. Regression results with year dummy variable as interaction variable to identify crisis

2008 and 2009 years together (2142 samples)				*2019 and 2020 years together (1497 samples)*			
Classification accuracy: 66.7%				*Classification accuracy: 61.5%*			
	Beta Coefficient	*Wald*	*Significance*		*Beta Coefficient*	*Wald*	*Significance*
Receivables	1.588***	32.116	0.000	Receivables	-0.744***	7.068	0.008
Receivables × Year dummy 08-09	0.299	0.570	0.450	Receivables × Year dummy 19-20	0.557	1.836	0.175
Payables	-1.327***	54.014	0.000	Payables	-1.039***	21.822	0.000
Payables × Year dummy 08-09	0.282	0.958	0.328	Payables × Year dummy 19-20	0.691**	4.098	0.043
Profitability	0.112**	6.046	0.014	Profitability	0.010	0.015	0.902
Profitability × Year dummy 08-09	-0.066	0.201	0.654	Profitability × Year dummy 19-20	0.304**	4.332	0.037
Size	0.442***	115.402	0.000	Size	0.497***	125.590	0.000

Size × Year dummy 08-09	-0.059	0.939	0.332	Size × Year dummy 19-20	-0.070	1.846	0.174
Leverage	1.474***	70.790	0.000	Leverage	0.948***	46.548	0.000
Leverage × Year dummy 08-09	-0.306	1.262	0.261	Leverage × Year dummy 19-20	-0.397*	3.483	0.062
Tangibles	1.965***	42.838	0.000	Tangibles	-0.214	0.543	0.461
Tangibles × Year dummy 08-09	0.565	1.656	0.198	Tangibles × Year dummy 19-20	0.694	2.498	0.114
Stocks	1.975***	30.677	0.000	Stocks	-0.347	0.749	0.387
Stocks × Year dummy 08-09	0.304	0.337	0.561	Stocks × Year dummy 19-20	0.055	0.009	0.926
Group	0.065	0.426	0.514	Group	-0.216*	3.381	0.066
Group × Year dummy 08-09	-0.195	1.550	0.213	Group × Year dummy 19-20	0.174	0.989	0.320
Constant	-4.087***	271.305	0.000	Constant	-2.080***	91.340	0.000
Classification accuracy: 66.9%				Classification accuracy: 61.6%			
	Beta Coefficient	Wald	Significance		Beta Coefficient	Wald	Significance
Net trade credit	1.368***	74.201	0.000	Net trade credit	0.388**	4.656	0.031
Net trade credit × Year dummy 08-09	-0.079	0.110	0.740	Net trade credit × Year dummy 19-20	-0.209	0.564	0.453
Profitability	0.114**	6.302	0.012	Profitability	-0.073	0.860	0.354
Profitability × Year dummy 08-09	-0.038	0.066	0.797	Profitability × Year dummy 19-20	0.386***	7.328	0.007
Size	0.440***	127.612	0.000	Size	0.458***	115.900	0.000
Size × Year dummy 08-09	-0.023	0.196	0.658	Size × Year dummy 19-20	-0.013	0.074	0.785
Leverage	1.475***	83.106	0.000	Leverage	0.724***	33.368	0.000
Leverage × Year dummy 08-09	-0.108	0.234	0.629	Leverage × Year dummy 19-20	-0.176	0.998	0.318
Tangibles	1.773***	59.574	0.000	Tangibles	0.376	2.034	0.154
Tangibles × Year dummy 08-09	0.289	0.624	0.430	Tangibles × Year dummy 19-20	0.342	0.721	0.396
Stocks	1.820***	30.731	0.000	Stocks	-0.037	0.009	0.925
Stocks × Year	0.099	0.039	0.843	Stocks × Year	-0.187	0.102	0.749

dummy 08-09				dummy 19-20			
Group	0.064	0.419	0.518	Group	-0.294**	6.519	0.011
Group × Year dummy 08-09	-0.171	1.214	0.271	Group × Year dummy 19-20	0.277	2.568	0.109
Constant	-3.891***	309.238	0.000	Constant	-2.397***	130.719	0.000

Note: dependent variable is the bank loan dummy variable.
Source: authors' own calculation.

4. DISCUSSION

From 2008 to 2009, the statistically significant levels of the variables do not change much except for profitability. In 2008 the statistical significance of profitability is at 0.05 level, whereas it is statistically insignificant in 2009. The statistically significant levels of receivables, payables, net trade credit, size, leverage, tangibles, and stocks are kept at 0.01 from 2008 to 2009. Group is statistically insignificant in both 2008 and 2009. From 2019 to 2020 the statistical significance of size and leverage is kept, while stocks keep being statistically insignificant. Receivables, payables, net trade credit, and group are statistically significant in 2019 but are not statistically significant in 2020. Profitability and tangibles are statistically insignificant in 2019 but are statistically significant in 2020.

The significance of receivables and payables generally remains stable from 2008 to 2009, while the significance becomes less from 2019 to 2020. The significance of profitability becomes less from 2008 to 2009 but is more stressed from 2019 to 2020. Therefore, in 2020 banks give more weight to the ability to generate internal cash flow than external trade credit in gaining bank loans. Signals regarding future business prospects are especially important for banks to evaluate whether granting loans (Blumberg and Letterie, 2008), and profitability can be seen as a crucial indicator that signals a firm's future. This is because more profitable firms should have better ability to generate internal funds and then could accumulate more resources. Regarding start-up firms, they are especially difficult to receive loans from banks, as banks have difficulties in judging the risk of a start-up project and then tend to be risk-averse (Blumberg and Letterie, 2008). According to Drakos (2013), more profitable firms tend not to face with tightening conditions for bank loans. Therefore, the signaling role of profitability is of particular importance for start-up firms to apply for bank credit.

The change of the significance of tangibles that becomes more important in 2020 than in 2019 also demonstrates the crucial role of start-up firms' capacity in collaterality in gaining bank loans. According to Bartoli et al. (2013), one main function of banks is to deal with the problems of information asymmetry between investors and borrowers, and the problems of information asymmetry can be lowered down through accumulating information from borrowers. For the firms applying for bank loans, collateral that plays a signaling role in presenting borrowers' credit quality can be used to reduce the problems of adverse selection and moral hazard, and can help firms gain better financing conditions in application for bank loans (Agostino and Trivieri, 2017). During crisis banks tend to cut down credit and take more cautious attitudes on granting loans, as the credit that can be supplied by commercial banks is usually limited by the central bank; thereby, providing sufficient collateral is a key factor that determines whether a firm can apply for bank loans successfully (Paulet et al., 2014).

Hence, we find that in the 2020 crisis banks tend to stress the internal capacity of start-up firms in generating profits and collaterality instead of external trade credit. One possible reason for the discreetness in the 2020 crisis compared to in the 2009 crisis may be the changes of the banks in Portugal after the European sovereign debt crisis. Because Portugal as a stressed country in the euro area was impacted in depth by the European sovereign debt crisis since 2010, there were more firms suffering credit constrains and being difficult to have access to bank finance in the period from 2010 to 2012 than in 2009 (Ferrando et al., 2017). Hence, profitability as the core ability of a business entity is especially highlighted by banks when assessing the application for bank loans.

CONCLUSION

This paper explores a traditional problem, that is, the relationship between trade credit and bank credit. In particular, the impacts of the use of trade credit on obtaining bank loans are investigated for Portuguese start-ups in manufacturing sectors. Specifically, the data during the global financial crisis and the Covid crisis as well as the data in the pre-crisis periods are compared for revealing the relationship between bank credit and trade credit. We find that, in 2008 and 2009, investments in trade credit (receivables) can benefit to access to bank loans and the use of trade credit as a financing source (payables) tends to extrude bank loans. Therefore, our findings here support a substitute relationship between trade credit and bank credit as well as a positive effect of exerting an aggressive strategy of trade credit (granting trade credit to customers) in helping to obtain bank credit.

From the perspective of receivables, we find that banks give weight to the sales of start-up firms when granting loans in that more receivables usually represent more sales. For start-up firms, generating sufficient sales and then occupying sufficient market share are the most important task, which are even more important than generating profits at the initial stage of firms. The positive effect of net trade credit as well as the negative effect of payables on access to bank loans in 2008, 2009 and 2019 endorse a pivotal role of sales and a substitute effect of trade credit finance on bank finance. By contrast, none of the trade credit variables shows statistical significance in the 2020 regressions, while profitability becomes a significant factor positively impacting on access to bank loans. Hence, our findings indicate a great change of the impacts of the trade credit factors on obtaining bank loans from 2019 to 2020 compared to from 2008 to 2009.

In addition to the influence of the European sovereign debt crisis that makes banks tighten granting loans during negative economic environment, another important reason for the difference between 2009 and 2020 may be the difference in economic situations and expectations. Although the economy of Portugal dropped much in both 2009 and 2020 compared to the previous years, the economic situation in 2020 was much worse than it was in 2009 and the predictions for future were different. The global financial crisis began in September 2008 after the Lehman Brothers Collapse in the United States, which resulted in a pessimistic prediction on the economy in 2009 before the start of economic downturn in European countries. Therefore, banks had time to adjust their policy to be mature enough to suit the upcoming market environment. By contrast, the Covid pandemic broke out suddenly and the lock-down policy started to exert swiftly after the diffusion of the pandemic, which cannot be predicted in 2019. Therefore, we argue that the relationship between trade credit and bank credit becomes weak and profitability becomes a crucial factor to identify the worthiness of bank credit when suffering unpredictable great economic downturn.

In a nutshell, on the basis of the previous research of Huyghebaert et al. (2007) and Baños-Caballero and García-Teruel (2023) regarding the use of bank credit and trade credit for start-up firms, this paper contributes to the empirical studies on the relationship between trade credit and bank credit and especially enriches the literature regarding the use of trade credit for start-up firms during crisis. Here, a substitute relationship between trade credit and bank credit (revealing the effect of financial burden) is supported for Portuguese start-up firms in manufacturing sectors in both the pre-crisis and the crisis periods, but not in a dramatically changed economic environment such as the Covid crisis. The research here is limited by the availability of data, and future research should enlarge the sample especially in time-span for getting richer findings.

REFERENCES

Adilkhanova, Z., Nurlankul, A., Token, A., Yavuzoglu, B. (2022), "Trade credit and financial crises in Kazakhstan", *Journal of Asian Economics,* Vol. 80, 101472, pp. 1-16. https://doi.org/10.1016/j.asieco.2022.101472

Agostino, M., Trivieri, F. (2014), "Does trade credit play a signalling role? Some evidence from SMEs microdata", *Small Business Economics*, Vol. 42, pp. 131-151. https://doi.org/10.1007/s11187-013-9478-8

Agostino, M., Trivieri, F. (2017), "Collateral in lending relationships. A study on European SMEs microdata", *International Review of Applied Economics*, Vol. 31, No. 3, pp. 339-356. https://doi.org/10.1080/02692171.2016.1257580

Andrieu, G., Staglianò, R., van der Zwan, P. (2018), "Bank debt and trade credit for SMEs in Europe: firm-, industry-, and country-level determinants", *Small Business Economics*, Vol. 51, pp. 245–264. https://doi. org/10.1007/s11187-017-9926-y

Arslan, Ö., Umutlu, G. (2009), "Trade credits and bank loans for SMEs in the textile sector", *Journal of Small Business & Entrepreneurship,* Vol. 22, No. 4, pp. 383-397. https://doi.org/10.1080/08276331.2009.10593461

Baños-Caballero, S., García-Teruel, P.J. (2023), "Investment in trade credit in small business start-ups: Evidence from Spain during a financial crisis", *Applied Economics,* Vol. 55, No. 3, pp. 273-282. https://doi.org/10.1080/00036846.2022.2086685

Bartoli, F., Ferri, G., Murro, P., Rotondi, Z. (2013), "Bank-firm relations and the role of Mutual Guarantee Institutions at the peak of the crisis." *Journal of Financial Stability,* Vol. 9, No. 1, pp. 90-104. https://doi.org/10.1016/j.jfs.2012.03.003

Blumberg, B.F., Letterie, W.A. (2008), "Business starters and credit rationing", *Small Business Economics,* Vol. 30, pp. 187–200. https://doi.org/10.1007/s11187-006-9030-1

Brygała, M. (2022), "Consumer bankruptcy prediction using balanced and imbalanced data", *Risks*, Vol. 10, No. 2, 24, pp. 1-13. https://doi.org/10.3390/risks10020024

Canto-Cuevas, F.-J., Palacín-Sánchez, M.-J., Di Pietro, F. (2019), "Trade credit as a sustainable resource during an SME's life cycle", *Sustainability*, Vol. 11, No. 3, 670, pp. 1-16. https://doi.org/10.3390/su11030670

Carbó-Valverde, S., Rodríguez-Fernández, F., Udell, G.F. (2016), "Trade credit, the financial crisis, and SME access to finance", *Journal of Money, Credit and Banking*, Vol. 48, No. 1, pp. 113-143. https://doi.org/ 10.1111/jmcb.12292

Del Gaudio, B.L., Porzio, C., Verdoliva, V. (2018), "Trade credit, SMEs and short-run survivorship: What we know and what we would like to know", *Qualitative Research in Financial Markets*, Vol. 10, No. 4, pp. 346-362. https://doi.org/10.1108/QRFM-02-2018-0014

Deloof, M., La Rocca, M. (2015), "Local financial development and the trade credit policy of Italian SMEs", *Small Business Economics,* Vol. 44, pp. 905-924. https://doi.org/10.1007/s11187-014-9617-x

Drakos, K. (2013), "Bank loan terms and conditions for Eurozone SMEs", *Small Business Economics,* Vol. 41, pp. 717–732. https://doi.org/10.1007/s11187-012-9454-8

Ferrando, A., Popov, A., Udell, G.F. (2017), "Sovereign stress and SMEs' access to finance: Evidence from the ECB's SAFE survey", *Journal of Banking & Finance*, Vol. 81, pp. 65-80. https://doi.org/10.1016/j.jbankfin.2017.04.012

Hernández-Cánovas, G., Martínez-Solano, P. (2010), "Relationship lending and SME financing in the continental European bank-based system", *Small Business Economics,* Vol. 34, pp. 465-482. https://doi.org/10.1007/s11187-008-9129-7

Horváthová, J., Mokrisová, M. (2020), "Comparison of the results of a data envelopment analysis model and logit model in assessing business financial health", *Information*, Vol. 11, No. 3, 160, pp. 1-20. https://doi.org/10.3390/info11030160

Huyghebaert, N., Van de Gucht, L., Van Hulle, C. (2007), "The choice between bank debt and trace credit in business start-ups", *Small Business Economics,* Vol. 29, pp. 435-452. https://doi.org/10.1007/s11187-006-9005-2

Kitowski, J., Kowal-Pawul, A., Lichota, W. (2022), "Identifying symptoms of bankruptcy risk based on bankruptcy prediction models—A case study of Poland", *Sustainability*, Vol. 14, No. 3, 1416, pp. 1-18. https://doi.org/10.3390/su14031416

Love, I. (2011), "Trade credit versus bank credit during financial crises", in Chauffour, J.-P., Malouche, M. (ED.), Trade Finance during the Great Trade Collapse. The International Bank for Reconstruction and Development / The World Bank, pp. 27-41. https://openknowledge.worldbank.org/server/api/core/bitstreams/47a0be98-5642-501e-a596-43ab27e8f136/content

Masiak, C., Block, J.H., Moritz, A., Lang, F., Kraemer-Eis, H. (2019), "How do micro firms differ in their financing patterns from larger SMEs?", *Venture Capital: An International Journal of Entrepreneurial Finance,* Vol. 21, No. 4, pp. 301-325. https://doi.org/10.1080/13691066.2019.1569333

Milosevic, D., Popovic, J., Avakumovic, J., Kvrgic, G. (2020), "The impact of the equity capital and trade credit financial sources on the company's performances sustainability", *Economics of Agriculture,* Vol. 67, No. 3, pp. 735-746. https://doi.org/10.5937/ekoPolj2003735M

Niskanen, J., Niskanen, M. (2006), "The determinants of corporate trade credit policies in a bank-dominated financial environment: The case of Finnish small firms", *European Financial Management,* Vol. 12, No. 1, pp. 81-102. https://doi.org/10.1111/j.1354-7798.2006.00311.x

Paulet, E., Parnaudeau, M., Abdessemed, T. (2014), "The SME struggle for financing: A clampdown in European banks post-crisis", *Journal of Business Strategy,* Vol. 35, No. 2, pp. 36-45. https://doi.org/10.1108/JBS-09-2013-0089

Peón, D., Guntín, X. (2021), "Bank credit and trade credit after the financial crisis: Evidence from rural Galicia", *Journal of Business Economics and Management,* Vol. 22, No. 3, pp. 616-635. https://doi.org/10.3846/jbem.2021.14270

Psillaki, M., Eleftheriou, K. (2015), "Trade credit, bank credit, and flight to quality: Evidence from French SMEs", *Journal of Small Business Management,* Vol. 53, No. 4, pp. 1219-1240. https://doi.org/10.1111/jsbm.12106

Rahman, A., Rozsa, Z., Cepel, M. (2018), "Trade credit and bank finance – Evidence from the Visegrad group", *Journal of Competitiveness,* Vol. 10, No. 3, pp. 132-148. https://doi.org/10.7441/joc.2018.03.09

Rodríguez-Rodríguez, O.M. (2008), "Firms as credit suppliers: An empirical study of Spanish firms", *International Journal of Managerial Finance*, Vol. 4, No. 2, pp. 152-173. https://doi.org/10.1108/17439130810864032

Santos, J., Silva, A. (2014), "The determinants of trade credit: A study of Portuguese industrial companies", *International Journal of Financial Research,* Vol. 5, No. 4, pp. 128-138. http://dx.doi.org/10.5430/ijfr.v5n4p128

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Montenegrin Journal of Economics

For citation:

Yessenova, M., Bugubayeva, R., Zhaparova, R., Assanova, M., Tapenova, G. (2026), "Foreign Experience in the Public Administration and Support for the Development of the Urban Transport Complex", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 101-116.

Foreign Experience in the Public Administration and Support for the Development of the Urban Transport Complex

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ARTICLE INFO

Received October 20, 2024
Revised from November 20, 2024
Accepted 20, December 20, 2024
Available online April 15, 2026

JEL classification: H10, H27, H30

DOI: 10.14254/1800-5845/2026.22-2.9

Keywords:

Public administration, transport system, urban transport, planning, infrastructure, urban transport complex.

ABSTRACT

The relevance of research. The article examines the foreign experience of public administration and support for the development of the urban transport complex, aimed at solving the problems of mobility, environmental sustainability and integration of transport infrastructure with the urban environment. *The purpose of the study is* to study the foreign experience of public administration and support for the development of the urban transport complex, analyze its key components and mechanisms, as well as develop recommendations for the use of effective solutions to improve mobility, sustainability and competitiveness of transport systems in the EAEU countries, including Kazakhstan. *The results of the study* showed that the effectiveness of urban bus transport in the EAEU countries largely depends on the development of logistics infrastructure and coordination with the general urban transport complex. Differences in standards, levels of digitalization, and transport planning policies complicate the integration of transport systems, emphasizing the need to unify approaches and create joint development programs at the state level. These results highlight the importance of regional coordination and the adoption of the best international practices for the modernization of the transport systems of the EAEU and Kazakhstan, in particular. *Conclusions.* Based on the analysis, recommendations are proposed to increase the stability of transport systems in countries with a high coefficient of variation through infrastructure modernization and regulatory measures, to maintain stable transport development by improving technology and logistics, and to strengthen transport integration within the EAEU to increase the overall stability and competitiveness of road transport.

INTRODUCTION

Modern cities face a number of complex challenges related to the development of transport systems that ensure the livelihoods, mobility and economic activity of the population. Rapid urban development, population growth and increasing requirements for environmental sustainability require the introduction of effective solutions in the management of the urban transport complex. Urban transport is becoming not only an important element of infrastructure, but also a factor determining the quality of life, the level of economic activity and environmental well-being (Sarlab et al., 2023; Suhany et al., 2024). Examples of successful transport strategies from countries such as Germany, Singapore, and the Scandinavian countries show that effective transport policies are possible through the integration of technology, greening, and sound public administration. At the same time, the EAEU countries face challenges in coordinating efforts and infrastructural harmonization, slowing down the pace of their transport development.

Foreign experience in managing and supporting the development of transport systems is a valuable source of practical solutions and innovative approaches. The relevance of the study of foreign experience in public administration and support for the development of the urban transport complex is due to a number of factors. In the context of urbanization and urban population growth, the need to provide affordable, environmentally sustainable and efficient transport is becoming one of the key priorities of urban planning.

Modern cities face many challenges, including overloaded transport systems, environmental degradation due to transport emissions, social inequality in access to public transport services, and limited resources for its modernization. Foreign experience demonstrates successful approaches to solving these tasks: from the integration of various modes of transport to the introduction of smart traffic management technologies, allowing not only to increase the mobility of the population, but also to reduce the negative impact on the environment.

The study of international practice and the use of artificial intelligence technologies in traffic management provides an opportunity to adapt the best solutions for implementation in Kazakhstan. This is especially important in the context of the digitalization of the economy and the pursuit of sustainable development, where the transport sector plays a key role. Effective management and support of the urban transport complex based on the adaptation of foreign experience (for example, the introduction of smart technologies, environmental initiatives and the integration of transport systems) contribute to increasing the sustainability, mobility and competitiveness of transport systems in the EAEU countries. This can be achieved through inter-regional coordination, modernization of infrastructure and optimization of logistics, which will lead to an improvement in the quality of transport services and a reduction in the environmental burden.

Thus, the study of foreign experience makes it possible to form effective state support mechanisms that contribute to the creation of a modern and sustainable transport infrastructure that takes into account economic, social and environmental aspects.

1. RESEARCH METHODS

The following methods were used in the research process and are reflected in Table 1.

Table 1. Applied Research methods

№	Method	Characteristic
1	Analysis of literary sources	study of foreign experience in the management and support of urban transport systems, as well as the regulatory framework of the EAEU countries related to the transport sector
2	Economic and mathematical modeling	calculation of the coefficient of variation, analysis of growth rates/increase in transportation volumes and passenger turnover to assess the sustainability of transport systems
3	Comparative analysis	study of differences and similarities in approaches to managing urban transport complex in the EAEU countries and leading world countries
5	Methods of statistical analysis	the use of average dynamics indicators, trend analysis and correlation analysis to identify relationships between the parameters of transport systems

6	Cartographic method	visualization and analysis of the spatial arrangement of transport infrastructure and its impact on logistics integration
7	Modeling development scenarios	forecasting possible changes in the urban transport complex of the EAEU countries when implementing innovative solutions and management strategies

Source: compiled by the authors

The study is of a combined nature, including elements of quantitative and qualitative approaches. The combination of statistical data analysis, sociological survey and modeling methods will provide a comprehensive approach to the study and assessment of problems and solutions in the field of urban transport complex (UTC) in the EAEU countries.

2. RESEARCH BACKGROUND

Urban transport is a major issue in all countries due to its close relationship with virtually every aspect of the urban environment. As urban populations continue to grow and building density increases, traffic problems become increasingly problematic (Table 2).

Table 2. Approaches related to urban transport management

№	*Author*	*Goal*	*Approach*
1	Anin E., Annan J., Alexander O. (2013)	Assessment of urban transport problems	Questionnaire
2	Kant G., Quak H, Peeters R, van Woensel T. (2016)	Evaluation of problems and achievements of urban transport	Market research reports, stakeholder opinions, literature
3	Ogunbodede E (2008)	Discussion of related issues of the automobile transportation system	Research method
4	Schünemann J, Finke S, Severengiz S, Schelte N, Gandhi S (2022)	Environmental Impact Assessment of Urban Freight Transport	Life Cycle Assessment Method
5	Solanke M (2013)	Identifying urban transport problems	Consideration of problems
6	Ecer F, Küçükönder H, Kayapınar Kaya S, Faruk GÖ (2023)	Challenges and Benefits of Evaluating Public Transport	Narratives based on historical sources
7	Hajduk S (2021)	Choosing a Smart City	TOPSIS, entropy
8	Deveci M (2022)	Evaluation of urban transport	Based on the effects of removing criteria
9	Simic V, Gokasar I, Deveci M, Švadlenka L (2022)	The Impact of Urban Transport on Climate Change	Measuring alternatives and ranking according to the solution
10	Bouraima, M.B., Ayyildiz, E., Ozcelik, G. et al. (2024)	Sustainable development of urban transport	Identification and categorization of problems related to sustainable development of urban transport

Source: compiled by the authors

Over the past few years, all the cities studied have improved their transport systems in all major aspects. This has had a positive impact on the impressions of citizens from using transport systems. Foreign experience in managing and supporting the development of the urban transport complex demonstrates a variety of approaches that depend on the level of motorization, urbanization and transport policy priorities in specific countries (Figure 1).

Studying foreign experience allows adapting effective management and support tools for urban transport systems to improve mobility and environmental sustainability in other countries, including Kazakhstan:

- Integration of transport modes. In cities such as Singapore and Berlin, developed transport hubs combine different modes of transport, which increases mobility and reduces the load on roads.
- Smart technologies. Traffic management systems based on artificial intelligence (for example, in Seoul) help optimize traffic flows and reduce traffic jams.

– Eco-transport. In the Scandinavian countries and Germany, bicycle infrastructure and electric transport are widely developed to reduce the environmental burden.

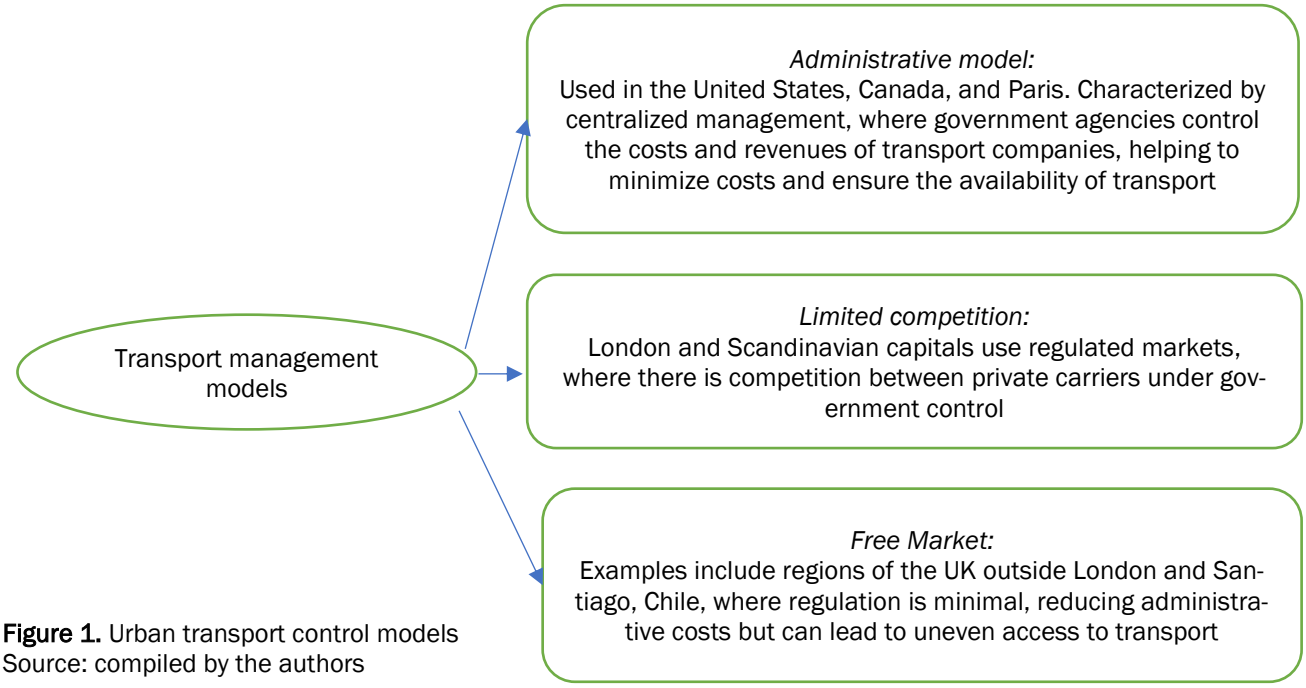


Figure 1. Urban transport control models
Source: compiled by the authors

Urban transport (hereinafter referred to as UT) is a complex problem, since it is closely related to key aspects of urban life, including the economy, ecology, social infrastructure and quality of life of the population. The relevance of the problem is due to several factors (Figure 2).

Addressing these challenges requires an integrated approach that includes the implementation of smart technologies, the development of public transport, the greening of transport systems and integration with urban planning strategies. Successful examples such as the development of the metro in Singapore or the use of electric vehicles in Copenhagen highlight the importance of planning and management to create efficient transport systems.

Transport systems play a vital role in modern cities, inextricably linked to essential services such as health, education and public utilities. Their efficiency is referred to as a “subsystem” rather than an isolated entity, and its effectiveness is of paramount importance for the overall functioning of the urban ecosystem. Current challenges, including increasing road traffic, highlight the need for sustainable solutions in urban transport (Salcedo-Sanz, S. et.al., 2024). The use of technologies and predictive methods is becoming essential for effective policy planning in an ever-changing urban landscape (Grotto, Andrea et.al., 2024). Public transport systems are the arteries of cities, transporting millions of people daily, yet their planning and optimization are complex tasks, as planning involves making trade-offs between objectives within limited resources and varying stakeholder interests (Hrelja et al., 2024).

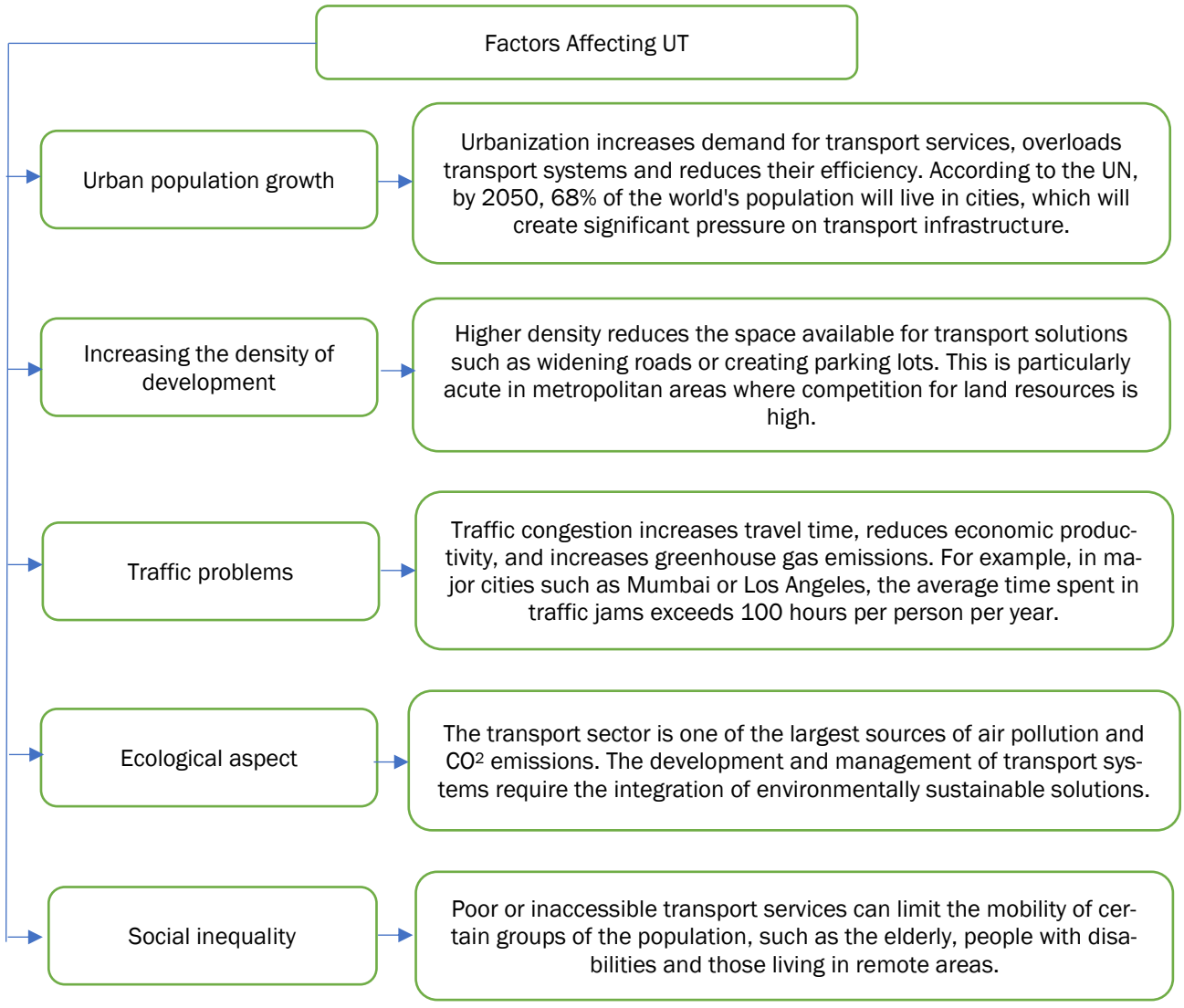


Figure 2. Factors influencing the development of UT
Source: compiled by the authors

Decisions regarding the design of public transport systems involve complex trade-offs, such as area coverage versus service frequency, service speed versus number of stops, operating hours, and frequency, which directly impact users (Ceder, 2016; Murray and Wu, 2003; Walker, 2008). In traditional public transport planning practice, the process of balancing system design objectives and options typically focuses on planning systems to achieve:

- Efficiency - traditional public transport planning focuses on the efficiency of resource allocation, seeking to maximize the use of existing infrastructure and services. The focus is on optimizing routes and schedules to minimize costs while meeting demand.
- Cost Minimization (Operating and Capital) - often includes decisions related to service frequency, route length, and fleet management to ensure cost-effective operations.
- Service Quality - includes factors such as punctuality, reliability, and passenger comfort aimed at attracting and retaining passengers (McLeod, 2017; Grise, 2021; Mulley, 2021; Khan, 2021).

Thus, a study of foreign experience in managing and supporting urban transport systems demonstrates the need for an integrated approach to solving current transport problems. These systems play a

key role in increasing mobility, ensuring environmental sustainability, and improving the quality of life in modern cities.

The experience of cities such as Singapore and Berlin shows that the creation of integrated transport hubs connecting different modes of transport effectively reduces the load on the road network and increases convenience for passengers. The use of AI-based transport management systems, such as in Seoul, helps to optimize traffic flows, reduce congestion and increase road capacity. The example of Scandinavian countries and Germany confirms that the development of bicycle infrastructure and the use of environmentally friendly electric transport can significantly reduce air pollution and noise. Effective management of the transport system requires taking into account the interests of all stakeholders and trade-offs between economic efficiency, environmental safety and the quality of services provided.

The results of reforms and the introduction of innovative approaches in such countries demonstrate that planning and public administration of transport infrastructure should take into account not only the current state of the transport network, but also the long-term needs of the population, including demographic changes, building density and the development of urban areas.

For Kazakhstan, an important area is the adaptation of the best world practices, including:

- development of an integrated and sustainable transport system in large cities such as Almaty and Astana;
- the use of digital technologies to forecast and manage traffic flows;
- attracting investment in environmentally friendly modes of transport and developing infrastructure for their use;
- continuous improvement of the urban transport system will increase its sustainability, accessibility and efficiency, as well as strengthen the connection of transport infrastructure with other elements of the urban environment.

3. ANALYSIS AND RESULTS

The urban transport complex has a multiplier effect on the development of freight and passenger transportation. Integration of modern technologies, improvement of infrastructure and competent flow management can significantly increase the efficiency of the transport system, reducing costs for businesses and improving the quality of life of the population. In most cities, transport systems are progressing towards sustainable development. There is a clear correlation between the sustainable development index of some cities and how developed their transport systems are in these cities, including public transport and infrastructure for individual mobility (Figure 3).

The urban transport complex significantly influences the use of bus transport as the main means of transport for the population. It provides wide coverage of the urban area, including remote areas where other modes of transport, such as metro or trams, may not be economically feasible. Bus transport is often more accessible to various social groups, including older people and people with disabilities.

We examined the factors influencing the passenger turnover of bus transport (Figure 4). The urban transport complex significantly influences the use of bus transport as the main means of transport for the population. It provides wide coverage of the urban area, including remote areas where other modes of transport, such as metro or trams, may not be economically feasible. Bus transport is often more accessible to various social groups, including older people and people with disabilities.

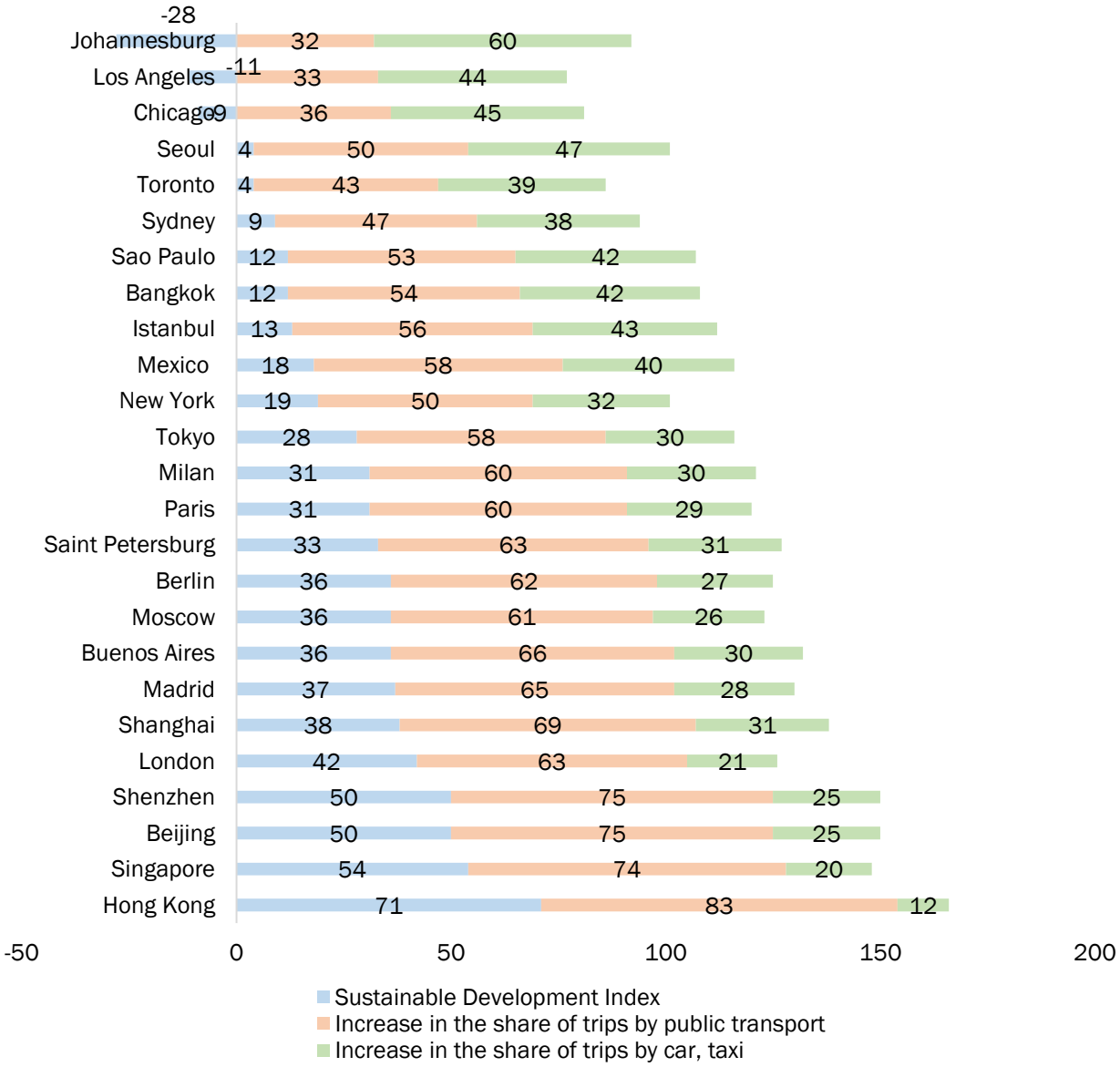


Figure 3. Components of Sustainable Development of UT
Source: compiled by the authors according to https://www.mckinsey.com

We examined the factors influencing the passenger turnover of bus transport (Figure 4).

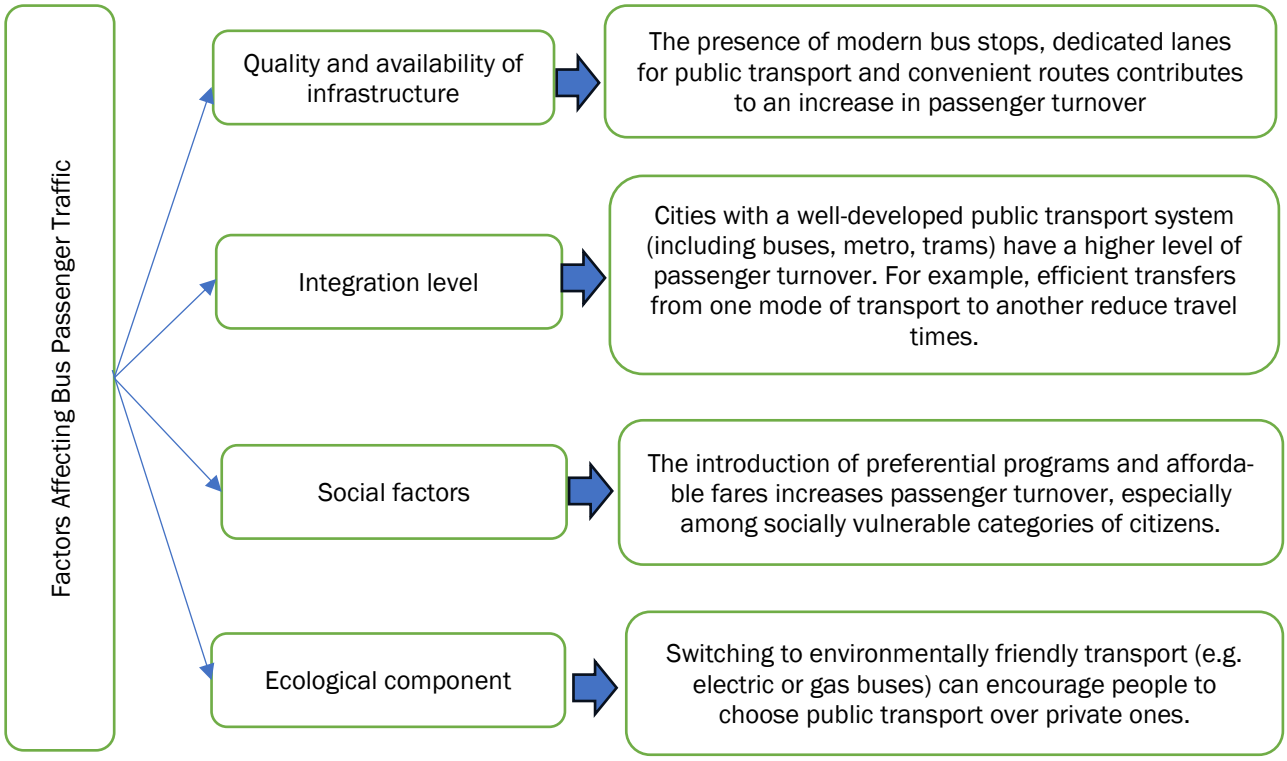


Figure 4. Factors Affecting Bus Passenger Turnover
Source: compiled by the authors

The relationship between urban bus transport, logistics infrastructure and the State Customs Service in the EAEU member states is a complex mechanism that requires coordination of efforts between states to ensure the efficiency and convenience of transport systems in the region. The author conducted a comparative analysis of automobile transport and presented data on passenger turnover of bus transport (Table 3,4).

Table 3. Cargo transportation by road, million tons

Countries	*2014*	*2015*	*2016*	*2017*	*2018*
EAEU	8 767,4	8 429,9	8 540,2	8 965,5	9 192,6
Armenia	4,4	6,9	16,2	23,6	24,5
Belarus	191,7	180,0	175,3	166,7	170,9
Kazakhstan	3 127,4	3 174,3	3 181,1	3 300,8	3 422,3
Kyrgyzstan	27,2	28,2	29,3	29,8	30,5
Russia	5 416,7	5 040,6	5 138,2	5 444,6	5 544,4
EAEU	9 488,7	8 881,3	8 997,8	9123,0	9250,0
Armenia	9,7	9,7	12,1	13,5	13,3
Belarus	161,7	159,8	154,8	150,0	145,0
Kazakhstan	3 550,3	3 288,7	3 314,2	...	262,1
Kyrgyzstan	31,7	24,5	26,2	35,9	37,1
Russia	5 735,3	5 398,6	5 490,5	5673,6	5 771,4

Source: compiled by the authors according to https://eec.eaeunion.org/

Table 4. Passenger turnover of bus transport, million pkm

Year	EAEU	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
2014	356192,7	2 535,6	9 946,0	214853,1	8 471,4	120 386,6
2015	359898,2	2 395,9	9 889,3	220869,0	8 910,0	117 834,0
2016	373625,8	2 436,5	9 825,4	235348,1	9 385,2	116 630,6
2017	378497,0	2 403,4	10405,5	239973,6	9 500,1	116 214,4
2018	383993,7	2 227,5	10650,8	246349,5	9 948,0	114 817,9
2019	397884,4	2 349,8	10881,8	260051,5	11242,2	113 359,1
2020	153159,1	685,2	8 264,6	58033,4	5 795,4	80 380,5
2021	148401,7	1 050,2	7 942,0	44549,2	7 066,6	87 793,7
2022	158 350,0	1609,7	8 500,0	35 200,0	8217,0	87 799,6
2023	162 400,0	1 836,9	8 900,0	27385,5	8 116,9	85 600,1
In the Republic of Kazakhstan, the data is presented taking into account the assessment of the volume of transportation by individual entrepreneurs engaged in commercial transportation.						

Source*:* compiled by the authors according to https://eec.eaeunion.org/

Differences in the dynamics of transportation volumes among the EAEU countries show different degrees of dependence on foreign trade, economic policy and transport infrastructure. An assessment of the sustainability of the transport system can be made based on the analysis of changes in data over the period under study. Trend changes in freight transportation show that the analysis of transportation volumes is characterized by a steady increase, as well as a decrease in the share of individual countries in the total volume. For example, the share of Kazakhstan remains stable during 2014–2023, while the share of Belarus shows a decrease, indicating changes in economic activity and the role of each country in the transport system. Kazakhstan's share in passenger turnover maintains its leading position, but with a decrease after 2020, which is associated with the impact of the COVID-19 pandemic on population mobility. To calculate the share of each country in the total volume of transportation (freight and passenger turnover), the ratio of each country's indicator to the total volume for the corresponding year was calculated, multiplied by 100 for presentation as a percentage (Table 5,6).

Table 5. Shares of countries in the total volume of freight transport by road (%)

Year	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
2014	0,05	2,19	35,67	0,31	61,78
2015	0,08	2,14	37,66	0,33	59,79
2016	0,19	2,05	37,25	0,34	60,16
2017	0,26	1,86	36,82	0,33	60,73
2018	0,27	1,86	37,23	0,33	60,31
2019	0,10	1,70	37,42	0,33	60,44
2020	0,11	1,80	37,03	0,28	60,79
2021	0,13	1,72	36,83	0,29	61,02
2022	0,15	1,64		0,39	62,19
2023	0,14	1,57	2,83	0,40	62,39

Source: Compiled and calculated by the authors

Table 6. Shares of countries in passenger turnover of bus transport (%)

Year	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
2014	0,71	2,79	60,32	2,38	33,80
2015	0,67	2,75	61,37	2,48	32,74
2016	0,65	2,63	62,99	2,51	31,22
2017	0,63	2,75	63,40	2,51	30,70
2018	0,58	2,77	64,15	2,59	29,90
2019	0,59	2,73	65,36	2,83	28,49
2020	0,45	5,40	37,89	3,78	52,48
2021	0,71	5,35	30,02	4,76	59,16
2022	1,02	5,37	22,23	5,19	55,45
2023	1,13	5,48	16,86	5,00	52,71

Source: Compiled and calculated by the authors

4. EXPERIMENTS

Looking at the coefficient of variation for countries allows you to:

- Assess the stability of indicators - the coefficient of variation (CV) measures the relative fluctuation of data. A high CV indicates significant fluctuations in transport indicators, indicating instability in the development of the country's transport system.
- Compare the degree of variability between countries - comparing the CV of different countries helps to identify which countries have the most stable development of the transport sector, and where there are significant fluctuations due to economic, social or political factors.
- Identify risks and vulnerabilities - countries with a high coefficient of variation (for example, Kazakhstan and Armenia) may face risks associated with unpredictable transport volumes, making it difficult to plan and finance infrastructure projects.
- Support management decision-making - CV analysis helps develop strategic measures to align the level of transport services, minimize risks and increase the sustainability of the transport system.
- Monitoring the effectiveness of policies - studying CV in dynamics allows us to assess the impact of government policy and regulation measures on the stability of the transport system, identify the need to adjust approaches or introduce new management tools (Figure 5).

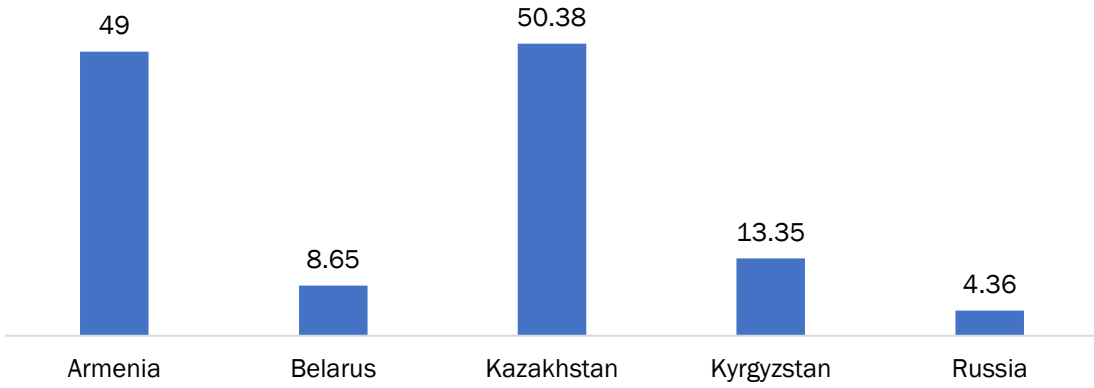
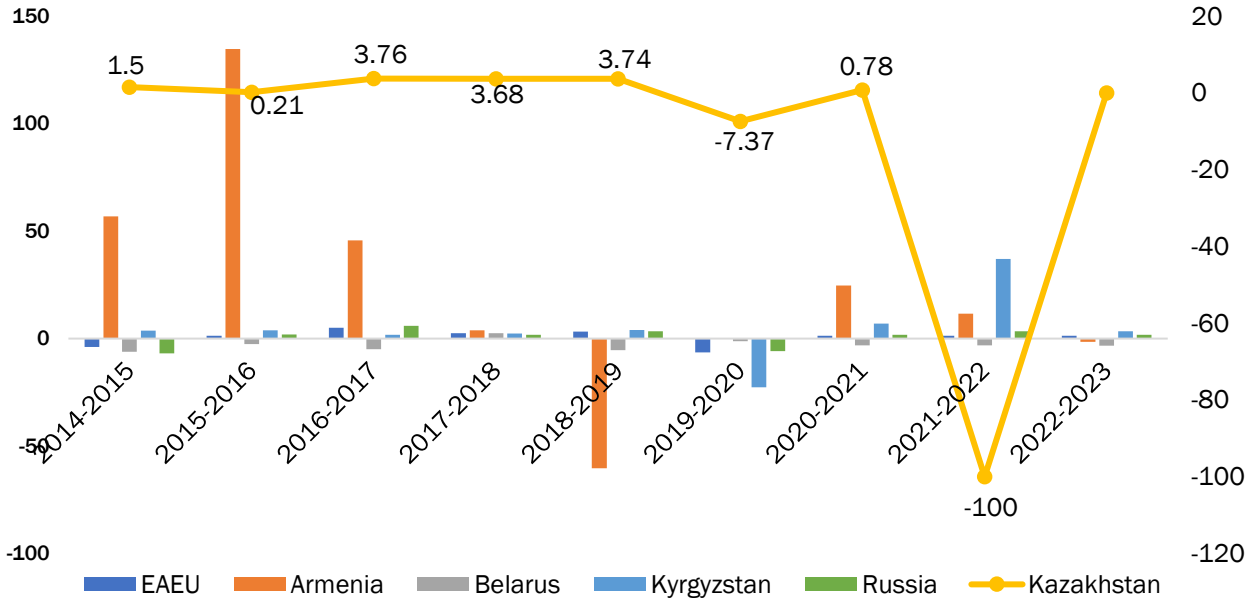


Figure 5. Variation coefficient for countries, %
Source: Compiled and calculated by the authors

The analysis of the results of calculating the variation coefficient shows that:

- high variation coefficients in Armenia and Kyrgyzstan indicate significant fluctuations in transportation volumes, associating this with economic instability, infrastructure limitations or dependence on foreign trade;
- low variation coefficients in Belarus and Russia indicate stability and predictability of transportation volumes, indicating developed infrastructure and stable demand;
- the average level of variation in Kazakhstan reflects moderate fluctuations associated with changes in the economy and logistics activity.

The analysis of the results of calculating the growth rates/increase in freight transportation by road transport allows us to assess the stability of freight transportation indicators for each EAEU country in dynamics over the period under study (Figure 6).



Year	*EAEU*	*Armenia*	*Belarus*	*Kazakhstan*	*Kyrgyzstan*	*Russia*
2014-2015	-3,85	56,82	-6,1	1,5	3,68	-6,94
2015-2016	1,31	134,78	-2,61	0,21	3,9	1,94
2016-2017	4,98	45,68	-4,91	3,76	1,71	5,96
2017-2018	2,53	3,81	2,52	3,68	2,35	1,83
2018-2019	3,22	-60,41	-5,38	3,74	3,93	3,44
2019-2020	-6,4	0	-1,18	-7,37	-22,71	-5,87
2020-2021	1,31	24,74	-3,13	0,78	6,94	1,7
2021-2022	1,39	11,57	-3,1	-100	37,02	3,33
2022-2023	1,39	-1,48	-3,33		3,34	1,72

Figure 6. Growth rates/increase in freight transportation by road transport by year
Source: Compiled and calculated by the authors

An analysis of the calculations performed shows that:

- from 2014 to 2019, there was a moderate increase in transportation volumes in most EAEU countries, attributing this to economic recovery and increased interregional trade;
- the increase in Kazakhstan and Russia is explained by their key position in the region's transport and logistics chains;
- a sharp decline in growth rates in 2020 is associated with the COVID-19 pandemic, which caused a decline in economic activity, a decrease in production and restrictions on movement;
- some countries (for example, Belarus) have seen a decrease in transportation volumes in recent years, attributing this to internal and external economic factors, including sanctions or trade restrictions;
- in 2021–2023, positive dynamics are visible in most countries, especially Kyrgyzstan and Armenia, indicating the recovery of the transport sector.

Thus, fluctuations in growth rates indicate a significant impact of the external economic environment, including global crises, trade restrictions and changes in demand for transport services. Positive growth rates in recent years indicate potential for further development of the sector, subject to investment in infrastructure, digitalization and logistics.

Using the trend model, the indicator "Cargo transportation by road to the EAEU countries, million tons" was forecasted. Initially, the time series was checked for the presence of anomalous observations, for this purpose the Irwin criterion was used (Table 7).

Table 7. Checking for the presence of anomalous observations in a time series

Year	*Cargo transportation by road to the EAEU countries, million tons*	*Observed value of Irwin's criterion*	*Calculation formulas*
2014	8 767,4		Observed value of Irwin's criterion $\lambda_t = \frac{\lvert y_t - y_{t-1} \rvert}{\sigma_y}, \quad t = \overline{2,\ 10}$ Critical value of Irwin's criterion $\lambda_{0,05} = 1{,}5$
2015	8 429,9	1,041	
2016	8 540,2	0,340	
2017	8 965,5	1,312	
2018	9 192,6	0,700	
2019	9 488,7	0,913	
2020	8 881,3	1,873	
2021	8 997,8	0,359	
2022	9 123,0	0,386	
2023	9 250,0	0,392	

Source: compiled by the authors according to https://eec.eaeunion.org/

The obtained results showed that the time series contains an abnormal value corresponding to 2020. This is due to the restrictions introduced in connection with the coronavirus pandemic. To obtain adequate modeling results, this level was smoothed using a three-term average. Next, a hypothesis was put forward about the presence of a trend in the analyzed time series, which was confirmed using the criterion of "ascending" and "descending" series (Table 8).

Table 8. Checking for a trend

General form of the criterion of "ascending" and "descending" series (for the presence of a trend, it is sufficient for at least one inequality to be violated)	Calculated values with error probability $0{,}05 < \alpha < 0{,}0975$
$\nu(n) > \left[\frac{2n-1}{3} - 1{,}96\sqrt{\frac{16n-29}{90}} \right]$	4 < 3
$K_{\max} < [K_0(n)]$	4=4

Source: compiled by the authors

To approximate the initial data, a first-degree polynomial was chosen as the growth curve:

$$y_t = a_0 + a_1 t + \varepsilon_t,$$

As a result of calculations using the least squares method, the following trend model was obtained:

$$y_t = 8579{,}420 + 74{,}245t$$

Next, the quality of the obtained model was assessed in two directions: adequacy testing and model accuracy assessment. To test the adequacy of the model, a number of residuals were examined, i.e. the discrepancy between the levels calculated by the model and actual observations. The most important properties of the residual component are: equality of the mathematical expectation to zero, randomness of the residuals and their compliance with the normal distribution law.

To test the hypothesis that the mathematical expectation is equal to zero, *t*-Statistic $t_{observ.} = 0$, which turned out to be less than the critical value $t_{crit.} = 2{,}31$, which confirms the hypothesis with 95% probability.

The randomness of the levels of the residual series was tested using the turning point criterion.

$$p = 3 > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right] = 2$$

The inequality is confirmed by calculations, therefore the model is adequate according to this criterion.

The correspondence of a number of residuals to the normal distribution law was determined using the RS-criterion.

$$RS = \frac{e_{max} - e_{min}}{S} = 3{,}04$$

The calculated value fell within the range of the criterion's boundary values (2.67-3.69), which confirmed the normality of the distribution with a probability of 95%. To assess the accuracy of the model, the average relative approximation error was calculated:

$$E_{rel.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t}\cdot 100\% = 2{,}08\%,$$

value, which indicates a good level of accuracy of the model.

Thus, the model is of high quality and can be used for forecasting.

To calculate the point forecast, the corresponding values of the time factor were substituted into the constructed model $t = n + k$. To construct an interval forecast, a confidence interval was determined at the significance level $\alpha = 0{,}05$. The width of the confidence interval was calculated using the formula:

$$U(k) = S_e t_\alpha \sqrt{1 + \frac{1}{n} + \frac{\left(n + k - \bar{t}\right)^2}{\sum_{t=1}^{n}\left(t - \bar{t}\right)^2}},$$

The results of constructing point and interval forecasts of the volume of cargo transportation by road to the EAEU countries for 2025-2027 are presented in Table 9.

Table 9. Point and interval forecasts for 2025-2027

Year	$n+k$	$U(k)$	*Point forecast, million tons*	*Interval forecast, million tons*	
				Max	*Min*
2025	16	734,93	9 470,37	8 735,43	10 205,30
2026	17	772,65	9 544,61	8 771,97	10 317,26
2027	18	813,61	9 618,86	8 805,25	10 432,46

Source: compiled by the authors

Based on the analysis, the author made the following recommendations:

- For countries with a high coefficient of variation (Armenia, Kyrgyzstan), develop measures to improve the sustainability of the transport system, including infrastructure modernization and simplification of regulatory barriers.
- For countries with stable indicators (Russia, Belarus), maintain the current level of development through further improvement of logistics and technological solutions.
- For the entire EAEU, strengthen interregional transport integration to improve the overall stability and competitiveness of road transport.

CONCLUSION

The study of public administration of urban transport infrastructure and logistics in the EAEU countries allows us to identify key aspects that influence the development and sustainability of transport systems. The relationship between bus transport, logistics infrastructure and the state transport complex in the region requires coordination of efforts between states to improve mobility and environmental sustainability. Based on foreign public administration experience, such as the integration of various modes of transport in Singapore and the use of smart technologies in Seoul, effective practices can be adapted in the EAEU countries to improve the operation of transport systems. The use of forecasting and optimization methods, as well as the introduction of innovative technologies such as electric vehicles and traffic management systems, can significantly improve the efficiency of transport services and reduce the environmental burden.

As a result of the analysis, the author proposed the following recommendations:

A) For countries with a high coefficient of variation (e.g. Armenia and Kyrgyzstan):

- it is necessary to strengthen support for the sustainability of transport systems;
- it is recommended to modernize the transport infrastructure and simplify regulatory barriers, allowing for increased mobility and reduced traffic jams.

B) For countries with more stable indicators (Russia, Belarus):

- continue to develop and improve logistics solutions;
- maintain existing transport infrastructures and introduce innovative technologies to improve services.

C) For the entire EAEU:

- strengthen interregional transport integration, improving the overall stability and competitiveness of road transport. Investments in infrastructure and more active implementation of environmentally friendly modes of transport will help to increase sustainability and reduce dependence on traditional energy sources.

D) Use of technologies:

- actively develop technologies such as intelligent traffic management systems that will facilitate more efficient use of existing transport capacity and reduce travel times for passengers and cargo.

These recommendations will contribute to the creation of more efficient and sustainable transport systems in the EAEU countries, which in turn will improve the quality of life of the population and improve economic indicators in the region.

REFERENCES

Anin, E., Annan, J., Alexander, O. (2013), "Assessing the causes of urban transportation challenges in the Kumasi Metropolis of Ghana", *American Based Research Journal*, Vol. 2, pp. 1–12

Bouraima, M.B., Ayyildiz, E., Ozcelik, G. (2024), "Alternative prioritization for mitigating urban transportation challenges using a Fermatean fuzzy-based intelligent decision support model", *Neural Computing and Applications*, Vol. 36, pp. 7343–7357. https://doi.org/10.1007/s00521-024-09463-x

Ceder, A. (2016), "Public transit planning and operation: Modeling, practice and behavior", *CRC Press*, pp. 86-89. https://doi.org/10.1201/b18689

Cervantes-Sanmiguel, K.I., Chavez-Hernandez, M.V., Ibarra-Rojas, O.J. (2023), "Analyzing the trade-off between minimizing travel times and reducing monetary costs for users in the transit network design", *Transportation Research Part B: Methodo*logical, Vol. 173, pp. 142–161. https://doi.org/10.1016/j.trb.2023.04.009

Deveci, M. (2022), "A decision support system for assessing and prioritizing sustainable urban transportation in metaverse", *IEEE Transactions on Fuzzy Systems*, Vol. 11, No. 8, pp. 397-408.

Ecer, F., Küçükönder, H., Kayapınar Kaya, S., Faruk, G.Ö. (2023), "Sustainability performance analysis of micro-mobility solutions in urban transportation with a novel IVFNN-Delphi-LOPCOW-CoCoSo framework", *Transportation Research Part A: Policy and Practice*, Vol. 172, pp. 103667

Grise, E., Stewart, A., El-Geneidy, A. (2021), "Planning a high-frequency transfer-based bus network: How do we get there?", *Journal of Transport and Land Use*, Vol. 14, No. 1, pp. jtlu. 2021.1742. https://doi.org/10.5198/jtlu.2021.1742

Grotto, A., Pau Fonseca, C., Zubaryeva, A., Sparber, W. (2024), "Formalizing Sustainable Urban Mobility Management: An Innovative Approach with Digital Twin and Integrated Modeling", *Logistics*, Vol. 8, No. 4, pp. 8040117. https://doi.org/10.3390/logistics8040117

Hajduk, S. (2021), "Multi-criteria analysis in the decision-making approach for the linear ordering of urban transport based on TOPSIS technique", *Energies*, Vol. 15, pp. en15010274. https://doi.org/10.3390/en15010274

Hrelja, R., Levin, L. Camporeale, R. (2024), "Handling social considerations and the needs of different groups in public transport planning: a review of definitions, methods, and knowledge gaps", *European Transport Research Review*, Vol. 16, No. 42, pp. 1-19. https://doi.org/10.1186/s12544-024-00664-y

Kant, G., Quak, H., Peeters, R., van Woensel, T. (2016), "Urban freight transportation: challenges, failures and successes", *Springer*, pp. 127-139.

Khan, J., Hrelja, R., Pettersson, F. (2021), "Increasing public transport patronage. An analysis of planning principles and public transport governance in Swedish regions with the highest growth in ridership", *Case Studies on Transport Policy*, Vol. 9, No. 1, pp. 260–270. https://doi.org/10.1016/j.cstp.2020.12.008

McLeod, S., Scheurer, J., Curtis, C. (2017), "Urban public transport: Planning principles and emerging practice", *Journal of Planning Literature*, Vol. 32, No. 3, pp. 223–239. https://doi.org/10.1177/0885412217693570

Mulley, C., Nelson, J. (2021), "Public transport network planning. In R. Vickerman", *International Encyclopedia of Transportation, Elsevier*, pp. 388–394. https://doi.org/10.1016/B978-0-08-102671-7.10781-X

Murray, A.T., Wu, X. (2003), "Accessibility tradeoffs in public transit planning", *Journal of Geographical Systems*, Vol.5, pp.93–107. https://doi.org/10.1007/s101090300105

Negrelli, A., Roukouni, A., Chassy, A. (2017), "Local Public Transport services: the efficiency of public enterprises competing with the private sector in the EU Member States" in *Network industries and social welfare: the experiment that reshuffled European utilities*, Florio M. (Ed.), Oxford University Press, Oxford, pp. 9781786439031.00019. https://doi.org/10.4337/9781786439031.00019

Ogunbodede, E. (2008), "Urban road transportation in Nigeria from 1960 To 2006: problems, prospects and challenges", *Ethiopian Journal of Environmental Studies and Management*, Vol. 1, pp. 7–18. https://doi.org/10.4314/ejesm.v1i1.41565

Salcedo-Sanz, S., Cuadra, L., Alexandre-Cortizo, E., Jiménez-Fernández, S., Portilla-Figueras, A. (2014), "Soft-Computing: An Innovative Technological Solution for Urban Traffic-Related Problems in Modern Cities", *Technological Forecasting and Social Change*, Vol. 89, pp. 236–244.https://doi.org/10.1016/j.techfore.2013.08.035

Sarlab, R., Rostamzadeh, R., Dehghanpouri, H., Saparauskas, J., Turskis, Z. (2024), "Importance and Impact of New Digital Technologies on Business's Performance", *Transformations in Business & Economics*, Vol. 23, No. 1 (61), pp. 62-85.

Schünemann, J., Finke, S., Severengiz, S., Schelte, N., Gandhi, S. (2022), "Life cycle assessment on electric cargo bikes for the use-case of urban freight transportation in Ghana", *Procedia CIRP*, Vol. 105, pp.721–726. https://doi.org/10.1016/j.procir.2022.02.120

Simic, V., Gokasar, I., Deveci, M., Svadlenka, L. (2022), "Mitigating Climate change effects of urban transportation using a type-2 neutrosophic MEREC-MARCOS model", *IEEE Transactions on Engineering Management*, Vol. 71, pp. 3233–3249. doi: 10.1109/TEM.2022.3207375

Solanke, M. (2013), "Challenges of urban transportation in Nigeria", *International Journal of Development and Sustainability*, Vol. 2, No. 2, pp. 891–901

Suhanyi, L., Gavura, S., Suhanyiova, A. (2024), "E-government and the sustainable public administration: digital interaction with public authorities in the regions of the EU", *Transformations in Business & Economics*, Vol. 23, No. 1 (61), pp. 106-126.

Walker, J. (2008), “Purpose-driven public transport: Creating a clear conversation about public transport goals”, *Journal of Transport Geography*, Vol. 16, No. 6, pp. 436–442. https://doi.org/10.1016/j.jtrangeo.2008.06.005
Electronic resource: https://unhabitat.org/annual-report-2021
Electronic resource: Passenger transportation by mode of transport among the EAEU countries. https://eec.eaeunion.org/
Electronic resource: Transport systems of 25 cities of the world. 2021. Components of success. https://www.mckinsey.com

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Tung, H.T., Anh, P.T.T. (2026), "The Effect of Economic Policy Uncertainty on the Capital Adequacy Ratio Adjustment of the Asian Banks",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 117-125.

The Effect of Economic Policy Uncertainty on the Capital Adequacy Ratio Adjustment of the Asian Banks

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ARTICLE INFO

Received November 27, 2024
Revised from December 28, 2024
Accepted January 15, 2025
Available online April 15, 2026

JEL classification: D24, E51, G21, G28

DOI: 10.14254/1800-5845/2026.22-2.10

Keywords:

Economic policy uncertainty,
bank regulation,
Basel regulation,
adjustment speed,
Asian banks.

ABSTRACT

Due to many factors, the CAR is frequently and continuously adjusted in the business. This research examines the factors that affect the CAR target and its adjustment speed. We apply the partial adjustment model to analyze the data of 9 Asia countries' banks from 2010 to 2019. Our key finding is that credit growth shows less influence and is statistically significant on the CAR target than the new variable created by the interaction between credit growth and the economic policy instability index. The adjustment has occurred through this new factor rather than adjustments to the risk sensitivity of the banks' assets or the growth of undivided profit. In addition, the Asian banks improved their CAR by increasing the main components of their core capital.

INTRODUCTION

Recently, uncertainty is a matter for economic decision-making that has been emphasized; economic policy uncertainty (EPU) helps predict recessions at the macro-level (Karnizova & Li, 2014) and in the presence of now-standard financial variables (Scott et al., 2015). The government has widespread effects on the country's overall economy (Ellen & Edward, 2005). When government policies are smooth and predictable, the economic sectors might be more informed about their business enlargement decisions. On the contrary, uncertainty about government policies has severe implications as firms tend to decrease investment and cut jobs (Scott et al., 2016; Huseyin & Mihai, 2016). Banks are sensitive and averse to EPU (Gissler et al., 2016); in reaction to EPU, banks may reduce credit growth to lower risk exposure (Bordo et al., 2016).

Recent studies focus on a bank lending channel through which economic policy uncertainty (EPU) slows US credit growth and eventually harms the economy (Bordo et al., 2016; Zelong and Jijun, 2018; Berger et al., 2018). Hu and Gong (2019) analyzed bank-level data in 19 major economies, adding

evidence that EPU significantly hinders bank credit growth. These authors also confirmed empirically that prudential regulation reduced the impact of EPU on bank lending. Hence, sound prudential policies help reduce bank credit risk when uncertainty rises.

After the financial crisis of 2008, bank regulations and supervision are being tightened to consolidate in the industry worldwide. The Basel Committee has identified the capital adequacy ratio (CAR) as one of the most important criteria financial institutions must follow to maintain their soundness. This requirement is carried out through the implementation of the high-quality capital concept. The public and private sectors have been urging banks to build more capital. Cohen and Scatigna (2016) analyzed 101 large banks from advanced and emerging economies; the results indicated that the adjustment was through the accumulation of retained earnings and shifting to the assets with other risk weights rather than through sharp adjustment in lending or asset growth channels. The authors also supposed that the developments in lending standards and lending spreads have been very weak relative to the other factors influencing bank lending supply. However, Asia countries, which are almost emerging economies, might have another way to comply with the CAR regulations. How did the Asian banks compliance the CAR? Especially with the impact of The World Uncertainty Index (WUI), a new upgrade index from the EPU. That is a gap that this study aims to fill.

1. LITERATURE REVIEW

The World Uncertainty Index (WUI) was developed by Hites Ahir (International Monetary Fund), Nicholas Bloom (Stanford University) and Davide Furceri (International Monetary Fund). The authors construct quarterly indices of economic uncertainty for 143 countries from 1996 onwards using frequency counts of "uncertainty" (and its variants) in the quarterly Economist Intelligence Unit country reports (Hites et al., 2022). The index is associated with greater economic policy uncertainty (EPU), stock market volatility, risk, and lower GDP growth (https://www.policyuncertainty.com/wui_quarterly.html). Uncertainty related to economic policy may affect the real economy. Firms tend to decrease investment and cut jobs amid high uncertainty, while households reduce consumption (Scott et al., 2016; Huseyin & Mihai, 2016).

Bordo et al. (2016) examined the impact of economic policy uncertainty on aggregate bank credit growth. The authors find that policy uncertainty significantly negatively affects bank credit growth. The effects are attributable to loan demand or loan supply if the impact varies with bank-level financial constraints. Findings are consistent with the possibility that high economic policy uncertainty may have slowed the United States' economic recovery from the Great Recession by restraining overall credit growth through the bank lending channel.

In the same line as Bordo et al. (2016), Hu and Gong (2019) analyzed bank-level data in 19 major economies and consolidated that the EPU has a significant negative effect on the growth of bank credit. In addition, the authors showed empirical evidence that the EPU significantly hinders bank credit growth, but the effect varies across banks. In particular, the negative effect of EPU on loan growth is greater for larger and riskier banks while weaker for more liquid and diversified banks. And the impact of EPU on bank lending depends critically on national prudential regulations. In addition, Badar and Yinjie (2019) analyzed bank data from 17 countries and concluded that the impact of EPU on banks' loan pricing remains persistent after controlling for banks' own idiosyncratic default risk and the political risk variables. These authors also found a significant positive association between loan spreads and the EPU index. Together, these results suggest that government economic policy uncertainty is an economically important risk factor for banks' loan pricing.

Recently, Badar and Yinjie (2919) concluded that government economic policy uncertainty has a significant positive association with interest rates on bank gross loans. Specifically, a one standard deviation increase in EPU leads to a 21.84 basis points increase in average interest rates on bank gross loans. CAR is suggested by the Basel committee as a benchmark for bank soundness and applied in the industry worldwide. Cohen and Scatigna (2016) analyzed data from 101 large banks from advanced and emerging economies to investigate the adjustment channel for the CAR implementation of these banks. The approach is based on the capital requirements regulatory. The authors indicated that retained earnings, issuing new equity, changing the asset side of the bank's balance sheet and shifting the risk-weighted asset (RWA) are the adjustment channels that the bank can employ. The evidence showed that the adjustment

channel was the accumulation of retained earnings, while reductions in risk weights were not the priority, and banks continued to expand their lending.

In addition (Shimizu, 2015) gave another approach to analyze the behavior of adjusting denominators of capital ratios upon the introduction of Basel II regulations of the Japanese banks. In this study, the first analysis investigates the adjustments to the size and composition of portfolios to achieve the target risk-weighted asset. Then, the second analysis investigates how quickly banks adjust the numerator and denominator of their capital ratio. The findings of Shimizu (2015) evidenced that banks adjusted the composition of their assets faster than their asset size to achieve the RWA targets. Besides, banks adjusted their level of regulatory capital faster than their RWA to achieve the capital ratio targets.

In this study, the author follows and combines the methods of both Shimizu (2015) and Cohen and Scatigna (2016) and also adds the economic policy uncertainty index (WUI) as a new factor into the analysis to find out whether this is a factor that might affect on the CAR adjustment speed of the banks in 9 Asia countries or the affect might cause the CAR through the interactive between the WUI and the loan growth.

2. METHODOLOGY AND DATA

The partial adjustment models are used to estimate the adjustment speed of the capital ratios and the contribution of the factors in the adjustment channels that build the CAR. The CAR is defined as the regulatory capital divided by the RWA. Defined by the formula below:

We begin with the simple definition of the RWA

$$\mathrm{CAR}_{i,t} = \frac{(\mathrm{Tier1+Tier2})_{i,t}}{\mathrm{RWA}_{i,t}} \qquad (1)$$

where RWA_{it} is the total risk-weighted assets of bank *I* at year *t*. Under the current regulations, the RWA is specified as the average risk weight on risky total asset:

$$\mathrm{RWA}_{i,t} = \Omega(\mathrm{Risky\ total\ asset})_{i,t} \quad (2)$$

where Ω is denoted as the average risk weight.

In formula (2), almost all risky total assets are in the total financial asset securities, gross loan and advance to customer, and other assets of each bank I at year *t*. The gross loan and advance, which is the largest proportion in the bank asset portfolio, is proxy by its growth to investigate whether this growth is connected with the adjustment of the CAR. Additionally, in the formula (1), the undivided profit is a component of tier 1, a very important channel that adds to the bank's capital to improve the numerator of the CAR. Therefore, the author separates tier 1 from the total equity and the capital generation to make it easier to recognize the contribution of each part in tier 1 to the CAR adjustment.

Dividing the numerator and denominator of the left-hand side of formula (1) to the total assets. In which the Ω is divided into total assets, the risk-weighted asset intensity. Assuming that the other factors are stable, changing each part in the numerator might cause a positive associate relationship with the CAR, while the parts of the denominator might cause an invert.

This research expects to find some evidence of the effect of the WUI index, which is the standard deviation of the government economic policy uncertainty and its interaction with the loan growth on the CAR. The standard deviation of the government economic policy uncertainty is a negative effect on loan growth (Badar & Yinjie (2019), Hu & Gong (2018), Bordo et al., (2016)), while loan growth represents the change in gross loans, which is a part of the denominator of CAR. These two new indicators are added to the estimation model to analyze how the WUI affects the CAR compliance of Asian banks.

Table 1. The summary of the variables

Variable	*Definition*	*Calculated*	*Expectation*
CAR	Capital Adequacy Ratio	$\mathrm{CAR}_{i,t} = \frac{(\mathrm{Tier1} + \mathrm{Tier2})_{i,t}}{\mathrm{RWA}_{i,t}}$	+
Size	The logarithm of total asset	The logarithm of total assets of bank *i,t*	-
LoanG	Loan growth ratio	(Gross loan$_{i,t}$ - Gross loan$_{i,t-1}$)/Gross loan$_{i,t-1}$	-
WUI	WUI index by country	Standard deviation WUI index by country year *t*	+/-
LoanG*WUI	The interaction of WUI with the loan growth	Multiply the Loan growth ratio by the WUI index	+/-
FS_TA	The ratio of total financial asset securities to total assets of a bank	Total financial securities$_{i,t}$/total assets$_{i,t}$	-
OA_TA	The ratio of other assets to total asset	Other assets$_{i,t}$/Total Asset$_{i,t}$	-
RWA_I	The ratio of total risk-weighted asset to total asset	Total Risk-Weighted Assets$_{i,t}$/Total Asset$_{i,t}$	-
TE_TA	Equity ratio	Total equity$_{i,t}$/Total asset$_{i,t}$	+
T2	Tier 2	Tier 2 capital$_{i,t}$	+
CET1	Growth of Capital generation ratio	(Net income$_{i,t}$ – dividend$_{i,t}$) /Total equity$_{i,t}$	+

Source: Summary by the authors

3. THE MODEL

To estimate the adjustment speed of the banks, in the long run, the CAR is a function of the factors that affect itself;

$$\mathbf{Y^*_{i,t+1}} = \sum_{j=1}^{j} \beta_j \mathbf{X_{j,i,t}} + \theta_n \mathbf{C_{n,i,t}}, n = 1 \quad (3)$$

Y* is the CAR target, the partial adjustment model of the CAR and its target:

$$\mathbf{Y_{i,t}} - \mathbf{Y_{i,t-1}} = \lambda\left(\mathbf{Y^*_{i,t}} - \mathbf{Y_{i,t-1}}\right) + \varepsilon_{i,t} \quad (4)$$

where Y is respectively the capital on total assets ratio and the capital on risk-weighted assets ratio of bank i, the X_j is the vector of factors j*th* that affect the adjustment of the CAR, and the C_n is the control variable, t is the year from 2010 to 2019; λ is the gap or speed of adjustment during a point time, ($0 \le \lambda \le 1$). Substituting equation (3) into equation (4), then a model that the speed of adjustment (λ) is estimated as follows:

$$\mathrm{Y_{i,t}} = (1 - \lambda)\mathrm{Y_{i,t-1}} + (\lambda\theta_n)\mathrm{C_{n,i,t}} + \sum_{j=1}^{j}(\lambda\beta_j)\mathrm{X_{j,i,t}} + \varepsilon_{i,t} \quad (5)$$

Then, the author includes bank fixed effects (Bank$_i$), year fixed effects (Year$_t$), country fixed effect (Country$_l$) and bank type effects (Bank_type$_k$) to absorb any unobserved, time-invariant bank and bank type heterogeneity and business cycle effects, respectively. In addition, the logarithm of the total asset (Size) is a control variable added into the equation, the same as almost all of the analyses in this area. The model could be rewritten as the function below:

$$CAR_{i,t} = (1-\lambda)CAR_{i,t-1} + (\lambda\theta)Size_{i,t} + (\lambda\beta_1)LoanG_{i,t} + (\lambda\beta_2)WUI_t + (\lambda\beta_3)WUI_t * LoanG_{i,t} + (\lambda\beta_4)FS\_TA_{i,t} + (\lambda\beta_5)OA\_TA_{i,t} + (\lambda\beta_6)RWA\_I_{i,t} + (\lambda\beta_7)TE\_TA_{i,t} + (\lambda\beta_8)T2\_TA_{i,t} + (\lambda\beta_9)CET1\_G_{i,t} + \varepsilon_{i,t} \quad (6)$$

3.1 Data

The sample was constructed by collecting the economic policy uncertainty index data from the website https://www.policyuncertainty.com/wui_quarterly.html. This website hosts the economic policy uncertainty index data developed by Hites et al. (2022). These authors have constructed a new index, the World Trade Uncertainty Index, that measures uncertainty related to trade for 143 individual countries every quarter from 1996 onwards, using the Economist Intelligence Unit (EIU) country reports. The approach to constructing the WTU index is to count the number of times uncertainty is mentioned within proximity to a word related to trade in the EIU country reports. In this research, we downloaded the index data for 9 Asian countries and merged them with bank-level financial statements yearly data of banks operating in these countries from the Bankscope database from 2010–2019.

4. RESULTS AND DISCUSSIONS

The collected data is an unbalanced panel data. The loan growth and capital generation ratio information are less than the other 12 observations and 01 observation, respectively.

Table 2. Summary statistics of the data

	N	Mean	Sd	min	max	Se
CAR	5040	0.123	0.317	0.001	4.882	0.004
Size	5040	7.779	1.265	1.643	11.489	0.018
LoanG	5028	0.118	0.441	-1.000	8.455	0.006
WUI	5040	0.096	0.053	0.000	0.376	0.001
FS_TA	5040	0.213	0.147	0.000	0.879	0.002
OA_TA	5040	0.250	0.177	0.000	0.727	0.002
RWA_I	5040	0.293	0.347	0.001	6.080	0.005
TE_TA	5040	0.126	0.129	-0.811	0.756	0.002
T2_TA	5040	0.006	0.010	0.000	0.202	0.000
CET1	5039	0.035	0.207	-7.826	7.843	0.003

Source: Calculated by the authors

Table 2a. Summary statistics by year – Mean

Year	*CAR*	*Size*	*LoanG*	*WUI*	*FS_TA*	*OA_TA*	*RWA_I*	*TE_TA*	*T2_TA*	*CET1*
2010	0.019	7.401	0.019	0.045	0.238	0.087	0.081	0.054	0.009	0.000
2011	0.017	7.438	0.038	0.146	0.241	0.099	0.061	0.110	0.008	0.000
2012	0.018	7.483	0.041	0.138	0.240	0.171	0.108	0.096	0.007	0.000
2013	0.041	7.500	0.072	0.132	0.242	0.136	0.065	0.115	0.004	0.001
2014	0.103	7.992	0.130	0.133	0.216	0.151	0.236	0.110	0.009	0.022
2015	0.098	7.956	0.166	0.110	0.217	0.166	0.275	0.116	0.006	0.032
2016	0.142	7.796	0.163	0.066	0.218	0.184	0.375	0.122	0.006	0.073
2017	0.143	7.813	0.142	0.092	0.227	0.181	0.341	0.125	0.006	0.039
2018	0.154	7.850	0.184	0.110	0.228	0.180	0.343	0.130	0.006	0.063
2019	0.151	7.798	0.141	0.084	0.218	0.189	0.330	0.152	0.006	0.043

Source: Calculated by the authors

Table 2b. Summary statistics by country – Mean

	CAR	*Size*	*LoanG*	*WUI*	*FS_TA*	*OA_TA*	*RWA_I*	*TE_TA*	*T2_TA*	*CET1*
China	0.153	7.378	0.195	0.069	0.290	0.288	0.546	0.106	0.007	0.123
India	0.124	6.990	0.131	0.124	0.243	0.153	0.411	0.115	0.009	0.061
Indonesia	0.227	9.169	0.204	0.104	0.108	0.236	0.647	0.162	0.011	0.057
Japan	0.111	7.709	0.051	0.106	0.251	0.164	0.078	0.074	0.004	0.007
Korea	0.135	10.826	0.082	0.094	0.157	0.106	0.536	0.075	0.015	0.069
Malaysia	0.288	6.643	0.113	0.112	0.224	0.339	0.497	0.194	0.011	0.075
Philippine	0.045	7.273	0.184	0.128	0.140	0.379	0.169	0.236	0.004	-0.005
Singapore	0.070	8.822	0.259	0.063	0.410	0.254	0.125	0.196	0.002	0.007
Vietnam	0.038	8.725	0.212	0.066	0.115	0.285	0.645	0.172	0.001	0.001

Source: Calculated by the authors

Table 2c. Summary statistics by bank type – Mean

	CAR	*Size*	*LoanG*	*WUI*	*FS_TA*	*OA_TA*	*RWA_I*	*TE_TA*	*T2_TA*	*CET1*
Commercial	0.108	7.883	0.138	0.096	0.217	0.211	0.334	0.105	0.007	0.050
Cooperative	0.133	6.369	0.102	0.091	0.243	0.204	0.538	0.101	0.011	0.030
Investment	0.395	7.860	0.225	0.092	0.332	0.423	0.081	0.271	0.002	0.014
Real estate	0.118	6.941	0.178	0.119	0.056	0.142	0.222	0.110	0.001	0.004
Saving	0.016	7.311	0.106	0.126	0.129	0.415	0.059	0.287	0.002	0.003

Source: Calculated by the authors

The figures in Table 2a show that in the three years from 2010 to 2012, the CAR was under 2%. The risk sensitivity was low during that time, and the banks almost did not increase their capital generation levels. Meanwhile, the equity to total assets ratio increased twice between 2010 and 2011, and the tier 2 capital ratio fluctuated slightly. After 2013, almost all the Asian banks in the data improved their CAR; the equity ratio and the capital generation were higher than the previous; meanwhile, the asset sensitivity also increased. The figures in Table 2b and 2c supplement the information that from 2010 to 2019, the CAR of the banks in China, India, Japan and Korea were around the middle range, while in Singapore, Philippines and Vietnam, the CAR was respective. The CAR in Malaysia and Indonesia were the highest and the second highest, respectively. In the industry, saving banks had the lowest CAR, 1.6%, while investment banks showed the highest at 39.5%.

Table 3. Correlation matrix between the independent variables

	CAR_{t-1}	*Size*	*LoanG*	*WUI*	*FS_TA*	*OA_TA*	*RWA_I*	*TE_TA*	*T2_TA*	*CET1*
CAR_{t-1}	1	0.1	0.07	-0.01	0.02	0.17	0.15	0.05	0.02	0.02
Size		1	0.06	-0.06	-0.02	-0.04	0.08	-0.04	0.05	0.01
LoanG			1	0	-0.04	0.07	0.01	0.04	-0.03	0.04
WUI				1	-0.05	-0.03	-0.08	0.01	0.06	-0.04
FS_TA					1	-0.18	-0.03	-0.03	0.02	0.06
OA_TA						1	0.03	0.34	-0.12	0.01
RWA_I							1	-0.04	0.44	0.19
TE_TA								1	-0.08	-0.01
T2_TA									1	0.07
CET1										1

Source: Calculated by the authors

In Table 3, the correlations matrix between variables shows that most of the variables do not have very high correlation coefficients between each other, suggesting that the chances of multicollinearity in multivariate analysis are low.

The estimated results of models (6) in Table 4 show the significance statistically for the CAR adjustment speed calculation, in which the year fixed effects (6a) provide a low adjustment speed at only 0.094 while the estimations added bank and country fixed effects (6b), bank and bank type fixed effects (6c) give almost the same CAR adjustment speed at 0.82. The control variable loses its significant statistical effect on CAR in both models (6a) and (6b) and shows a statistically significant from the estimation of the model (6b) at 95%. The results also provide that the loan growth variable has a statistically significant effect on CAR in models (6b) and (6c), but in model (6a), this factor does not have enough evidence of this effect. Additionally, the WUI alone does not give any evidence of its effect on the CAR. Meanwhile, the interaction of WUI and loan growth showed strong evidence that this interaction has a positive statistically significant effect on the CAR and has the highest impact compared with the other variables in the models. Results of the interactive variable might be understood that the impact of WUI on CAR might be calculated by the WUI multiple the coefficient of loan growth and the coefficient of the interactive variable, a magnitude of the loan growth and the WUI together impact on CAR and stronger than the impact of loan growth alone on the CAR. The findings are associated with and contribute to the findings of Bordo et al. (2016) and Hu & Gong (2018). The relationship between loan growth and economic policy uncertainty also provides evidence of its effect on the CAR adjustment of Asian banks from 2010 to 2019.

Table 4. Panel regression of Capital Adequacy Ratio: partial adjustment model

Dependent variable:	*CAR*		
Model	(6a)	(6b)	(6c)
Constant	-0.028	0.136	0.500
	(-1.386)	(1.363)	(1.521)
CAR1	0.906**	0.181***	0.180***
	(11.233)	(3.741)	(11.306)
	λ= 0.094	***λ= 0.819***	***λ= 0.82***
Size	0.003	-0.015	-0.054**
	(1.274)	(-0.667)	(-1.998)
LoanG	-0.022	-0.016**	-0.015***
	(-0.991)	(-2.421)	(-3.106)
WUI	-0.027	-0.041	-0.037
	(-0.519)	(-0.764)	(-0.359)
LoanGxWUI	0.096	**0.137*****	**0.139*****
	(0.766)	(3.411)	(3.412)
FS_TA	-0.001	-0.041	-0.036
	(-0.106)	(-0.473)	(-0.223)
OA_TA	0.046	0.130	0.146
	(1.618)	(0.991)	(1.232)
RWA_I	0.019	0.054	0.049
	(1.095)	(1.569)	(1.434)
TE_TA	0.030	0.753*	0.716
	(1.029)	(1.891)	(1.584)
T2_TA	0.286*	0.746**	0.804
	(1.788)	(2.075)	(0.510)
CET1	0.009	0.004	0.005
	(0.542)	(0.416)	(0.974)
Adj $R^{2:}$	0.775	0.879	0.879

Model 6a: Year fixed effects ($Year_t$)

Model 6b: bank fixed effects ($Bank_i$), year fixed effects ($Year_t$); and country ($Country_l$)

Model 6c: bank fixed effects ($Bank_i$), year fixed effects ($Year_t$) and bank type effects ($Bank\_type_j$)
Note: *p<0.1;**p<0.05;***p<0.01; numbers in the parenthesis are the t value.

Source: Calculated by the authors

The results also show evidence that the banks neither adjust their assets nor shift the risk weight to achieve their CAR target. On the other hand, some evidence indicates that in the period, the Asian banks improved their core capital, and these improvements had a positive, statistically significant effect on the CAR target. The core capital improvements of the Asian banks in the sample data were similar to the calculations of Cohen and Scatigna (2016) on the advanced economic banks and Tung et al., (2018) on Vietnamese commercial banks. Besides, even though the summary statistic shows a similar trend in the change of risk-weighted assets as the findings of Cohen & Scatigna (2016) on emerging-economy banks, the authors do not have evidence that the Asian banks shift risk-weight assets to adjust the CAR.

If we stand on the approach of Shimizu (2015), the results indicate that the CAR gets the impact from more factors of the numerator than the denominator. Additionally, the strength of the effect from the components of the numerator is also higher than that from the denominator. Only the estimation with the fixed effect of the bank type proves that the bank's asset size is associated with CAR. This result suggests that the different bank types might have other ways to achieve their CAR target. The difference might be within the characteristics of the assets held by each bank type.

Finally, the partial adjustment models provide the adjustment speeds, in which model 6a shows a very slow adjustment speed while models 6b and 6c indicate the speed at the CAR adjusts 82% toward its target within a year.

CONCLUSION

The results could indicate that to implicate the CAR regulation. Asian banks improved their core capital rather than adjusted their asset portfolio. This research finds that the loan growth is evident in the impact on the CAR adjustment; WUI has to interact with the loan growth and then show evidence of a magnified effect of the loan growth on the CAR adjustment. Applying fixed effects by the bank, country fixed effects, and bank type effects to absorb any unobserved, time-invariant bank type and country heterogeneity and business cycle effects give strong evidence of this than only the year used. During this period, Asian banks might not regularly use the shift of risk-weight assets to achieve their target CAR.

Our findings give the bank monitoring and manager a point to analyze when the economic policy uncertainty rises. Early on, this situation could not be found to be a factor that directly affected CAR improvement. However, there is evidence that the increase in economic policy uncertainty would cause a decrease in banks' lending in a year lag (Bordo et al., 2016; Hu & Gong, (2018)). Accordingly, the growth of loans is going to be decreased. Thus, through the interaction calculation between loan growth and WUI, the manager could estimate a CAR trend for managing this indicator.

REFERENCES

Ashraf, B.N., Shen, Y. (2019), "Economic policy uncertainty and banks' loan pricing", *Journal of Financial Stability*, Vol. 44(C), https://doi.org/10.1016/j.jfs.2019.100695

Berger, A., Guedhami, O., Kim, H., Li, X. (2018), "Economic policy uncertainty and bank liquidity creation", *Working Paper*.

Bordo, M.D., Duca, J.V., Koch, C. (2016), "Economic Policy Uncertainty and the Credit Channel: Aggregate and Bank Level US Evidence over Several Decades", *Journal of Financial Stability*, Vol. 26, pp. 90–106. doi: 10.1016/j.jfs.2016.07.002.

Cohen, B.H., Scatigna, M. (2016), "Banks and capital requirements: Channels of adjustment", *Journal of Banking & Finance*, Vol. 69, pp. S56–S69. https://doi.org/10.1016/j.jbankfin.2015.09.022

Ellen R.M., Edward C.P. (2005), “Taxes, Regulations, and the Value of U.S. and U.K. Corporations”, *The Review of Economic Studies*, Vol. 72, Issue 3, pp. 767–796, https://doi.org/10.1111/j.1467-937X.2005. 00351.

Hu, S., Gong, D. (2019). Economic policy uncertainty, prudential regulation and bank lending. *Finance Research Letters*, Vol. 29, pp. 373–378. https://doi.org/10.1016/j.frl.2018.09.004

Huseyin, G., Mihai, I. (2016), “Policy Uncertainty and Corporate Investment”, *Review of Financial Studies* Vol. 29, pp. 523–564.

Hites, A., Nicholas, B., Davide, F. (2022), "The World Uncertainty Index", *National bureau of economic research* Working Paper No. 29763.

Karnizova, L., Li, J.C. (2014), "Economic policy uncertainty, financial markets and probability of US recessions", *Economics Letters*, Vol. 125, No. 2, pp. 261–265. https://doi.org/10.1016/j.econlet.2014.09.018

Scott, R. B., Nicholas, B., Steven J. Davis. (2016), "Measuring Economic Policy Uncertainty", *Quarterly Journal of Economics*, Vol. 131, pp. 1593–1636. doi: 10.1093/qje/qjw024.

Shimizu, K. (2015), "Adjusting denominators of capital ratios: Evidence from Japanese banks", *Journal of Financial Stability*, Vol. 19, pp. 60–68. https://doi.org/10.1016/j.jfs.2015.05.005

Stefan, G., Jeremy. O., Doriana. R. (2016), “Lending on hold: Regulatory uncertainty and bank lending standards”, *Mimeo*.

Tung, H.T., Belás, J., Baideldinova, T. (2018), “How do banks implement the capital regulation requirement?”, *Journal of International Studies*, Vol. 11, No. 3, pp. 161-175. doi: 10.14254/2071-8330. 2018/11-3/14

Zelong, H., Jijun, N. (2017), “The effect of economic policy uncertainty on bank valuations”, *Applied Economics Letters*, DOI: 10.1080/13504851.2017.1321832.

https://www.policyuncertainty.com/wui_quarterly.html

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Youssef, I.S., Abonazel, M.R. (2026), Non-Performing Loans Indicators in Emerging Markets: Evidence from MENA Region",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 127-139.

Non-Performing Loans Indicators in Emerging Markets: Evidence from MENA Region

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ARTICLE INFO

Received October 07, 2024
Revised from November 11, 2024
Accepted December 11, 2024
Available online April 15, 2026

JEL classification: G20, G21, C23, C58

DOI: 10.14254/1800-5845/2026.22-2.11

Keywords:

Bank risk management;
credit risk;
nonperforming loans;
MENA;
bank size;
ROA;
operating efficiency;
loan growth.

ABSTRACT

This study aims to investigate the financial determinants of nonperforming loans of 36 conventional banks listed in the Middle East and North Africa (MENA) region. The research covers the period from 2013 to 2023 and includes selected countries namely, Jordan, Egypt, United Arab Emirates, Qatar, Kuwait, Bahrain, Lebanon, Morocco, Saudi Arabia and Tunisia. By utilizing dynamic panel data estimation techniques, the study scrutinized the relationship between four bank-specific determinant variables (Profitability, Operating Efficiency, Bank Size, and Loan growth) and nonperforming loans. Various analytical techniques, including ordinary least squares (OLS), fixed effects, random effects, and generalized method of moments (GMM) were employed in the data analysis phase. Results highlighted that except for loan growth, all variables had a significant positive impact on nonperforming loans. The findings of the study are beneficial to policy makers along with other stakeholders in establishing and reinforcing regulations that would ensure stability and soundness in the banking sector in MENA countries.

INTRODUCTION

Challenges facing the banking sector were extensively examined in several studies. Nonperforming loans (NPLs) are a key challenge that received significant attention in the banking sector. Deterioration in asset quality has negative implications. A possible result is a decline in profitability, as NPLs limit lending activity and impair banks' capital. Also, in the event of default blocking collateral harms the credit history of borrowers. Macro-level effects include hampering economic growth and aggravating financial instability.

The Middle East and North Africa (MENA) region accounts for a considerable level of NPLs. As of 2019, global average for NPLs was 4.2% as reported by Banker database; versus 5% in global banking system NPLs merely from MENA region (Alnabulsi et al., 2022). Weakness in banks' asset quality in MENA region countries was addressed over the years. Moving back to period from 2002 till 2010, NPLs in Tunisia and Egypt was above 20% from total loan portfolio. Other countries in the same period had a better asset

quality, namely Saudi Arabia and Kuwait. Prior to the COVID-19 pandemic in 2019, Lebanon, Algeria and Tunisia had NPLs in double digits; while Saudi Arabia and Qatar reported much lower figures (IMF, 2020).

Several countries in the MENA region undertook institutional measures in correspondence to high NPL levels that could threaten financial stability. To illustrate, bankruptcy laws were legalized in Kuwait in 2020. This implies avoidance of high-risk loans, along with hindering invalid decisions that involves premature liquidation of a going concern company–Reduced risk appetite, lower cost of borrowing and significant improvement in credit quality accompanied bankruptcy reforms both within and across MENA countries.

The focus on MENA region in addressed topic is useful for several other important reasons. On the digital transformation side, financial inclusion (FI) supports United Nations sustainable development goals. This includes promoting financial stability, enhancing economic growth, reducing income inequality and poverty. Level of financial inclusion in the MENA countries is merely 20% versus 76% in global financial inclusion rate (Hakimi et al., 2022). This is despite recognizable enhancement in digital transformation efforts that surpassed global averages; including internet use which recorded 66% and mobile cellular penetration rate reaching 97.5% in 2021 (Al-Smadi, 2023). Barriers for financial inclusion in the MENA region result from high level of regulations and financial literacy. Given considerable attention to financial inclusion that was stimulated recently, enhancement in FI levels in MENA region is inevitable. The impact of FI on bank stability is a double-edged sword. On the one hand, FI improves banks' stability through risk diversification. On the other hand, FI might cause deterioration in asset quality by lending more individuals or businesses with insufficient collateral (Hakimi et al., 2022). The threat of NPLs lessens attempts to accelerate financial inclusion levels.

Over the last 33 years, examining indicators for NPLs was rarely addressed for emerging markets with only 7% coverage ratio (Naili and Lahrichi, 2022). The results of this study will provide insightful implications for bank managers, regulators, investors and policymakers. This will allow better design for credit policy, along with reinforcing regulations that would ensure stability and soundness in the MENA region banking sector. This will further allow acceleration of financial inclusion as a significant part of digital transformation. Our study focuses on listed conventional banks in MENA region covering period (2013-2022) in 10 MENA countries namely, Lebanon, Bahrain, Egypt, UAE, Morocco, Tunisia, Jordan, Qatar, Kuwait, and Saudi Arabia.

1. LITERATURE REVIEW

Level of NPLs reflect the credit quality of loans within bank's loan portfolio, which in turn reflects level of credit risk that needs to be managed within banking sector. The role of banks as liquidity transformers makes NPLs monitoring a crucial role for central banks; as the banking sector could be severely impaired by balance sheet problems due to increase in NPLs. As non-performing loans increase, banks profitability decreases and banks are forced to raise additional capital to cover potential losses. In addition, banks failure and crises are triggered by higher NPLs due to instability and insolvency. Hence, equating excessive NPLs with "financial pollution". This study has been conducted in the context of theories of risk, such as Portfolio Theory of Markowitz (1991); Sharp (1963) and Leverage theories (1972). Loans account for the majority of assets of conventional banks. In order to reduce the risk of default, banks tend to diversify portfolios in compliance to theories of risk.

Previous research classified drivers of NPLs into internal bank-specific versus external macro-economic factors. Capital, profitability, efficiency, bank size, income diversification, concentration and lending activity are examples of bank-specific indicators. Macro-economic factors, on the other hand, could affect borrower's ability to service debt being influenced by business cycle conditions. NPLs could be realized in case of economic downturns. Other studies addressed relationship between government stability, institutional quality and NPLs (Hakimi et al., 2022). Institutional environment directly affects activities in banking sector. The soundness of banking industry is influenced by political stability and quality of institutional context. This in turn affects borrower's repayment capacity and level of NPLs, in case of negative impact on various economic sectors.

The relevance of banks' asset quality to aggregate NPLs was discussed in previous studies. In aggregate terms, level of NPLs identify the asset quality of banks in a certain country. Definition of NPLs might vary among countries. Impact of economic crisis is well recognized on level of NPLs. This includes 2008

financial crisis, COVID-19 pandemic, Russia-Ukraine war. The quality of a loan is a sign of strong economic status, as such NPLs during crisis was as a key concern to policy makers and bank supervisors. This is due to NPLs negative consequence on financial institutions survival.

Behavior of NPLs in several regions was discussed. In a study conducted by Tatarici et al. (2020) in the CESEE region, macroeconomic factors influenced NPLs to a greater extent than bank-specific factors. Adu (2022) examined how loan loss provision is a function of NPLs in Sub-Saharan Africa countries. Carvalho et al. (2022) study confirmed significance of macroeconomic information in determining level of NPLs of non-financial companies in Eurozone. Fell et al. (2021) addressed Asian region, showing how Asian financial crisis in 1990's was worsened by excessive NPLs from banking sector. Mdaghri (2022) findings indicated that banks in MENA region with higher deposits and that are well capitalized; experience better performance and lower NPLs. Ozili (2020) study on African region showed significant effect of institutional quality, foreign bank presence, banking concentration and bank efficiency; as determinants of NPLs. Significance of addressing NPLs from the scope of bank-specific level indicators was reflected in some consensus by regulators; in an attempt to reduce NPLs level for each individual bank. This further validates the focus of this study, as internal bank ~~factors~~ are key drivers for the size of NPLs.

2. BANK-SPECIFIC VARIABLES AND HYPOTHESIS DEVELOPMENT

2.1 Profitability

The relationship between profitability and NPLs has been studied by many scholars; yet no consensus was reached. Do and Phung (2020) investigated the impact of non-performing loans on profit generating ability of Vietnamese commercial banks and found a negative relationship in the period between 2008 and 2017. In a study conducted by Skorburg and Shenai (2021) on the effect of US smaller banks' profitability on asset quality, findings showed a significant negative impact of NPLs on bank profitability and market value. These findings illustrate that proper management of loan portfolios and more focus on lending practices is required to reduce level of NPLs. In a study conducted by Rachman et al. (2018) varies banking factors affecting NPLs were examined in Indonesia and results showed an inverse relationship between profitability and NPLs. This resulted from having a more effective credit supervision system and advanced lending activity.

However, an opposing view in study conducted by Ozili (2020), argues that more profitable European banks have higher NPLs. It was suggested that bank supervisors should improve risk management systems, examine credit policies and stress European banks' earning powers relative to the level of NPLs. This evidence coincides with results reported by Thornton and Di Tommaso (2021) in a study covering 521 banks in 28 European countries between 2007 and 2017. The positive significant relationship between NPL and profitability affects the supply of bank credit. This was particularly witnessed after the 2008 financial crisis; whereby lending capacity of banks was impaired affecting economic activity in Europe. Therefore, we propose the following hypothesis:

H1: Profitability has a positive effect on NPLs.

2.2 Operating efficiency

Bank operating efficiency is about reducing cost at all levels of output. Quality and efficiency of management affects the extent to which banks are cost-efficient. Several studies examined the relationship between bank efficiency and NPLs, yet no consensus was reached. In a study conducted by Onyango and Olando (2020) on commercial banks in Kenya, results reflected that low efficiency reduced NPLs. This was realized due to cutting expenses related to credit loan screening and credit assessment, thus a higher level of NPLs was realized. Similar results were obtained by Ersoy (2022) in a study conducted on Turkey banking sector for the period 2010 – 2019.

An alternative validation for the negative relationship between bank operating efficiency and NPLs is explained by the "bad management" hypothesis. The level of NPLs is reduced in efficient banks as risks are managed wisely. Inefficient banks, on the other hand, face the problem of high NPLs as inadequate loan underwriting and monitoring is realized. Addressed hypothesis was supported by Partovi and

Matousek (2019) and others. To provide new insights on the nature of relationship between bank efficiency and NPLs particularly with contradicting results of previous studies, we propose the following hypothesis:

H2: Bank efficiency has a positive effect on NPLs.

2.3 Loan Growth

Loan growth represents the growth in bank loans in consecutive years. Loan growth increases during good economic conditions, while NPLs are realized during economic downturn. In a study conducted by Alihodzicand Ekşï (2018) a positive relationship prevailed between loan growth and loan loss for the period from 2007 till 2017 in Turkey. Similarly, in a study conducted by Wu et al. (2022) loan growth leads to higher NPLs in case of poor management for loan portfolio; whereas NPLs can be reduced in case of good debt management based on examining 29 banks listed on Vietnam stock exchange from 2010 to 2020. Fast loan growth is associated with higher NPLs; in case a bank adopts poor borrower screening activity. This involves approving credit facilities for clients with low credit worthiness or without in-depth analysis for debt repayment capacity.-NPL concern faced by banks, could be a challenge with the increase in SMEs lending. Banks consider SMEs riskier in lending activity due to the common feature of limited information provided in business plans and financial projections; along with liquidity risk that might be faced. Financial inclusion provides a catalyst for SMEs lending. This sets a challenge for MENA region while attempting to enhance FI levels. Therefore, we propose the following hypothesis:
H3: Loan growth has a positive effect on NPLs.

2.4 Bank size

Similar to profitability, the relationship between bank size and NPLs has been studied by many scholars; yet no consensus was reached. Studies validating that large sized banks exhibit low NPLs; argue that large banks have stronger risk management practices, advanced credit risk analysis tools that reduce NPLs level (Naili and Lahrichi, 2022). Small-sized banks, on the other hand, have limited resources for credit risk assessment. Moreover, reducing information asymmetries and preventing moral hazard is more feasible within large banks. This further explains negative relationship between banks size and NPLs level.

However, an opposing view in study conducted by Koju et al. (2018), argues that NPLs level are positively related to bank size in a study conducted on Nepalese banking system. This study-based analysis on "too big to fail" hypothesis as large banks undertake excessive risk without proper in-depth loan assessment. Other study supporting same hypothesis was conducted by Ghenimi et al. (2021).

Given the contradicting empirical evidence, it worth investigating the relationship further. This is particularly important given that bank size matters when it comes to lending to SMEs; as loans to most SMEs have higher default risk. Similar to loan growth variable, this sets a challenge for MENA region while attempting to enhance FI levels. Therefore, we propose the following hypothesis:
H4: Bank size has a negative effect on NPLs.

3. DATA AND METHODOLOGY

3.1 Source of Data

Panel data are collected from Thomson Reuters DataStream for publicly listed banks operating in the MENA region for a selected sample of countries covering a total of ten countries over the period 2013-2022. Countries in the sample include Lebanon, Bahrain, Egypt, UAE, Morocco, Tunisia, Jordan, Qatar, Kuwait, Saudi Arabia. As such, a total sample of 36 banks from ten countries used in this study, as shown in Table 1. Only banks with an available complete dataset over the studied period are included.

Table 1. Number of commercial banks used in our study by country

Country	*No. of Commercial banks*	*Present (%)*
Jordan	9	25
Egypt	6	17

United Arab Emirates	6	17
Qatar	4	11
Kuwait	3	8
Bahrain	2	6
Lebanon	2	6
Morocco	2	6
Saudi Arabia	1	3
Tunisia	1	3
Total	36	100

Source: own

Table 1 presents a breakdown of commercial banks included in a study across 10 countries. Jordan leads with the highest representation, contributing 9 banks or 25% of the total sample. Egypt and the United Arab Emirates follow with 6 banks each (17% each), while Qatar and Kuwait contribute 4 and 3 banks respectively. Bahrain, Lebanon, and Morocco each have 2 banks in the study, with Saudi Arabia and Tunisia having the lowest representation at 1 bank each. The study encompasses a total of 36 commercial banks, with a notable disparity in representation across countries. This uneven distribution, particularly Jordan's prominence, suggests potential variations in data availability, which should be considered when interpreting the study's findings.

3.2 Variables

In this study and as presented in literature, the dependent variable is nonperforming loans reflected by overdue loans measured by the ratio of NPLs to total loans. This is the most popular measure of non-performing loans used in many studies such as Apergis (2022). The relationship between selected banks NPLs level and bank-specific determinants both theoretically and empirically, is reflected in Table 2.

Table 2. Variables measurement scales

Variables	*Definitions*	*Theoretical predicted signs*	*Major empirical studies' results*
Profitability (ROA)	Net Income / Total Assets	+/-	+
Operating Efficiency	Operating Expense/ Operating Income	+/-	+
Bank Size	Natural logarithm of total assets	+/-	-
Loan growth	Current year's gross loans as percentage of previous year	+/-	+

Source: own

3.3 Empirical Model of Estimation

Based on the literature mentioned above, the relationship between nonperforming loans and its determinants can be estimated by the following equation:

$$NPLS_{it} = \alpha + \beta_1 ROA_{it} + \beta_2\ OPERATING\ EFFICIENCY_{it} + \beta_3 BANK\ SIZE_{it} + \beta_4 LOAN\ GROWTH_{it} + \varepsilon_{it};\ i = 1, \dots, 36\ ;\ t = 2013, \dots, 2023,$$

where α is the intercept, β_1 to β_4 are the regression coefficients, and ε_{it} is the error term. To estimate this model, we will perform the following three-stage analysis: First, a descriptive analysis of all variables. Second: conducting pre-estimation diagnostic tests. Third, estimating different panel data models (static and dynamic models), and then choosing the best fit estimation model for the data based on specification tests. See Abonazel and Shalaby (2020).

4. EMPIRICAL RESULTS

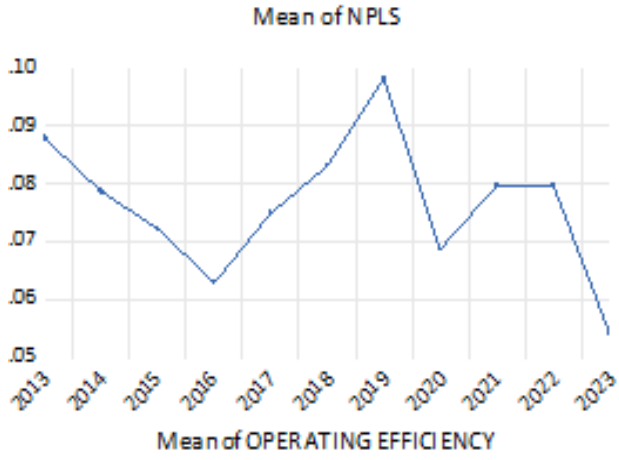
4.1 Descriptive Analysis

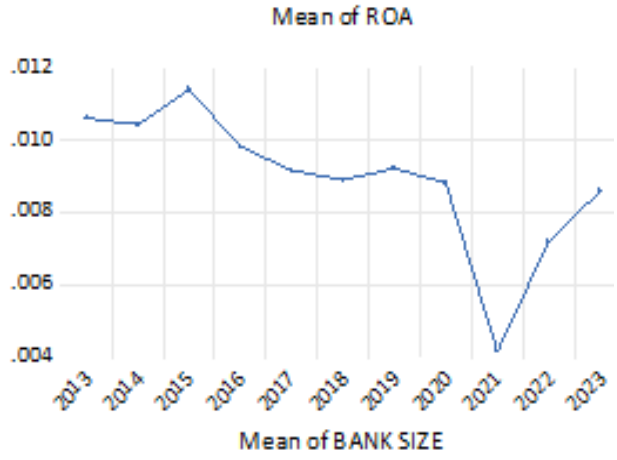
Table 3 shows the descriptive statistics for each variable (dependent and independent variables). The mean and median values of **NPLS** are 0.0764and 0.0623, whereas the minimum value is close to zero (0.0011), and the maximum is 0.9256. In addition, the mean and median values of **ROA** are 0.0090 and 0.0044; however, the minimum value is negative 0.0286. In terms of **OPERATING EFFICIENCY**, the mean and median values are 1.9620 and 1.6297; the mean and median values of **BANK SIZE** are 17.1851 and 16.9366; the mean and median values of **LOAN GROWTH** are 0.1105 and 0.0635.

Table 3. Descriptive statistics of all variables

Variable	Mean	Median	Max.	Min.	Std. Dev.	Obs.
NPLS	0.0764	0.0623	0.9256	0.0011	0.0804	379
ROA	0.0090	0.0044	0.0521	-0.0286	0.0114	394
OPERATING EFFICIENCY	1.9620	1.6297	53.0731	-1.6648	2.8347	390
BANK SIZE	17.1851	16.9366	24.7376	13.4645	2.4676	394
LOAN GROWTH	0.1105	0.0635	8.2068	-0.9016	0.4591	387

Source: Authors collected and processed from EViews 13





Mean of OPERATING EFFICIENCY

Mean of BANK SIZE

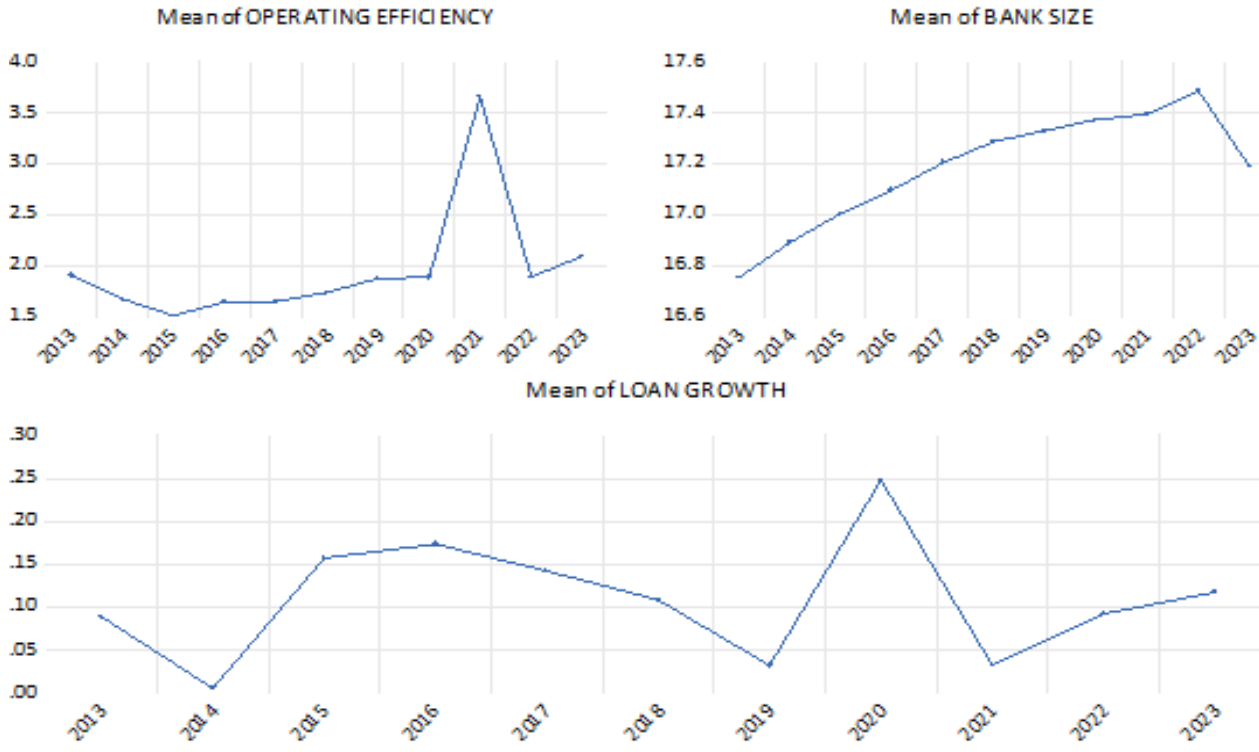


Figure 1. Mean trend of the studied variables during the period from 2013 to 2023
Source: own

Figure 1 shows that, on average, bank size values are increased over the sample period (2013 to 2023). However, the values of NPLS, and ROA are decreased over the sample period (2013 to 2023). In addition, it can be noted that operating efficiency and loan growth values have no increasing or decreasing trend over the sample period.

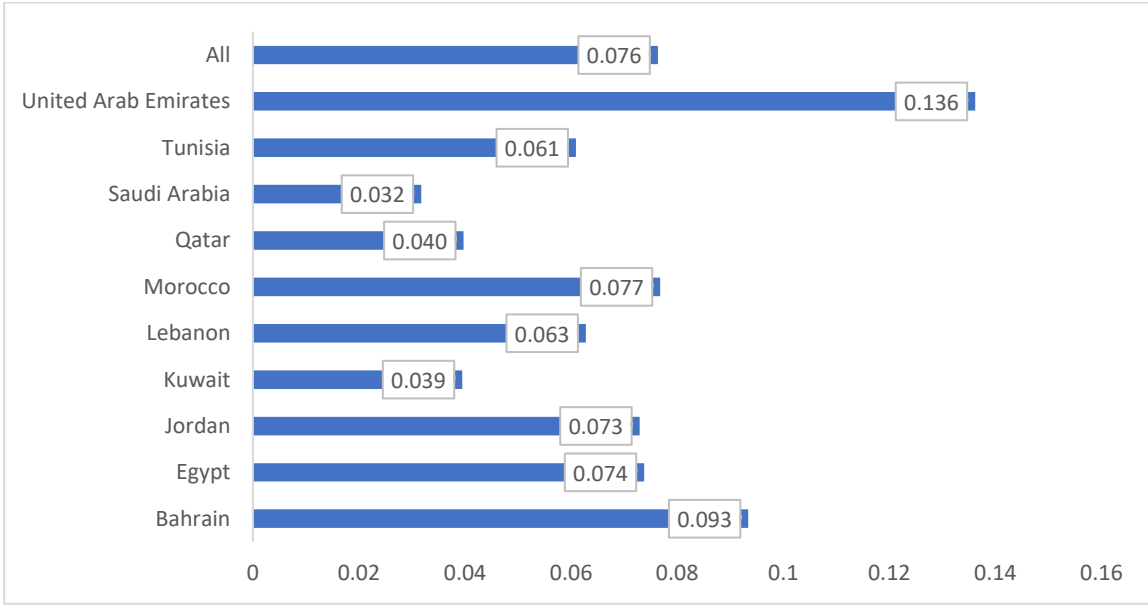


Figure 2. Mean of NPLs variable by country
Source: own

Figure 2 illustrates the mean value of Non-Performing Loans (NPLs) across various countries, revealing significant variations in financial health. The United Arab Emirates stands out with the highest NPL ratio at

0.136, far exceeding the overall average of 0.076, while Saudi Arabia reports the lowest at 0.032. Most nations fall within a range of 0.04 to 0.09, with Bahrain and Morocco also above average. Kuwait and Qatar join Saudi Arabia in having the lowest ratios. These disparities likely reflect differences in economic conditions, banking practices, and regulatory environments among the countries. The overall average suggests that 7.6% of loans in this region are non-performing, offering a broad indicator of credit risk and financial stability across these economies.

4.2 Pre-estimation Diagnostic Tests

4.2.1 Unit Root Test

In the beginning, it was used panel unit root tests to ascertain that the continuous variables used in our regression model specification are stationary. Fisher type tests (Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)) were used, which are based on combining the p-values of the test-statistic for a unit root in each cross-sectional unit. The null and alternative hypotheses of the unit root test are defined as: H_0: All panels contain unit roots, against H_1: At least one panel is stationary. The results of the panel unit root tests are reported in Table 4.

Table 4. Results of Panel Unit Root Tests for all variables

Variable	*ADF – Fisher test*		*PP – Fisher test*		*Integration (degree)*
	Chi-square	*p-value*	*Chi-square*	*p-value*	
NPLS	99.1400***	0.0082	140.646***	0.00001	I (0)
ROA	110.079***	0.0026	112.714***	0.0015	I (0)
OPERATING EFFICIENCY	149.314***	0.00001	198.259***	0.00001	I (0)
BANK SIZE	131.174***	0.00001	162.956***	0.00001	I (0)
LOAN GROWTH	167.256***	0.00001	243.191***	0.00001	I (0)

Note: *** significant at 0.01
Source: Authors collected and processed from EViews 13

From the results of Table 4, it can be noted that the null hypothesis of unit root tests has been rejected for all the examined variables, because the p-values are less than 0.01. This means that all variables are stationary in the level i.e., I (0).

4.2.2 Multicollinearity Test

In this stage, it should check the multicollinearity problem among independent variables. The term multicollinearity refers to a situation in which there is a linear relation among two or more of the independent variables. It can create inaccurate estimates of the regression coefficients, inflate the standard errors of the regression coefficients, deflate the partial t-tests for the regression coefficients, give false non-significant p-values, and degrade the predictability of the model.

Table 5. Pearson Correlation matrix and VIF values

Variable	*ROA*	*Operating Efficiency*	*Bank Size*	*Loan Growth*
ROA	1			
OPERATING EFFICIENCY	0.019617	1		
BANK SIZE	-0.53206	-0.13852	1	
LOAN GROWTH	-0.06305	-0.0196	0.007706	1
VIF	*1.407789*	*1.024379*	*1.429175*	*1.005477*

Source: Authors collected and processed from EViews 13

To detect multicollinearity, it can use two common methods. First, the Pearson correlation matrix among independent variables of the study. Second, the Variance Inflation Factor (VIF) for each independent variable. Practical experience indicates that if the value of VIF exceeds 5, it is an indication that the associated regression coefficients are poorly estimated. Table 5 shows that there is not a strong correlation among the independent variables (since all correlations are less than 0.8). Moreover, all VIF values are less than 5. This means that the model does not have a multicollinearity problem.

4.3 Estimated Panel Data Models

The outcomes of the static and dynamic panel data models are presented in Table 6. This study employs two tests to determine the optimal static panel data model. The group effect test is employed to ascertain the superiority of the fixed effects model over the pooled model. If the null hypothesis of the group effect test is rejected, it indicates that the pooled model is not appropriate for the data. Next, the Hausman test will be utilized to determine whether to use the fixed effects (FE) or random effects (RE) models. If the null hypothesis of the Hausman test is rejected, then the fixed effects (FE) model is appropriate for the data. For further details, refer to the works of Baltagi (2005) and Abonazel and Shalaby (2020). Based on the findings shown in Table 6, we may conclude that the null hypotheses for both the Group Effect and Hausman tests are rejected. This is due to the fact that the p-values obtained are lower than 0.01. Therefore, we may deduce that the fixed effects (FE) model is the most suitable model for analyzing this dataset.

However, according to the literature, *NPLS variable* is dependent on their past values. In this regard, we opted for FE dynamic panel data as our estimation methodology. Dynamic panel data model tackles the endogeneity issues in the presence of the lagged outcome variable and is therefore the right choice for our analysis. Based on Baltagi (2005) and Abonazel and Shalaby (2020), to eliminate the unobservable heterogeneity, conventionally FE estimations are used. However, this estimation is consistent only when firm characteristics are strictly exogenous. That is, they are purely random observations through time and are unrelated to the firm's history. Nevertheless, this assumption is rarely to be valid. Ordinary Least Squares (OLS) estimation of the pooled model may be biased because it neglects unobservable heterogeneity, and FE estimation may be biased since it ignores endogeneity. The problem of endogeneity can be solved by applying GMM estimator to estimate the impacts of all independent variables on *NPLS* in dynamic panel data model framework (Abonazel and Shalaby, 2020).

Table 6. OLS, Fixed Effects, Random Effects, and System GMM estimations

Variable	*Pooled Model*	*Static Model*		*Dynamic Model*
	Pooled (OLS)	*Fixed Effects (FE)*	*Random Effects (RE)*	*System GMM*
NPLS(-1)	0.773063***	0.571206***	0.762427***	0.341677***
ROA	-1.178864***	-1.662828**	-1.200542***	2.450719***
OPERATING EFFICIENCY	-0.000309	-0.000512	-0.000319	0.001902***
BANK SIZE	-0.003183	-0.009444	-0.003274**	0.016572***
LOAN GROWTH	-0.077752***	-0.067493***	-0.077381***	-0.054490***
Constant	0.091153***	0.217686	0.093695***	--------
Observations	339	339	339	303
Adjusted R-Squared	0.468463	0.486788	0.456162	
F-statistic/ Wald Test (χ^2)	60.57829***	9.014935***	57.70167***	559504.2***
p-value	0.00001	0.00001	0.00001	0.00001
- Specification Tests				
Group Effect Test (χ^2)	2.099426***			
p-value	0.0005		--------	--------
Hausman Test (χ^2)	--------	32.511095***		--------
p-value	--------	0.00001		--------
Specification (Sargan and Arellano-Bond) Tests of System GMM model				
Sargan Test	--------			33.42826
p-value	--------			0.350139
Arellano-Bond Test AR (1)	--------			-7.457359***
p-value	--------			0.00001
Arellano-Bond Test AR (2)	--------			-1.091616
p-value	--------			0.2750

Note: *** significant at 0.01, ** significant at 0.05
Source: Authors collected and processed from EViews 13

We have utilized the two-step Generalized Method of Moments (GMM) estimator. Two specification tests have been performed to verify the suitability of the GMM model for fitting the data. The first specification test for the system GMM model is the Arellano-Bond (1991) test, which examines the presence of second order serial correlation in the residuals. The result is reliable since there is no significant second-order serial correlation. This is supported by the p-value of the AR (2) test, which is 0.2750 and does not provide enough evidence to reject the null hypothesis. The second specification test is the over-identifying restriction test, which is conducted to verify the correctness of the instruments. The null hypothesis posits that there is no correlation between the instruments and the residuals. According to the data in Table 6, the p-value of the Sargan test for the system GMM model is 0.350139. Based on this finding, we cannot reject the null hypothesis. The implication here is that the validation of over-identifying limitations is justified. Therefore, we may deduce that the system GMM model is favored due to its ability to provide more reliable and uniform outcomes. The estimated regression equation for the NPLS variable is as follows:

$$NPLS_{it} = 0.341677\ NPLS_{i,t-1} + 2.450719\ ROA_{it} + 0.001902\ OPERATING\ EFFICIENCY_{it} + 0.016572\ BANK\ SIZE_{it} - 0.054490\ LOAN\ GROWTH_{it} + \varepsilon_{it};\ for\ i = 1, \dots, 36\ ;\ t = 2013, \dots, 2023$$

4.4 Discussion and Implications

The results of "system GMM dynamic model" in Table 6 shows the following variables have significant impact on the *NPLS*:

- The lagged *NPLS* is positive and significant at (0.01) level. This indicates that the existing NPLS has an important role in attracting more NPLS. This finding implies a prolonged impact on banking system that would be realized in case of any shocks in NPL level. This is consistent with previous study by Alodayni (2016).

- *ROA* is positive and significant at (0.01) level. This implies that managers are inclined to take excessive risk when high profitability is realized. As such, with more lenient credit policy, a higher flexibility is encountered in both screening and monitoring of loans which will lead to higher NPLs. Less profitable banks apply more rigid credit policies to avoid additional losses. This finding is consistent with study conducted by Ozili (2020) and another reported by Thornton and Di Tommaso (2021).
- *Operating Efficiency* is positive and significant at (0.01) level. The ratio of operating efficiency implies that the higher the ratio, the lower is the bank's operating efficiency. This is due to the increase in operating expenses compared to operating income. The positive relationship in our findings indicates that increase in operating efficiency (decrease in the ratio) leads to decrease in NPLs. This aligns with "bad management" hypothesis stating that bank inefficiencies lead to higher non-performing loans. Hence, improvement in bank efficiency implies good management in terms of loan monitoring. In a study conducted by Githaiga (2020), results indicate that banks experience lower NPLs when adequate capital and resources are allocated to credit risk assessment and evaluation process. This is consistent with another study by Al Zaidanin and Al Zaidanin (2021) whereby significance of allocating sufficient financial resources for risk management and credit assessment was well supported by regulatory authorities in UAE by Central Bank of UAE (CBUAE) particularly after 2008 financial crisis. Likewise, another study on Kuwait by Bioumy (2024) reflects significant change in mega size banks in an attempt to improve risk management and reduce credit risk with higher capital allocation. This is in an attempt to reduce the levels of NPLs.
- *Bank Size* is positive and significant at (0.01) level. The positive association between bank size and NPLs rejects prior findings by Naili and Lahrichi (2022). These studies address the ability of larger banks to reduce level of information asymmetry, associated adverse selection and moral hazard problems by using advanced risk management tools which leads to lower NPLs. This is aligned with better screening and monitoring that reduces loan default risk. The opposite applies to smaller sized banks due to limited resources. Given the increase in SMEs lending which sets a challenge for MENA region; banks particularly large sized banks with higher exposure to SMEs face higher default risk. This explains findings of this study which is consistent to previous research by Wang and Yang (2021). Another study conducted on Egypt by Hassouba (2023) confirms growth in SMEs financing which imposes a real challenge for banks. Central Bank of Egypt (CBE) increasing imposed percentage of loan portfolio directed to SMEs lending to be 25% instead of 20%. This would leave larger banks with higher risk associated with SMEs funding.
- *Loan Growth* is negative and significant at (0.01) level. This implies that growth in lending is accompanied by enhancement in screening standards which reduces the level of NPLs. This is aligned with the crowding-out effect resulting from growth in risk-free loans directed to government financing. Significant growth in these types of loans was witnessed lately in most of MENA countries. Increase in demand for loans from government side resulted in lower funds directed to private credit growth. To illustrate, Jordan is a good example for ample growth in government mega projects related to Syrian refugees including their accommodation. This in turn reduced private sector loans in construction sector which is one of the main sectors accountings for 24% of total private borrowing (World Bank, 2020). Hence, imposing additional challenge on both individual and corporate level with weak credit scoring to obtain loan approval. Hence, reducing level of NPLs. Banks in MENA region face a high challenge in supporting SMEs loan growth as part of financial inclusion initiative. Given that SMEs are riskier in lending activity, a prudent borrower screening activity is necessary for addressed finding to apply in case of SMEs lending.

5. LIMITATIONS

This study, though insightful, bears a few notable limitations. First, generalizability of findings might be limited due to geographic concentration on MENA region. Differences in macroeconomic conditions and regulatory frameworks among regions affect how banks operate. As such, results obtained from conducted study on MENA region may be inapplicable to other locations of the world. Also, duration of the study covered critical period from 2013 till 2023 whereby major global events happened and was not clear their impact on study conducted. This includes recent Hamas-Israel war, Russai-Ukraine war and Covid-19 pandemic. This study only focused on bank-specific variables. As such, it is recommended that future research should consider macroeconomic variables to understand the impact of these events that could have profound economic repercussions with substantial influence on NPLs.

CONCLUSION

The aim of this research is to investigate core bank-specific determinants for nonperforming loans in MENA region between 2013 and 2023. Panel data analysis was used. The findings of the System GMM estimation revealed that all variables, except loan growth, had a highly significant positive impact on nonperforming loans. The negative significant impact of loan growth emphasizes improvement in risk management techniques utilized to control credit risk encountered with increase in lending activity. Hence, reducing nonperforming loans. Theories of risk were utilized in the hypothesis development to support the findings of this study. Studying the impact of bank-specific variables on the level of nonperforming loans is significant for various stakeholders including but not limited to, policymakers, regulators, investors and banks management. The outcomes of the study would support stakeholders in making sound decisions that would ensure stability and soundness of the banking industry. This could include enforcing stricter lending standards and adopting more advanced risk management techniques to allow better detection and mitigation for the risk of default. Moreover, bank management can benefit from this study by improving their lending practices to enhance profitability. Future research should consider a more comprehensive set of macroeconomic variables to understand impact of economic conditions like Ukraine-Russia war and Hamas-Israel war better. This would enrich benefits for external stakeholders like government and central bank policy makers in making sound decisions to ensure favorable economic consequences.

REFERENCES

Abonazel, M.R., Shalaby, O.A. (2020), "Using dynamic panel data modeling to study net FDI inflows in MENA countries", *Studies in Economics and Econometrics*, Vol. 44, No. 2, pp. 1-28.

Adu, D.A. (2022), "Competition and bank risk-taking in Sub-Saharan Africa countries", *SN Business & Economics*, Vol. 2, No. 7, 80.

Al Zaidanin, J.S., Al Zaidanin, O.J. (2021), "The impact of credit risk management on the financial performance of United Arab Emirates commercial banks", *International Journal of Research in Business and Social Science*, Vol. 10, No. 3, pp. 303-319.

Alaoui Mdaghri, A. (2022), "How does bank liquidity creation affect non-performing loans in the MENA region?", *International Journal of Emerging Markets*, Vol. 17, No. 7, pp. 1635-1658.

Alihodzic, A., Ekşï, İ.H. (2018), "Credit growth and non-performing loans: evidence from Turkey and some Balkan countries", *Eastern Journal of European Studies*, Vol. 9, No. 2, pp. 229-249.

Alnabulsi, K., Kozarevic, E., Hakimi, A. (2022), „Assessing the determinants of non-performing loans under financial crisis and health crisis: Evidence from the MENA banks", *Cogent Economics & Finance*, Vol. 10, No. 1, 2124665.

Alodayni, S. (2016), "Oil prices, credit risks in banking systems, and macro-financial linkages across GCC oil exporters", *International Journal of Financial Studies*, Vol. 4, No. 23.

Al-Smadi, M.O. (2023), "Examining the relationship between digital finance and financial inclusion: Evidence from MENA countries", *Borsa Istanbul Review*, Vol. 23, No. 2, pp. 464-472.

Apergis, N. (2022), "Convergence in non-performing loans across EU banks: The role of COVID-19", *Cogent Economics & Finance*, Vol. 10, No. 1, 2024952.

Arellano, M., Bond, S. (1991), "Some Testes of Specification for Panel Data: Monte Carlo Evidence and Application to Employment Equation", *Review of Economics Studies*, Vol. 58, pp. 277-297.

Baltagi, B.H. (2005), *Econometric Analysis of Panel Data*, 3rd Ed., John Wiley and Sons, England.
Bioumy, M.A.M. (2024), *The Effect of Competitiveness of Kuwaiti Banks on Risk Profile and Profitability*, https://kibs.edu.kw/wp-content/uploads/2024/01/The-Effect-of-Competitiveness-of-Kuwaiti-Banks-on-Risk-Profi.pdf
Carvalho, P.V., Curto, J.D., Primor, R. (2022), "Macroeconomic determinants of credit risk: Evidence from the Eurozone", *International Journal of Finance & Economics*, Vol. 27, No. 2, pp. 2054-2072.
Ersoy, E. (2022), "The determinants of the non-performing loans: The case of Turkish banking sector", *International Journal of Insurance and Finance*, Vol. 1, No. 2, pp. 1-11.
Fell, J., Grodzicki, M., Lee, J., Martin, R., Park, C.Y., Rosenkranz, P. (2021), *Nonperforming Loans in Asia and Europe—Causes, Impacts, and Resolution Strategies*, Asian Development Bank.
Ghenimi, A., Chaibi, H., Omri, M.A.B. (2021), „Liquidity risk determinants: Islamic vs conventional banks", *International Journal of Law and Management*, Vol. 63, No. 1, pp. 65-95.
Githaiga, P.N. (2020), "Revenue diversification and quality of loan portfolio", *Journal of Economics and Management*, Vol. 42, No. 4, pp. 5-19.
Hakimi, A., Boussaada, R., Karmani, M. (2022), „Is the relationship between corruption, government stability and non-performing loans non-linear? A threshold analysis for the MENA region", *International Journal of Finance & Economics*, Vol. 27, No. 4, pp. 4383-4398.
Hassouba, T.A. (2023), "Financial inclusion in Egypt: the road ahead", *Review of Economics and Political Science*, https://doi.org/10.1108/REPS-06-2022-0034.
International Monetary Fund (2020), *Regional Economic Outlook (Middle East and Central Asia*), IMF, Washington, DC.
Koju, L., Koju, R., Wang, S. (2018), "Macroeconomic and bank-specific determinants of non-performing loans: Evidence from Nepalese banking system", *Journal of Central Banking Theory and Practice*, Vol. 7, No. 3, pp. 111-138.
Naili, M., Lahrichi, Y. (2022), "The determinants of banks' credit risk: Review of the literature and future research agenda", *International Journal of Finance & Economics*, Vol. 27, No. 1, pp. 334-360.
Onyango, W.A., Olando, C.O. (2020), "Analysis on influence of bank specific factors on non-performing loans among commercial banks in Kenya", *Advances in Economics and Business*, Vol. 8, No. 3, pp. 105-121.
Ozili, P.K. (2020), "Non-performing loans in European systemic and non-systemic banks", *Journal of Financial Economic Policy*, Vol. 12, No. 3, pp. 409-424.
Rachman, R. A., Kadarusman, Y. B., Anggriono, K., Setiadi, R. (2018), "Bank-specific factors affecting non-performing loans in developing countries: Case study of Indonesia", *The Journal of Asian Finance, Economics and Business*, Vol. 5, No. 2, pp. 35-42.
Skorburg, S., Shenai, V. (2021), "Impact of non-performing loans on smaller us bank profitability and value in the post-crisis period", *Journal of European Economy*, Vol. 20, No. 2, pp. 327-349.
Tatarici, L.R., Kubinschi, M.N., Barnea, D. (2020), "Determinants of Non-Performing Loans for the EEC Region", *A Financial Stability Perspective. Management & Marketing. Challenges for the Knowledge Society*, Vol. 15, No. 4, pp. 621-642.
Thornton, J., Di Tommaso, C. (2021), "The effect of non-performing loans on credit expansion: Do capital and profitability matter? Evidence from European banks*", International Journal of Finance & Economics*, Vol. 26, No. 3, pp. 4822-4839.
World Bank (2020), *Economic opportunities for Jordanians and Syrian refugees: Progarm-for- results*, The World Bank, Washington, DC.
Wu, S.W., Nguyen, M.T., Nguyen, P.H. (2022), "Does loan growth impact on bank risk?", *Heliyon*, Vol. 8, No. 8, e10319.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Kenawy E. (2026), "The Ethiopian Renaissance Dam and its economic impacts on Egypt",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 141-156.

The Ethiopian Renaissance Dam and its economic impacts on Egypt

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ARTICLE INFO

Received April 11, 2025
Revised from May 17, 2025
Accepted May 22, 2025
Available online April 15, 2026

JEL classification: Q2, Q25, Q28, Q34

DOI: 10.14254/1800-5845/2026.22-2.12

Keywords:
Ethiopian Renaissance Dam,
economic impacts,
water security,
Egypt

ABSTRACT

This paper aims to discuss the economic impacts of construction the Ethiopian Renaissance Dam (GERD) on Egypt, by clarifying the nature of the water crisis between the Nile Basin countries, particularly the Nile River water problem between Egypt and Ethiopia. It then identifies the most important economic and legal determinants of the water conflict and dispute between Egypt and the Nile Basin countries, as well as identifying the roles played by Israel, the United States, and the World Bank in the water conflict and dispute between Egypt and the Nile Basin countries. Furthermore, it determines whether this crisis is economic, political or technical? It explains the scenarios and mechanisms for dealing with this crisis in the future to avoid the negatively attributed impacts of the Renaissance Dam on Egypt's annual water share. This paper assumes that the Ethiopian Renaissance Dam construction will reduce Egypt's annual water share, which will have negative impacts on the agricultural, electricity, energy, and other sectors, as well as increasing unemployment in Egypt and negative effects on the country's public budget in the event of resorting to alternative sources such as desalination. To achieve the objectives of this paper, descriptive analysis and the prospective approach has been used. The findings showed that the World Bank's proposal to introduce new concepts such as privatization, water pricing, water exchange, and water markets, which may lead to water conflict and disputes in the Nile Basin countries, because the United States' dominance and other developed countries over the World Bank's policies and approaches. In addition, there is no collective agreement that brings together all countries located in the Nile Basin concerning the regulations and exploitation of water in the Nile River, and there is no international law regulating it. This leads to the continuation and increases of water conflict and disputes between Egypt and the Nile Basin countries. This paper recommends the continuation of diplomatic negotiations to find a formula for consensus between the parties with the aim of achieving joint cooperation between Egypt and the Nile Basin countries to achieve water security.

INTRODUCTION

The Renaissance Dam is technically known as a dam that was built on the Nile River inside Ethiopia and has a clear impact on the Nile Basin countries' share of water, especially Egypt and Sudan. The Grand Ethiopian Renaissance Dam (GERD) is one of the largest water projects in Africa. Located on the Blue Nile in Ethiopia, it has sparked widespread controversy since its construction began due to its direct impact on

the Nile water shares on which Egypt and Sudan, the two downstream countries, depend. The GERD's storage capacity is approximately 74 billion cubic meters. The GERD's primary objective is to support economic development, generate electricity with a capacity of approximately 6,000 megawatts, export energy, and develop the Ethiopian economy in general.

The dilemma of countries located in the Nile Basin has various dimensions including economic, political, technical, and legal ones. It is a dilemma which has global, domestic, and regional dimensions. For Egypt, the cause of the Nile water is counted as one of the causes of dispute that was posed between Egypt and the countries located in Nile Basin on the resources of water over the last thirty years due to the absence of Egypt from Africa over these years, and the intervention of America and Israel to these countries besides the cause manipulation of water security. The cause of water security is currently not as important as that of Egypt's national security. The dispute has been extended since the early 1990s on water resources, particularly in the middle east because of water limited resources. These resources are disputed in the major basins of rivers like the Nile River. Because of the advanced technological development witnessed by the globe, particularly since the 1990s, development rates, which depend on natural resources and one of the most essential natural resources is water, that has turned to be a strategic good because of the shortage of alternatives while there are other increased alternatives are available for energy (Al-Behery,2016).

Accordingly in the national security issues, priority is given to the issue of water resources preserving and benefit maximization from them, especially in Egypt. The Nile River is one of the longest rivers in the world, as it passes and, flows through ten countries: Ethiopia, Sudan, Egypt, Burundi, Rwanda, Tanzania, Eritrea, Kenya, and the Congo. These nations vary in how much they rely on the Nile's waters, with Egypt being the most dependent. As a result, the issue of water security is deeply intertwined with Egypt's national security. Egypt receives an annual share of 55.5 billion cubic meters out of the Nile's total flow of 84 billion cubic meters, based on the 1929 legal agreements that govern water distribution. Notably, around 85% of the Nile's water originates in Ethiopia. Since the late 1990s, Egypt has faced growing challenges due to the involvement of external actors—such as Israel, the United States, and the World Bank—in the Nile Basin. These entities have introduced new ideas like water pricing, privatization, and water trading, which risk escalating tensions among Nile Basin countries. The internationalization of the issue moves it beyond a regional matter and poses additional pressures on Egypt, potentially threatening its national security (Majeed,2022).

Ethiopia's recent unilateral agreements with some Nile Basin countries regarding the diversion of the Blue Nile to construct the "Renaissance Dam" are considered unusual and problematic both legally and regionally. This action raises concerns due to its potential negative impact on Egypt and Sudan. Water allocations among Nile Basin countries are governed by established treaties and agreements, which stipulate that no country can undertake projects or make decisions affecting the Nile's waters without the consent of both Egypt and Sudan. Ethiopia's actions are viewed as a breach of international law and could cause harm to other countries in the region (Qutb & Darwish,2022).

Tensions over the Nile River's waters escalated in 2011 when Burundi joining to some Nile Basin countries and signing a new agreement framework that included Ethiopia, Tanzania, Uganda, Kenya and then Rwanda, which known as the Entebbe Agreement, aimed at redistributing the Nile's waters. Egypt, however, rejected the agreement and refused to recognize its legitimacy (Hany,2015). This is in addition to the official ratification by the State of South Sudan of the (Entebbe Agreement) in July 2024, as a result of regional and international pressures aimed at affecting Egypt's national security, interests, water rights, and water security. The construction of Ethiopia's Renaissance Dam is possibly a political reaction to Egypt and Sudan's refusal to sign the new Nile Basin agreement. The dam is seen as a form of leverage against Egypt, especially in light of Egypt's post–January 25, 2011 revolution foreign policy, which emphasizes greater independence in decision-making. In light of this, Egypt has many important documents to manage this historical issue from Egypt's perspective (Zakaria,2019).

This paper seeks to explore several key questions: What are the economic drawbacks Egypt may face due to the construction of the Ethiopian Renaissance Dam, and what risks does it pose? Is the dispute and

conflict among the countries of Nile Basin primarily economic, political or technical in nature? What are the main factors driving the conflict between Egypt and other Nile Basin states, particularly Ethiopia, and what strategies can be used to address it? Lastly, what roles do Israel, the United States, and the World Bank play in the ongoing water dispute involving Egypt and the Nile Basin countries?

This paper aims to examine the potential risks associated with the construction of the Renaissance Dam and to highlight the possible impacts on Egypt. It also seeks to identify the key factors—whether economic or legal—driving the water dispute and conflict between Egypt and the Nile Basin countries. Additionally, the study explores the roles played by Israel, the United States, and the World Bank in this ongoing dispute.

This paper is based on the following hypotheses: Ethiopian efforts aim to weaken Egypt's position at the regional level and control its share of the Nile River waters, by establishing water projects and dams on the Nile's sources. The construction of the Ethiopian Renaissance Dam will reduce Egypt's annual water share, which will have negative effects on the agricultural sector and increase unemployment in Egypt. Finally, Ethiopia's policy in the Nile Basin region, supported by a foreign agenda, may increase the conflict among the Nile Basin countries in the future, especially between Egypt and Ethiopia.

The paper methodology adopts a descriptive-analytical approach to examine the nature of the water crisis in the Nile Basin region. It analyzes the implications of the Ethiopian Renaissance Dam and its potential negative economic effects on Egypt, while also assessing whether the crisis is rooted in political, economic, or technical factors. In addition, a prospective approach is used to forecast the future consequences of the dam's construction on Egypt.

Key Terminology: The main concepts relevant to this study are defined as follows:

Water Security: The state's capacity to ensure an adequate supply of clean water for drinking and various uses (such as agriculture and industry), both now and in the future, by managing water resources to meet demand (Sabry, 2020).

Water Risk: A condition where per capita annual freshwater availability ranges between 1,000 and 1,500 cubic meters, indicating a state of water vulnerability (Riyad, 2016).

Water Deficit: A more severe condition where freshwater availability drops to between 500 and 1,000 cubic meters per person annually, reflecting a state of water shortage (El-Tayeb, 2015).

Water Policy: The set of internal and external rules and strategies that guide a country's management of water resources (Yosry, 2016).

Water Resources: The total quantity of both conventional and non-conventional water sources available to a country within a given time frame (Nour El-Din, 2019).

This paper is organized into six sections in addition to the introduction: The first section includes a literature review. The second section discusses the potential risks of the Grand Ethiopian Renaissance Dam (GERD). The third section presents the potential negative economic impacts of the construction of the Grand Ethiopian Renaissance Dam (GERD) on Egypt. The fourth section addresses the economic and legal determinants of the water dispute and conflict between the Nile Basin countries specially with Egypt. The fifth section explains the roles of Israel, great powers, major countries, and international institutions (world bank) in the water dispute and conflict between the Nile Basin countries and Egypt. Finally, the sixth section includes the conclusion.

1. LITERATURE REVIEW

There are many studies that have addressed the various effects (economic, political or legal) of the construction of the Ethiopian Renaissance Dam on Egypt. In this paper, the focus will be on the political economy dimension only, considering that this issue is primarily a political economy issue, which include the following studies:

Taye (2011) discussed the economic impact of regional and international powers on water interactions in the Nile Basin. The study showed that extreme poverty and political instability in the countries of the Nile Basin are among the important reasons that make the region an attractive environment for foreign intervention. The study pointed to the role of political factors in influencing water interactions in the Nile Basin region. The results of the study show that the United States, China, and Israel play a major role in stimulating conflict over water, which affects Egyptian water security.

Hammond (2013) explained how the Nile water is managed between the countries of Nile Basin and the most important effects resulting from water management. The development requirements and population growth in the Nile Basin countries are factors of pressure on the available water resources, which makes water management difficult in this region. The results of the study indicated that the development requirements in Ethiopia were the reason for Ethiopia's insistence on building the Renaissance Dam. The study suggested the necessity of working within a cooperative framework in order to achieve the interests of all parties.

Sharaky (2014) discussed the natural challenges facing Ethiopia, which cause the failure of 70% of its water projects for geological and technical reasons. The study showed the geology of the Renaissance Dam area, and the identification of the areas of land suitable for irrigation. The results of the study showed that Egypt and Sudan lost about 14 billion m^3 of water based on the storage capacity announced by Ethiopia for three years. The study suggested the necessity of consulting with Egypt and Sudan in terms of quantity and operating dates in order to take the necessary precautions and avoid the water shortage crisis during the periods of filling the dam reservoir.

Allam (2014) discussed the crisis of Ethiopian Renaissance Dam as a political cause or a technical dilemma, then Egypt's efforts throughout history to secure and develop the Nile River as a basic resource, then discussed the Ethiopian plans for a long time to build dams and control the river's water. In addition, the development of the stages of the dispute over water shares between the Nile Basin countries, especially (Ethiopia, Egypt and Sudan). Then, the provisions of the 2010 Entebbe Agreement were identified and compared to the 1997 United Nations Agreement on Shared Rivers and the negatives of the Entebbe Agreement were evaluated in light of the negotiations with the Nile Basin countries. The study suggested continuing the negotiations to reach a solution to this crisis.

Huiyi & Ashok (2014) believe that the Renaissance Dam will be a major source of sustainable energy production and will relieve Ethiopia of energy shortages, which will help in the economic development of Ethiopia and the countries of the region, in addition to Ethiopia's attempt to involve Egypt and Sudan in joint management of the project, but it did not succeed due to the fixed Egyptian position. The study suggested the need for the Nile Basin countries to deepen the dialogue in order to find ways of partnership that are beneficial to all parties.

Hamdan (2015) explained that the Nile River is a vital artery for Egypt and Sudan, and that water disputes are linked to political problems in the Nile Basin countries. Relations have become strained with Ethiopia's construction of the Renaissance Dam on the Blue Nile River, which affects the water share of Egypt and Sudan. The study discussed the negatively attributed effects to the construction of the Renaissance Dam on Egypt and Sudan, and the positive effects on Ethiopia. The results of the study are that Egypt and Sudan reject any Ethiopian action regarding the construction of dams unilaterally. The study suggested internationalizing the Renaissance Dam issue in light of international law through diplomatic means.

Kottan (2017) discussed the real causes of the water dispute in the Nile River, the role of development needs in increasing demand for water, and the call for its redistribution between the Nile River countries in general, and Ethiopia, Egypt, and Sudan in particular, and the extent of the impact of the Ethiopian Renaissance Dam on Egypt and Sudan's water share of the Nile River. The results of the study showed that the Ethiopian Renaissance Dam is part of a Zionist-American plan aimed at threatening Egyptian national security. The study recommended the necessity of renegotiating by Egypt and Sudan by all means the terms of disagreement in the "Entebbe Agreement" of 2010.

Waterbury (2018) discussed the Egyptian-Ethiopian dispute over the risks of building the Renaissance Dam on Egypt, in addition to the need for Egypt and Ethiopia to agree on the period of filling the reservoir, as well as agreeing on what will happen during drought periods. The results of the study showed that building the dam does not reduce Egypt's share of water if the rules regulating the filling process of the reservoir are agreed upon with Ethiopia. The study suggested that Egypt and Sudan should change their policy in dealing with the water issue and benefit from desalination of seawater as well as purification of wastewater.

Marey (2020) discussed the determinants of the water conflict between Egypt and the Nile Basin countries, with an application to the Ethiopian Renaissance Dam project, which represents a crisis between Egypt and Ethiopia, then the orientations of Egyptian diplomacy in light of the international and regional interaction with the crisis and its effects on Egyptian national security and the succession of tripartite negotiations (Egyptian-Sudanese-Ethiopian) after the June 30, 2013 revolution in Egypt. Findings showed the stability of the Egyptian position regarding the negatively attributed effects to the Renaissance Dam on water security, and the study suggested Egypt's desire to expand areas of cooperation and integration of goals with the Nile Basin countries.

Shafey (2021) addressed the Grand Ethiopian Renaissance Dam crisis through a dynamic framework, then explained the mechanism of Ethiopian hegemony and its challenges, the Ethiopian reasons for building the Renaissance Dam and Egypt's reservations about it, and the Egyptian scenarios to confront it. The results indicated that Ethiopian ambition is not limited to building the Renaissance Dam, but rather aims to bring about a complete change in the hegemony system in the Nile River, so that Ethiopia becomes the dominant party in the future. In this case, Egypt will be forced to submit to Ethiopian conditions within the framework of the possibility of purchasing water from it or resorting to the military option in the event that Egyptian water security is threatened.

Salim (2022) discussed the dispute over the Renaissance Dam, and pointed out that despite the existence of many agreements related to the Nile River that regulate relations between the Nile Basin countries; the current reality confirms Ethiopia's violation of these agreements and the Renaissance Dam was constructed unilaterally with absence of the Arab Republic of Egypt and the Sudan. The study showed the reasons for the dispute between the three countries, and the results of the study showed Ethiopia's violation of all legal principles and rules regulating the use of international rivers. The study suggested the importance of cooperation between the three countries to resolve this dispute peacefully.

Qassem & Hasan (2023) explained that the Ethiopian thinking in establishing huge development projects is due to its good relations with Western countries, as well as the Ethiopian economic growth. It tried to benefit from its water resources and develop its water policy by establishing the Renaissance Dam with the aim of controlling the waters of the Nile River and 145ancelling or reducing the role of the High Dam, which affects the political, economic, security and social conditions in Egypt and limits its regional role. Without Ethiopia's commitment to the principles governing relations between international river partners, especially prior notification and non-harm, this will lead to reducing Egypt's water share from 55.5 billion m^3 to about 40 billion m^3.

The subject of this paper differs from previous studies that dealt with the Renaissance Dam from different aspects, but this paper attempts to study the issue of the Renaissance Dam crisis from a political economy perspective, considering it an issue more important than the oil issue, and that Egypt will face a real war over its water rights unless this crisis is resolved in a fair manner that satisfies all parties benefiting from the river water.

2. THE ETHIOPIAN RENAISSANCE DAM AND ITS POTENTIAL RISKS

The construction of the Renaissance Dam could lead to the loss of nearly half a million acres of agricultural land, about 31,000 people from the area surrounding the dam left their homes and searched for safer alternative places. In addition, both Sudan and Egypt could face significant reductions in their water supplies after their respective water allocations were reduced which—estimated between 16 to 24 billion

m^3 —particularly during this initial phase the dam's operation. This is due to the large volumes of water required to fill the dam's reservoir, which draws heavily from the Blue Nile, ultimately reducing the flow reaching downstream countries, namely Sudan and Egypt (Jajan,2018).

Studies indicate that the soil on which the Grand Ethiopian Renaissance Dam is built is unsuitable due to its inability to store and preserve water for long periods, which leads to the failure and ineffectiveness of dam construction in these areas. The costs of building the dam by Ethiopia become ineffective in light of the weakness of the Ethiopian economy, its low growth rates, and the increasing rates of inflation and unemployment in recent years. If the Grand Ethiopian Renaissance Dam project is financed by other foreign countries such as China, Israel, and some Arab countries, this project is unlikely to succeed economically; rather, its underlying objective appears to be hindering Egypt's development efforts and compromising its water security. Additionally, the Renaissance Dam poses growing risks, including an increased likelihood of volcanic and seismic activity in the area around the reservoir. There is also a heightened risk of structural failure or cracking due to geological conditions and the intense flow of the Blue Nile's waters. Such a collapse could result in severe flooding, potentially submerging Sudanese towns and villages—particularly Khartoum—as well as parts of Egypt located along the Nile (Fouad,2016).

To understand the geostrategic risks of the Grand Ethiopian Renaissance Dam (GERD), there are two factors determine this, the first is the capacity of the dam reservoir relative to the river's flow, this determines the ability of the country constructing the dam to control the outflow to downstream countries. When the capacity coefficient is less than 1, the capacity is weak, but if the capacity coefficient is greater than 1, the capacity is strong. This means that the country which constructing the dam can withhold the dam's discharge for months or more to raise water levels and generate electricity in the country constructing the dam. The second factor is the location of the dam in relation to agricultural lands, this factor determines the purpose of constructing the dam, in this fall Ethiopia does not have an agricultural purpose in constructing the dam, but rather to generate electricity.

A reduction in water storage behind Egypt's High Dam could lead to a significant decline—between 20% and 40% in hydroelectric power generation. Meanwhile, the financial demands of building the Renaissance Dam exceed Ethiopia's economic capacity. According to the United Nations Development Programme's Human Development Report, Ethiopia is among the world's poorest countries. World Bank data from 2011 showed that Ethiopia's GDP was under $30 billion, with an average annual per capita income of only $370—one of the lowest globally. Estimates place the cost of the Renaissance Dam between $5 and $8 billion. Although China pledged $2 billion toward the project, the World Bank declined to fund it due to ongoing disputes among Nile Basin countries regarding dam construction. However, some nations with adversarial positions toward Egypt appear strongly committed to supporting and financing the dam (Kamal,2020).

This indicates that the primary motivation behind building the dam is political rather than economic, driven by external countries outside the Nile Basin that are funding the project to diminish Egypt's water share and exacerbate its economic and social challenges following the revolution in 2011, the goal is to negatively impact Egypt and weaken its ability to achieve development. Furthermore, it is anticipated that an agreement between Israel and Ethiopia may be reached, with Israeli companies potentially managing the electricity generated by the Renaissance Dam, which would have adverse effects on both Egypt and Sudan (Al-Bendary,2018).

3. THE POSSIBLE ECONOMIC IMPACTS OF THE ETHIOPIAN RENAISSANCE DAM ON EGYPT

The Nile River is a central element of Egypt's economy, which is primarily agricultural. According to the 1929 agreement among Nile Basin countries, Egypt is allocated 55.5 billion m^3 of Nile water annually. Based on this share allocated to Egypt from the river water, various projects were developed and

established in various agricultural, industrial and service fields. Any reduction in Egypt's water share is expected to impact Egypt's economy in several ways.

3.1 Impact on water resources and agriculture

It is estimated that if Ethiopia completes the Renaissance Dam and fills the dam quickly without coordination with the Nile Basin countries, Egypt's share of Nile water, which amounts to approximately 55.5 billion m^3 annually, could decrease by approximately 9 to 12 billion m^3. This reduction is likely to halt land reclamation projects in Egypt due to water shortages, potentially halting the irrigation of approximately 8 million acres of agricultural land. Given Egypt's population of approximately 108 million, which is growing at an estimated annual rate of 1.9%, existing agricultural land is already insufficient to meet future needs. The lack of agricultural land expansion, coupled with population growth, will severely impact agricultural and food production. Despite its current water share, Egypt already imports approximately 62% of its food. A further decline in water availability and a halt to agricultural expansion will exacerbate this dependency, especially given that the construction of the Grand Ethiopian Renaissance Dam is likely to halt the cultivation of 2-3 million acres of existing agricultural land in Egypt, particularly in the Delta and Upper Egypt regions. In addition, the rising cost of irrigation: Egypt may be forced to resort to more expensive irrigation methods such as groundwater or desalination. In addition, agricultural production will decline and desertification will increase due to reduced production of staple crops such as wheat, rice, and corn. This will lead to increasing in Egypt's trade balance deficit, which suffers from a persistent deficit because of the increasing bill of food import (Abdel Shafey,2020).

3.2 High Unemployment Rate

The loss of existing agricultural land or the halting of desert reclamation projects in Egypt would result in the loss of many jobs in Agricultural sector, which now employs around 7.1 million people. This would lead to a rise in unemployment within agriculture. It's important to note that even with a high economic growth rate of 7%, Egypt's unemployment rate was about 13%. If agricultural land decreases following the construction of the Ethiopian Renaissance Dam, unemployment is expected to rise sharply, making the agricultural sector less attractive for employment due to difficulties in securing sufficient water for farming (Solieman,2018).

3.3 Impact on water deficit increase

The construction of Ethiopia's Renaissance Dam is expected to worsen Egypt's water challenges. Currently, the per capita water availability in Egypt is about 753 m^3 annually, which is below the global average of around 1,000 m^3 per person. By 2050, this figure is projected to drop to 527 m^3 per person if Egypt's Nile water share remains unchanged. However, if the Renaissance Dam reduces Egypt's water share by 9 to 12 billion m^3 annually, this would further decrease per capita water availability by 17.3% to 22.8%. Such a decline would impose additional economic burdens on Egypt, including the costs of seawater desalination to meet drinking water needs and wastewater treatment for agricultural irrigation. These costly measures could hinder Egypt's development plans amid its ongoing social and economic challenges (Abdel Wahab,2019).

3.4 Impact on electricity and energy

Electricity and Energy conservation has been a significant problem for Egyptian government over the last ten Years. Since 2008, Egypt has pursued a actions and instrument to phase out energy subsidies, which have placed a heavy burden on the national budget—around 120 billion Egyptian pounds (approximately 2.6 billion U.S. dollars) annually. This subsidy removal targeted energy-intensive industries and involved increasing fuel prices for vehicles and households to encourage more efficient energy use. The situation worsened considerably following the January 25 revolution. The construction of Ethiopia's Renaissance Dam is expected to reduce Egypt's water share, leading to a decrease in electricity generated

by the High Dam, which currently accounts for about 10 to 12% of Egypt's total energy production (Fadlallah,2018). The decrease in the water level behind the High Dam may lead to a reduction in the High Dam's ability to generate electricity and store water, which will negatively affect industries and energy and cause economic losses.

The reduction in Egypt's water share puts its economy under significant strain now and in the future. A decline in electricity production from the High Dam means Egypt must rely on alternative energy sources, which are often more costly—something the country may struggle to afford. Among electricity sources, hydropower is comparatively clean, while alternatives like wind, solar, or waste recycling could take considerable time to develop. Turning to nuclear energy carries risks and requires thorough studies and international approval. Relying on fossil fuels such as oil and gas is expensive, especially as Egypt faces a sharp decline in domestic production and currently imports more oil and gas than it exports, a situation worsened by flawed export policies before the January 25 revolution.

3.5 Food and Economic Security

The decline in production of major crops (such as wheat, rice, and corn) leads to poor food security and increased unemployment in the agricultural sector, thus increasing dependence on imports. This leads to a widening trade deficit and declining foreign exchange reserves. The Grand Ethiopian Renaissance Dam also poses a threat to Egyptian national security by controlling the flow of the Nile and undermining Egyptian sovereignty.

3.6 Impacts on Trade and Transport

If the Nile's water level were to fall below its current level, river navigation would likely be negatively impacted, ultimately impacting domestic trade as a whole.

3.7 The economic cost of adaptation measures

Investing in desalination plant projects entails high costs, as do developing modern irrigation systems, constructing water treatment plants, and providing support to affected farmers, which represents an additional burden on Egypt's public budget.

There are some potential positives of the Grand Ethiopian Renaissance Dam if cooperation and coordination among the Nile Basin countries are achieved, including: Regulating the flow of the Blue Nile could help reduce flooding in Sudan and Egypt. There are also opportunities to purchase electricity from Ethiopia, such as, if an agreement is reached, Egypt could benefit from Ethiopia's surplus electricity at lower prices. In addition to regional cooperation, the dam could serve as a project for integration between the three countries rather than conflict, yielding shared economic benefits, including the possibility of trilateral cooperation in water management, coordination in energy production and exchange, and the development of joint agricultural projects that enhance regional food security.

4. THE LEGAL AND ECONOMIC DETERMINANTS OF THE WATER DISPUTE BETWEEN THE ARAB REPUBLIC OF EGYPT AND THE COUNTRIES LOCATED IN THE NILE BASIN

4.1 The legal and economic determinants of the water conflict

Water resources refer to the total water resources available to a country, whether conventional or unconventional, over a specific period of time. They vary depending on the measurement standard, and there are usually multiple indicators and measures that can be relied upon to determine the abundance or scarcity of available water resources, including economic, qualitative, and quantitative indicators. The water

situation in the Nile Basin countries can be examined by applying these previous indicators to determine whether the region faces water scarcity or not, as outlined below (Keshk,2016):

4.1.1 Quantitation indicator of the limited resources of water

Water scarcity is assessed using two main indicators: first, whether the per capita water availability falls below the global water poverty threshold of 1,000 m^3 per year; and second, whether the available water supply is insufficient to meet demand. Based on these quantitative measures, the Nile Basin countries generally do not have any challenge and problems from scarcity of water, as all countries surpass the water poverty line if the river's flow were equally divided among them. However, dependence on Nile water varies across the basin, with northern Sudan and especially Egypt relying heavily on the Nile—Egypt obtains over 95% of its surface water needs from it. Unlike Egypt, most Nile Basin countries have additional water sources within or beyond their borders. Egypt is unique in the basin for fully utilizing its water resources and facing a demand for food and drinking water production that is likely to exceed its renewable the supply of water. Therefore, Egypt is the only Nile Basin country experiencing water scarcity when comparing its needs to available renewable resources (Mustafa,2020). In conclusion, while upstream countries generally have sufficient water resources and use less than their annual renewable supply, downstream countries like Egypt and Sudan face significant water limitations.

4.1.2 Qualitativeness indicator of the limited resources of water

Water quality is assessed by the level of pollution and whether it renders the water unusable despite being abundant. Using this qualitative measure, the Nile River maintains high water purity because of its steep gradient from south to north, which promotes rapid water flow. As a result, the river's water quality is generally good, indicating that there are no significant limitations related to water quality.

4.1.3 Economic Indicator of Limited Water Resources

This is assessed by the lack of essential water infrastructure needed to deliver the water to households and industries, often due to economic poverty. The economic indicator depends on various factors, including poverty levels and population size. According to the World Bank's 2019 Development Report, most Nile Basin countries, except Egypt, are classified as low-income developing nations. Egypt is the only country in the basin categorized as middle-income. The widespread extreme poverty in these countries—excluding Egypt—has negatively impacted their ability to build the necessary water infrastructure. This includes limited systems for water transportation, delivery, and inadequate sewage network coverage in most of these nations, without Egypt. Therefore, we can conclude that many Nile Basin countries suffer from "water poverty" meaning they lack the financial resources required to develop water infrastructure for transport, storage, and distribution across various sectors (Demerew, 2022).

Although the Nile River Basin is abundant in water resources both in quantity and quality, it remains economically underdeveloped and lacks the necessary organizational capacity to manage these resources effectively. As a result, water in the basin is considered limited—not because of physical scarcity, but due to inefficient use and poor planning. This limitation is likely to worsen over time, especially with the added pressure of external factors such as climate change, which may lead to rising temperatures and further strain on the basin's resources, and the impact of environmental pollution, combined to a significant rise in population, creates increased economic pressure, particularly in Agriculture to satisfy the growth demand for food in the future (Bashier).,2021).

The interaction of these elements could trigger international water conflicts between downstream countries like Egypt and Sudan, which face water scarcity, and upstream countries that have abundant water but lack the economic resources to fully utilize it. Egypt relies on over 95% of the Nile's water, whereas Ethiopia uses about 1%, Kenya 2.3%, Tanzania 3.4%, Congo 1.4%, Burundi 5%, and Sudan 15%. Due to higher rainfall in these upstream countries, their dependence on Nile water is lower. This imbalance

in water availability and usage is likely to lead to ongoing disputes over water resources in the future (Al-Shammary,2021).

4.2 The Legal Determinants of Water Conflict

It is important to note that there is no universally accepted legal framework governing the procedural and legal matters concerning the Nile Basin. This lack of a comprehensive, inclusive agreement creates room for international disputes over water resources among the Nile Basin countries. Although various treaties and agreements have been signed, most of them are bilateral rather than multilateral. These include agreements made during the colonial era by imperial powers, as well as those signed after some countries gained their independence like as the 1959 Agreement between Egypt and Sudan (Al-Deeb, 2007).

One of the earliest notable agreements is the Rome Protocol, signed on April 15, 1891, between Britain and Italy. This protocol stipulated that no water-related projects would be developed on the Atbarah River (which flows from Ethiopia into Sudan) without prior consultation with Egypt. Similarly, the 1906 agreement between France, Britain, and Italy included a clause (Article IV) obligating these countries to cooperate in ensuring the continued flow of the Blue Nile and its tributaries into Egypt (Bayoumy, 2019).

Another significant agreement is the 1929 treaty between Egypt and Britain. It prohibits any irrigation or hydropower projects on the Nile or its branches—including lakes feeding the river—without Egypt's prior consent, especially if such projects would reduce Egypt's water share, alter the timing of water delivery, or otherwise harm Egyptian interests. This agreement also affirms Egypt's historical and natural rights to the Nile's waters.

Additionally, the 1959 agreement signed in Cairo between Egypt and Sudan was shaped by new developments, such as plans to construct the High Dam. This treaty confirmed Egypt's existing right to 48 billion m^3 of water annually and allocated 4 billion m^3 to Sudan. Furthermore, it provided for shared use of the High Dam's water, with Egypt receiving 7.5 billion m^3 and Sudan 14.5 billion m^3 annually from the dam's estimated 22 billion cubic meters output—bringing Egypt's total annual share to approximately 55.5 billion m^3 and Sudan's to about 18.5 billion m^3.

The existing agreements highlight the absence of a unified and inclusive treaty among all Nile Basin countries. There is no comprehensive international legal framework governing the use of Nile waters. Instead, the current agreements are mostly outdated, bilateral in nature, and lack broad acceptance across the region. As a result, several Nile Basin countries rejected these agreements upon gaining independence. This underscores the urgent need for a collective, multilateral agreement among all basin states. The lack of such an agreement has led to ongoing disagreement and conflict, particularly over the equitable sharing of the Nile's waters.

There is a strong case for reconsidering and redistributing the Nile River's water shares among all basin countries, given the absence of a comprehensive agreement that outlines clear criteria for water allocation. Currently, only the 1929 agreements and also 1959 both signed exclusively by Egypt and Sudan, the states the downstream address the Nile's waters distribution. These agreements do not include the upstream countries and have been a source of ongoing controversy, particularly regarding their legitimacy and relevance in today's context. Disputes also persist over the legal authority of earlier treaties signed during the late 19th and early 20th centuries, and whether these agreements can serve as a valid legal and procedural framework for managing the Nile's resources. Additionally, there is ongoing disagreement over whether upstream countries are obligated to provide prior notification before undertaking water-related projects in the Nile Basin. These unresolved legal and procedural issues have led to increased tensions and growing instability in the relationships between upstream nations and the downstream countries, Egypt and Sudan (Zakaria, 2019).

5. THE ROLE OF ISRAEL, THE UNITED STATES, AND THE WORLD BANK IN THE WATER CONFLICT BETWEEN EGYPT AND THE NILE BASIN COUNTRIES

5.1 The Israeli role

There is no doubt that Israel's interference in water issues in the region has deep historical dimensions. According to domestic Israeli sources, the country's renewable water resources are limited to approximately 1,850 million m^3 annually. Due to population growth, the amount of renewable freshwater available per person has declined to about 228 m^3 per year, and it is projected to fall further to 265 m^3 per capita by 2025. Recognizing this crisis, Israel officially declared a "drought state" on April 15, 1999, at which time it called on the European Union to provide rapid assistance in addressing the water shortage.

Israel's water scarcity is not solely due to limited renewable resources. It results from a combination of factors including population growth, continuous Jewish immigration, agricultural expansion, industrial development, and environmental degradation. In response, Israeli policy has increasingly leaned toward the "militarization" of water resources—exerting strict control domestically over water sources seized by force, and pursuing influence over regional water resources at the international level. This includes efforts to gain control, either directly or indirectly, over external surface water sources to meet rising domestic demands (Al-Ajjal, 2018).

Regarding the Nile Basin, Israel employs a two-pronged strategy to advance its water security goals. The first approach involves a direct attempt to acquire a portion of Egypt's Nile water allocation—about 1% of the river's total flow—by purchasing it. However, consistent with Egypt's longstanding water policy, such proposals have been firmly rejected. Consequently, Israel has shifted to an indirect strategy aimed at undermining Egypt position in the Nile Basin. This involves a policy of "containment," designed to isolate and pressure Egypt by strengthening relations with upstream Nile countries.

Under the guise of economic cooperation and development assistance, Israel has expanded its presence in the region. It provides loans to newly independent African nations, funds development projects, sends technical experts, and offers training programs to African professionals. Moreover, Israel has engaged with select political groups to bolster their hold on power or create political instability, thereby leveraging these relationships to influence upstream countries against the interests of downstream states like Egypt. As a result of these efforts, Israel has significantly expanded its diplomatic, military, and economic presence in Africa. Once regionally isolated, Israel has now emerged as a key player in African affairs and a formidable competitor in regional influence (Essa, 2014).

It is important to note that Israel, in pursuit of its strategic interests in the Nile Basin's downstream countries, appears to rely on three key mechanisms. First, it supports the rise of a new generation of African leaders, particularly those from minority groups within their own countries, who maintain close ties with the United States and, by extension, with Israel. Second, it seeks to contain Arab national security—especially that of Egypt and Sudan—through a broader strategy often referred to as the "Pacific Alliance," which aims to reshape regional alliances to its advantage.

Israel has sought to establish alliances with various countries and groups that have affiliations with Israel and are known for their hostility toward Arab states, while simultaneously implementing a strategy centered around offering grants and training programs for African professionals. One of Israel's strategic successes has been maintaining a continuous presence in Ethiopia, regardless of changes in political leadership. This presence is reinforced through the supply of arms and military equipment for domestic security purposes.

Israel's influence in the Nile Basin is evident in various sectors, particularly in technical cooperation, trade, labor, and agriculture. Among these, agriculture receives the most attention, given its reliance on

water resources. Israel has shown particular interest in exploiting water from Lake Victoria and supporting agricultural and hydroelectric projects in Ethiopia near the Nile's headwaters.

Trade has become a key indicator of Israel's growing influence in countries such as Ethiopia and the Democratic Republic of Congo. This expansion is supported by the cooperation in forming a joint chamber of commerce, in addition to providing financial grants and various types of economic assistance in various fields. Trade volumes between Israel and African nations now exceed one billion dollars annually (Ramadan, 2018).

5.2 The American role

The American intervention in the water issue of the Nile Basin countries is primarily indirect, centered around limiting the influence of Egypt and Sudan in the region to reinforce its own strategic and political dominance. Part of this approach includes paving the way for Israel's role by reshaping the regional power dynamics within the Nile Basin. Additionally, the U.S. has supported policies aimed at redrawing Sudan's political and geographic landscape to create a new, U.S. aligned state.

Following the end of World War II, American foreign policy towards the Nile Basin countries became completely different compared to before the war, as it became more involved and cooperative in various fields, especially the water issue, with the goal of integrating Africa into the global economy (Taie, 2015). A key objective of American policy is to open up emerging markets, especially in Africa, which is viewed as rich in investment opportunities and as a potential outlet for U.S. products. Military, political, and economic goals are intertwined with promoting democracy, human rights, and regional security.

The U.S. has also used its relations with non-Arab Nile Basin countries as leverage to exert pressure on Egypt and Sudan, both of which are Arab states aligned against Israeli interests. A telling example of American interest in the Nile water issue is its insistence on participating in all relevant water negotiation committees—both multilateral and bilateral—particularly those formed after the 1991 Madrid Peace Conference.

The United States has focused on strengthening ties with Ethiopia, which is critically important as the Ethiopian highlands supply about 80% of the Nile's waters. The U.S.-Ethiopia relationship spans military, political, economic, and commercial dimensions. Furthermore, Washington's engagement with a new generation of African leaders poses challenges for Egypt's regional influence. U.S. support for South Sudan's secession and efforts to redistribute power and resources between northern and southern Sudan have implications for Egypt's water security and could undermine its regional leadership in both the Nile Basin and the broader Arab world (Ramadan, 2018).

5.3 The World Bank role

The World Bank is a major global institution with significant influence, particularly in developing nations. Through its financial tools—such as grants, loans, and development aid—it plays a key role in supporting infrastructure and development projects, including those related to the management and utilization of international rivers. The World Bank can play a dual role in the Nile Basin: it may contribute to tensions and conflict on one hand, while also having the potential to promote cooperation and positive engagement on the other. The international shifts of the 1990s—most notably the rise of globalization—introduced new concepts and mechanisms for managing trans boundary water resources. These developments have significantly influenced how international water governance is approached, including in the Nile Basin (Wheeler,et al, 2016).

The World Bank has introduced several new concepts under what it terms "new water thought," which includes ideas such as pricing of water, privatization of water, water trading, and water markets creation. These ideas are part of a broader push to reform water resource management by promoting privatization, based on the belief that the private sector is more efficient at managing water and ensuring its distribution

across a country. However, this approach has faced opposition from countries like Egypt, which fear that privatization could open the door to foreign interference in national water affairs.

Water pricing relies on market mechanisms to boost economic efficiency, as promoted by the World Bank and reduce political and bureaucratic influence over water distribution. Yet, implementing such models requires extensive study and preparation, especially in developing nations where institutional capacity is limited—particularly in managing pricing systems for irrigation water. Due to these challenges and its alignment with certain countries' perspectives (such as Israel and Turkey), the World Bank cannot be considered a neutral actor in the water disputes. By framing water as an economic commodity, its policies risk undermining historical water rights. This shift could lead upstream countries to demand financial compensation for water flowing to downstream nations. There is a concern that such a model could be extended to the Nile Basin, especially as some countries—like Kenya—have already implemented water pricing systems, collecting up to 20% of the value of irrigation water. These developments are further complicated by external influences that encourage upstream nations to adopt water pricing, thereby increasing tensions in the region (Al-Bendary, 2018).

On the other hand, the World Bank has also important a constructive role to managing and resolving transboundary water disputes, including those involving the Nile River. Since 1998, it has supported efforts to enhance cooperation among Nile Basin countries by funding joint studies and development projects. The Bank allocated around $100 million to facilitate these cooperative efforts, aimed at promoting shared water management. A central part of this initiative is the Nile Basin Initiative (NBI), which was established with the Bank's backing to develop a cooperative legal and institutional framework for the basin.

In conclusion, while the World Bank has contributed to cooperative efforts in the Nile Basin, its policy direction appears to favor of the upstream countries, and this reflects the influence of the great powers and major countries that have special interests in the Nile Basin countries region (Kamal,2020).

5.4 Scenarios for Resolving the Ethiopian Renaissance Dam Crisis

With the escalating security and political tensions in the Nile Basin region, and Ethiopia's determination to complete the Grand Ethiopian Renaissance Dam project, there are several possible scenarios for resolving the crisis. The most prominent of these scenarios are:

First scenario: Strengthening Egyptian hegemony through forming strong alliances with other countries, such as Sudan and South Sudan. Although this scenario does not necessarily mean that Egypt will continue to receive its full share of the Nile's water, it enables it to maintain a relatively large degree of hegemony and achieve consensual solutions regarding its water share.

Second scenario: The emergence of counter-hegemony with multiple centers of hegemony. However, there is a need for external powers capable of mediating a solution to the crisis. China and some Gulf states, which are participating in financing the dam, could intervene and offer solutions or cease funding the dam.

Third Scenario: The success of the counter-hegemonic forces in reaching an alternative system to the Nile Basin Initiative, especially after the South Sudanese Parliament approved the ratification of the Entebbe Agreement in July 2024. Despite the seriousness of this step, as it aims to impact Egypt's water interests and demonstrate Ethiopia's hegemony in the Nile Basin, it is difficult to predict the future balance of power in the Nile Basin countries, especially in light of the increasing population and demand for water resources. This indicates expectations of the possibility of water wars and conflict over this natural resource in the Nile Basin countries.

The Grand Ethiopian Renaissance Dam poses a major strategic economic challenge to Egypt and poses other serious challenges if it is operated without a binding agreement to guarantee Egypt's fair share of water. The economic impacts could be significant, particularly on the agriculture, energy, and food security

sectors. However, with political will and comprehensive agreements, the damage can be minimized and mutual benefits achieved. To mitigate the negative impacts, it is essential to implement the following proposals: accelerate negotiations under international auspices that safeguard everyone's interests, invest in desalination and modern irrigation technology, increase the efficiency of water resource use, and enhance regional cooperation in the energy and water sectors.

CONCLUSION

This paper aims to discuss the economic impacts of construction the Renaissance Dam in Ethiopia on Egypt, by clarifying the nature of the Nile Basin countries' water crisis, especially the Nile River water problem between Egypt and Ethiopia. The study concludes that the ongoing water conflict within the Nile River Basin largely stems from internal factors. These include challenges related to water scarcity, limited economic resources, and most significantly, the absence of a unified and comprehensive legal framework governing water usage in the basin.

The paper highlights several key findings: First, the current water situation in the Nile Basin countries is a major factor of tension and conflict in the region as a whole, particularly when viewed through an economic lens. Many of these countries lack the financial means to build the necessary infrastructure for water delivery, making them more susceptible to external influence. Foreign powers have taken advantage of this by offering financial support for dam construction and other water-related projects, thereby increasing their presence in the region. Second, the lack of a universally accepted legal agreement among Nile Basin nations continues to fuel disputes, especially between Egypt and other basin states. Third, Israel's growing involvement directly strengthened political and economic ties with upstream Countries is part of a broader strategy to encircle Egypt and potentially claim a portion of Nile water. Finally, the United States has expanded its influence in the region through bilateral partnerships and by promoting the formation of alliances or blocs that could undermine cooperation between Egypt and the other countries of Nile Basin.

The World Bank has introduced new water management concepts such as privatization, water pricing policies, water trading, and the establishment of water markets. While intended to improve efficiency, these approaches may inadvertently heighten tensions and contribute to potential water conflicts among Nile Basin countries. Moreover, the influence of major global powers on the World Bank's policies has raised concerns about the institution’s impartiality in addressing transboundary water issues. Despite Egypt’s continuous efforts to resolve the Grand Ethiopian Renaissance Dam crisis, meaningful progress with upstream countries has been difficult to achieve, largely due to the backing these nations receive from external actors opposed to Egypt’s position.

This paper offers several recommendations: Strengthen Strategic Cooperation: Egypt should work on building a framework of strategic cooperation with other countries of Nile Basin to ensure collective the security of water. This includes leveraging the unique resources and capabilities of each country to maximize mutual benefits from the Nile's waters and investing in the development of non-traditional water sources to increase overall water availability. Enhance Economic Ties: Establish stronger trade partnerships with countries of Nile Basin and make use their economic and natural resources to support regional socio-economic development. Establish a Unified Legal Framework: A new, inclusive institutional and legal agreement involving all Nile Basin states is necessary to resolve current disagreements. This framework should recognize and uphold Egypt's historic water rights as outlined in prior treaties. Revise Egypt’s Africa Policy: Egypt should reassess its foreign policy toward Africa, aiming to play a more proactive role in promoting stability through security, economic, and political agreements that limit the influence of external powers in the region. Leverage Regional Alliances: Egypt could apply pressure on Ethiopia by strengthening ties with its neighboring countries such as, Somalia, Djibouti and Eritrea which have existing tensions with Ethiopia. This could serve the challenge Ethiopian desire and interests in the region. Pursue International Legal Channels: Egypt should consider taking the GERD dispute to arbitration at the international level to defend its historical of Nile waters share —similar to the approach taken in the Taba border dispute. Mobilize Global Support: Work on shaping international and regional public opinion in favor of Egypt’s position to build momentum toward an agreement that deters Ethiopia from harming Egypt’s water interests. Avoid

Military Action: At this stage, military intervention should not be considered, as it could have negative consequences for Egypt that outweigh any potential gains.

CONFLICT OF INTEREST STATEMENT

The author declares that the paper was conducted in the absence of any commercial or financial relationships which could be construed as a potential conflict of interest. No potential conflict of interest or any other similar divergence associated with this research article by the author. Additionally, I hereby confirm that there are no potential conflicts of interest relating to this manuscript.

REFERENCES

Abdel Shafey, E.F. (2020), "The Renaissance Dam, the Water Issue, and Egyptian National Security," Political Studies, Egyptian Institute for Studies, April, Cairo, pp.82-84.

Abdel Wahab, A. (2019), "Towards an Integrated Egyptian Strategy in the Nile Basin Countries," International Politics Journal, Al-Ahram Center for Political and Strategic Studies, Issue 178, October, Cairo, pp.161-164.

Al-Ajjal, L. (2018), "The Israeli Role in the Nile Basin Region and Its Implications for the Reality and Future of Water Security in the Nile Basin Countries", published PhD thesis, Faculty of Law and Political Science, University of Batna, Algeria, pp.151-154.

Al-Behery, Z.M. (2016), "Egypt and the Nile Problem, the Ethiopian Renaissance Dam Crisis", Egyptian General Book Authority, Cairo,pp. 106.

Al-Bendary, S. (2018), "The Renaissance Dam Problem and Reformulating the Directions of Egyptian Foreign Policy in Africa", Journal of African Studies and the Nile Basin, Arab Democratic Center, Vol. 1, Issue 1, Berlin, Germany, pp.94-98.

Al-Deeb, E.F. (2007), "The Legal Nature of Treaties Concerning the Use of International River Waters and International Waterways for Non-Navigational Purposes, with an Applied Study of the Agreements Related to the Nile River", unpublished PhD thesis, Faculty of Law, Cairo University, pp.122-125.

Allam, N.M. (2014), "The Renaissance Dam Crisis, a Political Issue or a Technical Problem", Al-Mahrousa Center for Publishing and Services, Cairo University, First Edition, Cairo, pp.214-216.

Al-Shammary, S. (2021), "Egyptian Diplomacy and Its Role in the Renaissance Dam Crisis, Challenges and Solutions", Tikrit University Journal for Humanities, Vol. 28, No. 8, pp.67-71.

Bashier, M. (2021), "Cooperative Operation of the Grand Ethiopian Renaissance Dam Reduces Nile Riverine Floods", River Research and Applications. Vol, 37, No. 6 ,pp.157.

Bayoumy, O.G. (2019), "The Renaissance Dam between National Security and International Law", Dar Al Nahda Al Arabiya, Cairo, pp.161-167.

Demerew, K. (2022), "Realist Perspectives on Nile Politics: Conflict and Cooperation Between Ethiopia and Egypt", African Security. Vol, 15, No. 3, pp. 213-215.

El-Tayeb, A. (2015), "The Economic, Social and Environmental Impacts of the Construction of the Ethiopian Renaissance Dam", unpublished PhD thesis, Omdurman Islamic University, Sudan, pp. 144-147.

Essa, S.S. (2014), "The Coming War: The Water War and the Conflict with Israel", Dar Al-Riyadh for Publishing and Distribution, Saudi Arabia, pp. 224-227.

Fadlallah, S.J. (2018), "The Nile River in Egyptian-Ethiopian Relations", National Library, First Edition, Cairo, pp. 153.

Fouad, K. (2016), "The Ethiopian Renaissance Dam, Egypt and the Crisis of Difficult Choices", Egyptian Institute for Political and Strategic Studies, Istanbul, Turkey, pp. 34-37.

Hamdan, S. (2015), "The Impact of the Ethiopian Renaissance Dam on the Future of Water Resources in Egypt and Sudan", Al-Mustansiriya Journal of Arab and International Studies, Al-Mustansiriya Center for Arab and International Studies, Al-Mustansiriya University, Baghdad, Iraq, Vol. 12, No. 51, pp. 292-295.

Hammond, M.F. (2013), "The Grand Ethiopian Renaissance Dam and the blue Nile: Implications for trans boundary water governance", Global Water Forum, University of Exeter, United Kingdom, February, pp. 64-69.

Hany, S. (2015), "Nile Basin initiative an insight into Egypt position", African Affairs, Vol, 17 ,pp. 27-31.

Huiyi,C., Ashok S.(2014), "The Grand Ethiopian Renaissance Dam: Evaluating Its Sustainability Standard and Geopolitical Significance", Energy Development Frontier, March, Vol. 3, No. 1, pp. 11-19
Jajan, A. (2018), "The Impact of the Ethiopian Renaissance Dam on the Future of Water Resources in Egypt and Sudan", Kirkuk University Journal for Humanities Studies, Vol, 13, No. 2, pp. 66-69.
Kamal, G. (2020), "The Ethiopian Renaissance Dam between Negotiations, Reality and Future Scenarios", Sawt Africa Magazine, Dar Al Bayan for Publishing and Distribution, Vol. 1, No. 3, Benghazi, Libya, pp. 87-81.
Keshk, A.M. (2016), "Egyptian Water Policy towards the Nile Basin Countries", Cairo: Egyptian African Studies Program, Faculty of Economics and Political Science,pp. 62-64.
Kottan, W. (2017), "The Ethiopian Renaissance Dam and its Impact on Water Security in Egypt and Sudan", PhD Thesis, College of Education for Human Sciences, University of Diyaly, Iraq, pp. 141-144.
Majeed, M.R. (2022), "The Impact of Water Variables and the Renaissance Dam Problem on Egyptian-Ethiopian Relations", Dar Amjad for Publishing and Distribution, First Edition, Amman, Jordan, pp. 123-125.
Marey, N.D. (2020), "The Ethiopian Renaissance Dam and the Water Conflict between Egypt and the Nile Basin Countries", Al-Araby for Publishing and Distribution, Cairo, Egypt, pp. 112-115.
Mustafa, M. (2020), "The Renaissance Dam, the Most Complex File in the African Continent and the Most Dangerous to Egypt", Journal of African Studies and the Nile Basin, Arab Democratic Center, Issue 9, Berlin, Germany, pp. 41-43.
Noureldin, N. (2019), "Egypt and the Nile Basin Countries, Water, Dams and Conflict", Dar Al-Nahda, First Edition, Cairo, pp. 72-74.
Qassem,N., Hasan S. (2023), "The Renaissance Dam Crisis between Egypt and Ethiopia", Hammurabi Journal of Studies, Hammurabi Centre for Research and Strategic Studies, Vol. 2 ,No. 45, pp. 141-143.
Qutb, H., Darwish, S. (2022), "The Renaissance Dam Crisis between Egypt and Ethiopia", Journal of African Studies, Vol. 44, No. 2, Cairo, pp. 64-66.
Ramadan, I.S. (2018), "The Responsibility of Ethiopia, Financing Countries and Implementing Companies for the Construction of the Ethiopian Renaissance Dam", Dar Al Nahda Al Arabiya, First Edition, Cairo, pp. 85-87.
Riyad, M. (2016), "Egypt and the Ethiopian Renaissance Dam", International Politics Magazine, Al-Ahram Center for Political and Strategic Studies, Vol. 51, No. 203, pp .66-71.
Sabry, M. (2020), "The Water Conflict, the Renaissance Dam Crisis between Egypt and Ethiopia", Dialogue of Thought Journal, Vol. 15, No. 51, pp. 44-48.
Salim, H. (2022), "The international dispute over the Renaissance Dam between Egypt, Ethiopia and Sudan", Al-Zaytoonah University of Jordan Journal for Legal studies, Vol. 3, No. 2, pp. 127-129.
Shafey, B.M. (2021), "Egypt, Ethiopia, and the Struggle for Hegemony over the Nile Basin, the Renaissance Dam as a Model", Al Jazeera Center for Studies, January, Doha, Qatar, pp.56-59.
Sharaky, A. (2014), "Geology of the Ethiopian Renaissance Dam and its impact on the safety of the dam", Water Issue Conference, Cairo University, March 15, pp. 112-114.
Solieman, A.T. (2018), "The Ethiopian Renaissance Dam and the Future of Egyptian National Security", Al-Azhar University, First Edition, Cairo, pp. 45-48.
Taie, M. (2015), "The International Conflict over Water in the Nile Basin Countries", unpublished PhD thesis, Faculty of Economics and Political Science, Cairo University, pp. 92-97.
Taye, S. (2011), "The Impact of Regional and International Powers on Water Interactions in the Nile Basin, in: Egyptian Water Security: Reality and Future", Cairo, Egyptian Council for Foreign Affairs, Vol. 46, pp. 80.
Waterbury, J. (2018), "The Grand Renaissance Dam and prospects for cooperation", University Of North California at Chapel Hill, USA, pp. 124-126.
Wheeler, K. G. et al. (2016), "Cooperative Filling Approaches for the Grand Ethiopian Renaissance Dam", Water International. Vol, 41, no,4, pp. 611-634.
Yosry, I.R. (2016), "The Nile and the Renaissance Dam, a Journey Through History and Geography", Egyptian Institute for Strategic Studies, Cairo, pp. 55-57.
Zakaria, R.M. (2019), "The Ethiopian Renaissance Dam Crisis in Light of Agreements and Principles of International Law", Arab Center for Research and Policy Studies, Cairo, pp. 86.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Al-Own, B., Al-Eitan, G.N., Saidat, Z., Jawabreh W.J. (2026), "CEO Inside Debt Compensation
and European Banks' Default Risk: Evidence from GMM Panel Analysis",
Montenegrin Journal of Economics, Vol. 22, No. 2, pp. 157-168.

CEO Inside Debt Compensation and European Banks' Default Risk: Evidence from GMM Panel Analysis

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ARTICLE INFO

Received November 21, 2024
Revised from December 22, 2024
Accepted January 15, 2025
Available online April 15, 2026

JEL classification: G21, J33, G33

DOI: 10.14254/1800-5845/2026.22-2.13

Keywords:

Banks,
Inside Debt,
Bank Stability,
Insolvency Risk,
Europe

ABSTRACT

This paper examines the impact of chief executive officer (CEO) inside debt compensation on bank default risk by using the two-step system generalised method of moments (GMM). The selected sample features 30 European banks, with 180 observations from 2007 to 2012. Merton's distance was used as a default model (DD), showing that increased inside debt compensation positively influences bank distance to default. This analysis indicates that debt-like compensation limits bank risk and encourages executives to reduce risk and improve bank stability. Additional further analysis shows that increased CEO inside debt holding is associated with a lower probability of insolvency. These findings support the argument that inside debt compensation is among the more effective tools seeking to align CEO incentives with debtholders' incentives. In this way, it provides empirical support for European regulators and other related responsible parties seeking ways to improve the resilience of European banks.

INTRODUCTION

The most recent credit crisis has generated great debate about the ineffective corporate governance mechanisms. Many accusations have been at level and the structures of executive compensation in the banking sector. Executive compensation, as a corporate governance mechanism, is primarily designed to address agency problems; nevertheless, it may contribute to excessive risk-taking incentives, thus weakening financial stability and triggering global economic disasters. Credit crises thus naturally place the incentives generated executive compensations under additional scrutiny (Bhagat and Bolton, 2014).

Several recent studies have discussed the effect of debt-based compensation ("inside debt") on risky policy decisions. Due to its time-bound nature, debt-based compensation is expected to mitigate the

conflict between the executive and debtholders and to induce the executive to adopt more conservative behaviours. According to agency theory, the pay-off of inside-debt compensation is that it exposes managers to losses, making them more similar to creditors with regard to risk (Sundaram and Yermack, 2007; Cassell et al., 2012).

Default risk often depends on executives' risk-taking, and the relevant CEO compensation contract is an essential determinant factor driving firm investment decisions and financial policies. The components of this contract are assumed to shape manager's risk-taking incentives (Srivastav et al., 2018). However, despite its importance, relatively little is known about how inside debt compensation affects the riskiness of banks.

The pursuit of sound compensation practices to guarantee the financial stability of the banking sector has become a priority for regulators and bank supervisors worldwide. However, the existing empirical evidence on the role of inside debt is limited and contradictory. Examining how incentives such as inside debt holding influence banks' default risk is thus fundamental, particularly with regard to whether executive compensation induces managers to avoid excessive risk that might otherwise harm economic and bank safety.

This study thus provides two key contributions to the literature on executive compensation and default risk. First, while several studies have already analysed the relationship between inside debt and firm risk, this study is the first to consider a sample from the European banking sector using both a market based measure of default risk (Distance to Default) and an accounting based measure (Z-score). Second, this study uses system GMM, which addresses endogeneity issues caused by omitted variables and unobserved heterogeneity.

The empirical results in this work show that using inside debt compensation in the banking sector results in lower default risk, based on higher distance to default. The same association held when Z-score was used as a measure of bank default risk, suggesting that greater inside debt holding contributes to higher bank stability.

LITERATURE REVIEW

Despite a growing body of literature suggesting that inside debt holding curbs managers' excessive risk-taking, whether and how inside debt holding affects default probability thus remains an important open question. The majority of empirical research studies on the impact of inside debt holding emerged only after 2006 (Sheikh, 2019). This is because before 2006, there was no requirement to provide the actual present value debt-based compensation.

Several studies have, however, investigated the implications of CEO inside debt holding outside the banking industry (Cassell et al., 2012; Freund et al., 2018; Kabir et al., 2013). Cassell et al. (2012) documented a robust inverse association between managers inside debt compensation and the volatility of stock returns using a sample S&P 1500 index. They also found that larger CEOs inside debt lowered firm risk and reduced bankruptcy risk. Using a sample of 237 US firms, Sundaram and Yermack (2007) empirically showed that higher inside debt holding encouraged CEOs to become more conservative in behaviours, reducing default risk. Similarly, Borah et al. (2020) provided evidence that nonfinancial firms awarding managers more inside debt compensation had less cost of debt, lower default risk, and relatively better performance. Lee et al. (2021) concluded that CEOs with inside debt in nonfinancial firms largely reduced those firms' idiosyncratic risk and R&D investment risk. However, they also suggested that inside debt provides less motivation for a CEO to reduce a firm's systematic risk. Likewise, Sheikh (2019) used a sample of nonfinancial firms to produce evidence that inside debt holdings influence managerial risk-taking decisions and reduce firms' future risk. Kabir et al. (2013) observed that using debt-like compensation in UK nonfinancial firms generated risk-avoiding incentives by reducing borrowing costs. These studies provide empirical evidence that confirms the agency theory prediction of an inverse relationship between CEO inside debt holding and managerial risk-taking in nonfinancial firms. In contrast, Li and Zhao (2020) showed that inside debt compensation in UK firms did not induce risk-averse managerial behaviour. They thus argued that managers used inside debt to minimise their income tax liabilities, removing any linkage between executives inside debt compensation and risk-taking incentives.

In the context of financial firms, Srivastav et al. (2018) found that bank default risk is lower when CEOs have higher inside debt incentives. Bennett et al. (2015) found that, during last credit crisis, higher inside debt-based compensation rates corresponded with lower risk of default. Bekkum (2016) also showed that higher top-management inside debt holdings reduce banks risk and provide risk-reducing incentives.

More recently, Bhabra and Hossain (2024) provided empirical evidence that inside debt compensation in US firms plays a vital role in mitigating firm risk. The same conclusion holds for insurance firms; Milidonis et al. (2019) showed that debt-based compensation in the insurance sector lowers CEOs' incentives to take risks.

Another strand of empirical studies investigated how inside debt compensations influences risky investments and financial policies and risk management strategies. For example, Srivastav et al. (2014) showed that CEOs' debt-based compensation in US banks led to lower default risk probability and aligned their incentives with those of debtholders. They also found a positive association between inside debt holdings and reductions in payouts to preserve cash and reduce bankruptcy risk. Belkhir and Boubaker (2013) identified a positive relationship between managers inside debt and risk management using derivatives in US banking industry.

In contrast, several prior studies also document mixed results or provide different conclusions on the effect of inside debt compensation on firm risk. Boyallian and Ruiz-Verdu (2018) showed no association between debt-based compensation and bank risk across large US financial firms during financial crises. Similarly, Duong et al. (2021) found insignificant and mixed results regarding whether holding a higher ratio of inside debt induces CEOs to introduce risk mitigation.

This study extends the literature by investigating the extent to which inside debt holding among CEOs affects bank default risk within the EU. Bekkum (2016) and Bennett et al. (2015) both focused on US banks and highlighting the need for more studies on the impact of inside debt on bank default risk in other contexts. Further, the mixed results emerging from the empirical studies thus have highlighted that the role played by inside debt in alleviating firm risk requires further research. The current study is thus based on the related idea that the inverse relationship between inside debt holdings and risk reduction can be critically captured through examining the likelihood of bankruptcy or default risk.

2. DATA, VARIABLES, AND METHODOLOGY

2.1 Sample

The sample used in this study was extracted from publicly listed European banks for the period 2007 to 2012. The sampling commenced at the end of fiscal year 2007 based on the fact that data on the value of CEO inside debt compensation became available only after 2006 (Srivastav et al., 2014). Post-July 2006, the compulsory disclosure of the present value of inside debt compensation required by the Securities and Exchange Commission increased the transparency and level of details in annual reports (Eisdorfer et al., 2015).[1] This has facilitated more research on the implications of inside debt compensation for managers (Milidonis et al., 2019; Borah et al., 2020).

An initial sample consisting of 55 European banks' data from 2007 to 2012 was first used, with all banks publicly listed at least in one of the main European market indices (EU-27). Restrictions were imposed in cases on data non-availability for at least one year, excluding all banks with missing data for variables included in computing risk indicators to calculate risk measures accurately. Finally, following Freund et al. (2018) and Jiang et al. (2024) only bank CEOs who had been disclosed as having non-zero inside debt were included, to control for any possible bias. This left 30 banks remaining, for 180 bank-year observations.

[1] The SEC only adopted the mandatory disclosure of executive pension pay in 2007; before 2007, pension values were calculated using elaborate actuarial methods (Vallascas and Hagendorff, 2013).

Publicly traded banks were selected because banks are heavily leveraged firms where debt represents a large percentage of the capital structure. This makes debt agency conflict between agents and debtholders in indebted firms more critical (Bekkum, 2016).

2.2 Inside debt measure

Edmans and Liu (2011) theoretically proposed a ratio of CEO's debt-based compensation relative to equity-based compensation, scaled by the firm's debt to equity ratio as a measure for CEO inside debt incentives. They explained that the conflict between debtholders and shareholders can be alleviated if the CEO holds debt and equity in proportions similar to the firm's overall equity ratio; CEO incentives are thus more aligned with debtholders than shareholders when the ratio is greater than one. Following previous empirical studies, inside debt in this work is defined as CEOs' debt holding relative to the value of equity-based compensation (Sheikh, 2019; Erkan and Nguyen, 2021; Cassell et al., 2012; Bekkum, 2016), divided by bank debt to equity ratio:

$$\text{inside debt} = \frac{\text{CEO Inside debt /CEO equity}}{\text{Bank debt /bank equity}} \quad \text{..... (1)}$$

The CEOs inside debt benefit is the sum of any defined benefit pension and deferred compensation (Srivastav et al., 2014; Milidonis et al., 2019; Sheikh, 2019). CEO equity is measured as the CEO's stocks and stock-option holding value, calculated by multiplying the number of stocks held by the stock price at the end of the year to calculate the value of the CEO stocks. The Black-Scholes model is thus used to value CEO stock options. Bank debt value is the sum of the firm's current and long-term liabilities (Bekkum, 2016). Bank equity is the value of the outstanding shares at the end of the fiscal year. The ratio of CEO debt-based compensation to equity based-compensation is divided by the bank debt to equity ratio to capture the relative fraction of executive inside debt and equity-based wealth (Srivastav et al., 2014). Data on executives' debt-based (defined benefit pensions and deferred compensation) were manually collected using bank annual reports. CEO stock and stock options were also hand-collected using yearly annual reports.

2.3 Bank default risk measures

This paper examines the ways in which inside debt compensations influence European banks risk, based on two measures of default risk. The first is Merton's (1974) distance to default model, which the banking literature uses as a market-based measure suitable as an indicator of default probability (Gropp et al., 2006). The Merton's model measures likelihood of default as the number of standard deviations by which the market value of assets exceeds the default point (Kato and Hagendorff, 2010). As a market-based measure of bank fragility, it outperforms other indicators such as debt and CDS spreads (Gropp et al., 2006).

The higher the positive distance from the default of firm value to firm liabilities, the lower the default risk (Gropp et al., 2006), with a higher distance to default indicating better bank stability. The distance to default is calculated using data drawn from DataStream and the bankss' annual reports as follows:

$$DD_t = \frac{\ln(V_{A;t}/L_t) + (rf - 0.5\sigma^2{}_{A;t})T}{\sigma_{A;t}\sqrt{T}} \quad \text{.....(2)}$$

where VA_t is the banks' market value of assets; L_t is the book value of debt; rf is the risk-free rate is the risk-free rate; $\sigma A,_t$ is the annualized volatility of assets; T is time to maturity; and σE is the historical volatility of banks' equity.

Z-score was used as the second measure for bank risk (distance from insolvency) to facilitate more robust analysis. Z-Score measures a bank's distance from insolvency such that a lower Z-score suggests more bank risk (Bhagat and Bolton, 2014; Milidonis et al., 2019). Z-scores were calculated as follows:

$$\text{Z-score} = \frac{\text{ROA}+[\frac{\text{Equity}}{\text{Assets}}]}{\sigma\ \text{ROA}} \quad \text{..... (3)}$$

where ROA is the bank's return on assets at the end of the year, while σROA is the standard deviation of ROA. Higher value Z-scores signal more bank stability; following previous studies, this study took the log transformation of the Z-scores to manage the fact that the distributions of the raw Z-scores of banks are skewed (Minhat and Abdullah, 2016).

2.4 Measuring control variables

Bank characteristics include Charter value, Leverage, Size, and ROA. Many previous banking studies have control for these bank characteristics. Each bank's Charter value was used to control for investment opportunities as a determinant of future return. Charter value is defined as the MV of assets to the BV of assets at the end of the year (Coles et al., 2006; Srivastav et al., 2018). Leverage was used as a control for the amount of balance sheet expansion that rationally enables the firm to increase profits through accepting more risk. The debt ratio (BV of debt to BV of assets) was used to measure this. A higher leverage level is a financial policy choice that typically increases bank risk and increases the probability of default (Vallascas and Hagendorff, 2013). Bank Size was also used as a control variable. Number of sales represents one of the most common ways to measure firm size (Coles et al., 2006), and this analysis thus included the sales logarithms as a bank size measure.

Finally, a proxy for bank profitability was found by using ROA as a control variable. Previous literature on the relationship between executive compensation and default risk suggests that high profits enable banks to retain more earnings, enlarge their capital, and increase the distance to default (lowering default risk). On the other hand, high profitability may indicate high levels of risk-taking, increasing default risk. Following the previous literature, bank profitability was measured using return on assets (Bekkum, 2016; Milidonis et al., 2017; Freund et al., 2018). Data on all bank characteristics were mainly obtained from the DataStream database.

CEO characteristics included CEO Cash-based compensation, equity-based compensation, and CEO age and tenure. Previous studies have used CEO cash compensation (summing annual salary and cash bonus) to proxy for CEO outside wealth and risk aversion levels (Sheikh, 2019; Lee et al., 2021). Cash compensation is thus the dollar value of the base salary and bonuses the CEO earns during a given fiscal year. Cash compensation was scaled as a percentage of total CEO compensation.

The previous literature was again followed to calculate the vega-to-delta ratio as a control variable for the relative CEO risk-taking incentive (Roger, 2002; Erkan and Nguyen, 2021). The vega is the CEO stock options' sensitivity to stock return volatility (Sheikh, 2019), while the delta is the sensitivity of the stocks and options to changes in the price of the firm's stock overall (Coles et al., 2006). According to Roger (2002), the CEO incentives can be captured better using this ratio than using the vega and delta individually.

CEO personal characteristics that may be related to career concerns, such as age and tenure are also included. Older CEOs may be expected to be incentivised to decrease risk as the have fewer years left in the firm before retirements. However, Vallascas and Hagendorff (2013) suggested that older CEOs face less regulatory scrutiny as compared to their younger counterparts; potentially leading to more risk-taking behaviours. Tenure was used as a proxy for the CEO's risk aversion level, based on the expectation that CEO tenure should have an inverse relationship with bank risk (Coles, 2006). Longer executive tenure should encourage managers to undertake less risky behaviours. Tenure is based on the number of years the CEO has acted in that position (Bennett et al., 2015; Boyallian and Ruiz-Verdu, 2018).

2.5 Estimation method

To investigate how inside debt compensation affect default risk, a two-step generalised method of moment (GMM) approach, as adopted by many previous empirical studies (Sheikh, 2019; Bennett et al., 2015), was undertaken. Specifically, the approach used by Arellano and Bover (1995) and Blundell and Bond (1998) was adopted, in which the GMM model is an instrumental variable estimator that treats dependent variables as endogenous. GMM model uses lagged dependent and independent variables as instruments and is considered one of the most reliable dynamic panel models, particularly for short panel and endogenous explanatory variables (Flannery and Hankins, 2013).

The instrument in the GMM estimator is internal instrument obtained within the panel (Blundell and Bond 1998). GMM controls for unobserved heterogeneity in the distance to default risk and considered one of the most reliable dynamic panel models, particularly for short panel and endogenous explanatory variables (Vallascas and Hagendorff, 2013).

Following previous studies (Bennett et al., 2015; Milidonis et al., 2019; Lee et al., 2021), the association between CEO inside debt and bank default risk was explored using the following model:

$$Risk_{it} = \beta 0 + \beta 1 inide\text{-}debt_{it} + \beta 2 Leverage_{it} + \beta 3 Charter_{it} + \beta 4 Size_{it} + \beta 5 ROA_{it} + \beta 6 Age_{it} + \beta 7 Tenure_{it} + \beta 8\ Vega\text{-}to\text{-}delta_{it} + \beta 9\ Cash_{it} + \mu_t + \acute{\varepsilon}_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

3. EMPIRICAL ANALYSIS AND RESULTS

3.1 Main results

Table 1 reports the correlations among explanatory variables. The correlation test results imply that multicollinearity is not a concern in this analysis. This were also confirmed with another multicollinearity diagnostic test, using the variance inflation factors (VIF) to ascertain the absence of multicollinearity for these variables. The VIF value for all variables was less than 2.5 verifying the absence of multicollinearity problems.

Table 1. Correlations between variables

Variables	1	2	3	4	5	6	7	8	9	10	11	VIF
(1) Distance to default	1											1.51
(2) Z-score	0.0067	1										1.46
(3) inside debt	**0.2350***	0.0776	1									1.14
(4) Leverage	0.0833	0.1188	-0.0651	1								1.41
(5) Charter	**-0.4583***	**0.4323***	**-0.2005***	-0.0416	1							1.59
(6) Size	0.0859	-0.0329	**0.1653***	0.0487	-0.1213	1						1.49
(7) ROA	**-0.1574***	**0.4987***	**-0.2247***	**0.3935***	**0.4736***	-0.0749	1					1.98
(8) CEOage	**0.1969***	-0.052	-0.0056	-0.0571	-0.1238	**0.3129***	-0.0935	1				1.35
(9) CE-Otenure	-0.0547	0.0414	-0.0254	**0.1480***	-0.0287	-0.0286	**0.1659***	**0.3062***	1			1.23
(10) Vega-to-delta	0.1086	-0.0143	0.0686	-0.0311	-0.0586	0.0396	0.0079	-0.0292	-0.0225	1		1.27
(11) Cash-comp	0.1217	0.0783	**0.0601**	**0.2149***	-0.0942	**-0.3369***	0.0391	0.0067	-0.0243	**-0.4017***	**1**	1.65

* Indicates significance at the 5 % level
Source: own

A positive and significant correlation between inside debt and default risk (0.2350; at p<5%) emerged, which suggests preliminary support for a positive relationship between the main dependent and independent variables (inside debt increase distance to default ratio and lower default risk). The correlation between distance to default and control variables is also consistent with theoretical predictions.

Table 2 presents the results of GMM model of the relationship between inside debt and distance to default. Before interpreting the primary variables of interest, several tests were conducted to verify the validity of the dynamic panel model. The P-value of the Hansen test for over-restriction was greater than 0.05, suggesting that the instrumental variables are not correlated with the residuals. No over-identification restrictions were thus detected, rejecting the hypothesis that the instruments are irrelevant.

The insignificant probability values of AR2 prove that the momentary conditions of the model are met, despite the rejection of the first-order autocorrelation hypothesis (AR1). These results do, however, confirm that the diagnostic tests are satisfactory. It is possible to estimate system GMM via a one step or a two-step approach. However, the two step GMM system lowers bias and corrects standard errors (Vallascas and Hagendorff, 2013).

Table 2. CEO inside debt compensation and bank default risk using Merton's distance to default model

Variables	*Model (1)*	*Model (2)*	*Model (3)*
inside debt	0.0438492	0.070626	0.0622577
	(0.0180628)**	(0.0304742)**	(0.0261787)**
Leverag	2.10154		-2.489759
	(4.258287)		(8.832683)
Charter	-7.151442		-6.769154
	(1.426042)***		(1.714809)***
Size	0.6296277		-0.460015
	(0.1208732)***		(0.7484999)
ROA	0.8144829	0.1474824	0.9312117
	(0.4589098)*	(0.4710743)	(0.5051351)*
Age		1.285811	5.120402
		(0.5195924)	(2.952458)*
Tenure		0.3823403	0.6062627
		(0.670456)	(0.7987087)
Vega-to-delta		1.65397	1.068666
		(1.80885)	(1.192386)
Cash		1.703627	-2.982404
		(2.578192)	(2.258235)
Crisis dummy			4.849499
			(2.022473)**
Hansen J-statistic	13.92237	13.98068	13.47805
Prob(J-statistic)	0.125113	0.123014	0.127545
AR1 (p-value)	0.0076	0.0036	0.0028
AR2 (p-value)	0.3721	0.2561	0.3431

Source: own

In Table 2, the results of the GMM model derived from the main specification described in (Eq.1) are offered. In all three columns, the dependent variable is Merton's distance of default, while the main variable of interest is CEO inside debt. The first column of Table 2 shows the relationship between inside debt (using CEO debt-based compensation as a percentage of equity based compensation, divided by the bank debt to equity ratio) and default risk, controlling for bank characteristics. The second column controls for CEO characteristics. Column 3 reports the comprehensive regression results that include both bank and CEO characteristics. Inside debt was expected to positively influence (risk-reducing) the default distance. As inside debt represents unsecured and unfunded rewards and exposes managers to similar risk and insolvency treatment as outside creditors, inside debt holding should, theoretically, incentivise executives to avoid risk (Sundaram and Yermack, 2007; Borah et al., 2020).

Robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The GMM estimation results confirmed the initial expectations. Column (1) reports on the results that control for firm characteristics. A significant positive association between inside debt and bank default risk

(coefficient=0.0438; p< 5%) emerged. The inside debt ratio in all columns is positive and statistically significant, indicating that the higher the debt compensation, the lower the bank default risk (increased distance to default). The same process was repeated in column (2) as in column (1), including only CEO characteristics as control variables. This generated consistent results, with the analysis showing that CEO inside debt and distance to default have strong positive association (coefficient=0.0932; p< 1%).

In Column (3), the results of the whole model are tabulated, giving qualitatively similar results. A positive and high significant correlation was found between inside debt and distance to default. The results presented in Table 2 thus imply that CEOs inside debt compensation is more likely to reduce bank risk by increasing distance to default probability. More debt-based compensation could thus increase CEO risk aversion to the extent where it could reduce the bank's default probability. As a result, a CEO with higher deferred pay levels would be more likely to prefer less risk-taking behaviours and to exhibit more decisions aligned with the interests of debtholders.

Several interesting results for control variables also emerged. The results for bank size matched results from previous studies supporting the argument that large banks are more diversified and better able to manage risk (Vallascas and Hagendorff, 2013).

The results in Table 2 further indicate that growth opportunities negatively affect bank distance to default. Coefficients of Charter value are positive and significant at the 1% level across all models, implying that higher growth opportunities are associated with lower distance to default (higher risk). This finding is consistent with the positive linkage suggested in the literature between growth opportunities and risk level (Coles et al., 2006; Sheikh, 2019).

The coefficient signs for age were positive and significant, indicating that older CEOs are more likely to avoid risk and adopt a conservative strategy (Vallascas and Hagendorff, 2013). The positive and insignificant coefficients of other CEO compensation variables imply that cash and incentives from equity-based compensation reduce managerial risk aversion and increase bank risk, however. CEO tenure and vega-to-delta ratio were also insignificant, and the results for bank profitability measured using ROA were as expected. The positive and significant sign for ROA implies that higher bank profitability lowers bank risk (increased distance to default).

These results provide empirical evidence supporting the idea that inside debt compensation aligns the incentive of CEOs with those of debtholders by reducing the overall bank default probability. This evidence is robust across different model specifications, confirming that inside debt compensation increases risk reduction behaviours, resulting in a higher distance from default.

3.2 Additional Robustness Tests

Alternative Proxy for Default Risk

This section discusses the various robustness tests applied in order to investigate whether the results continue to hold when using alternative default risk proxy. In particular, the Z-score, a common accounting measure used in the literature for distance to insolvency, was applied. All analyses were re-run using the Z-score to assess the robustness of the prior results. Z-score captures the probability of a negative return that increases the chance of default. When the bank Z-score is high, it has relatively higher return to payoff its debt liability, which lower default risk.

The results are presented in Table 3. Overall, the results obtained regarding the association between inside debt holding and Z-score were similar to those in Table 2. This offers support for a positive linkage between inside debt and Z-score. In particular, the coefficient on inside debt is positive and significant at the 10% level. This finding suggests that an increase in CEO inside debt compensation increases the bank's Z-score risk (reduces insolvency risk). CEO tenure is significant at the 10% level. The positive relationship between CEO tenure and Z-score shows that, as the CEO remains in office longer, the bank's Z-score increases (risk reduces).

Overall, tables 2 and 3 show that inside debt positively impacts banking sector stability in Europe. The results from the GMM model indicate that any increase in inside debt compensation will lead to a higher distance to default and a higher Z-score.

Table 3. CEO inside debt compensation and bank insolvency risk using Z-score

Variables	*Model (1)*	*Model (2)*	*Model (3)*
inside debt	0.0155539	0.0143054	0.0146536
	(0.0084673)*	(0.008309)*	(0.0081208)*
Leverage	0.5435042		0.2827596
	(1.321135)		(1.338327)
Charter	0.251708		0.2696788
	(0.2728464)		(0.2506293)
Size	-0.0201489		0.1155052
	(0.0256476)		(0.2593663)
ROA	-0.2267491	-0.1280384	-0.2239558
	(0.1529161)	(0.1813984)	(0.1815608)
Age		-0.0749566	-0.6330934
		(0.1329017)	(1.081561)
Tenure		0.0926635	0.028396
		(0.1592494)	(0.0171985)*
Vega-to-delta		0.074711	0.2083326
		(0.5820265)	(0.5477808)
Cash		0.2456711	0.2760249
		(0.5064197)	(0.5918705)
Crisis dummy			0.9004077
			(0.221)
Hansen J-statistic	11.06355	12.98153	8.759197
Prob(J-statistic)	0.271378	0.235388	0.459793
AR1 (p-value)	0.0017	0.0028	0.0034
AR2 (p-value)	0.2441	0.3672	0.5261

Source: own

Alternative proxy for inside debt

The reported results in Tables 2 and 3 are based on the primary explanatory variable, CEO inside debt ratio. This section presents the results of employing an alternative measure of CEO inside debt. In accordance with the previous literature, an indicator variable that takes a value of one when CEO debt to equity ratio relative to bank debt to equity ratio is greater than one, and zero else, was applied (Borah et al., 2020). Table 4 shows the results of using this indicator variable to represent CEO inside debt.

Table 4. CEO inside debt compensation (alternative measure) and bank distance to default

Variables	*Model (1)*	*Model (2)*	*Model (3)*
inside debt	2.443006	2.140507	2.992691
	(0.7943703)***	(1.044194)**	(1.288384)**
Leverag	-8.416923		-17.83952
	(9.651574)		(11.79031)
Charter	0.9035268		0.3964802
	(0.7268161)		(0.9489506)
Size	0.5063529		-0.873637
	(0.1848395)		(1.008298)

ROA	0.1460413	1.314855	0.8696398
	(0.0850835)	(0.6831991)	(0.7602579)
Age		1.238693	6.130021
		(0.7291792)	(4.388279)
Tenure		0.5026178	1.095487
		(0.8253365)	(0.9916227)
Vega-to-delta		2.014532	1.192346
		(1.766037)	(2.345387)
Cash		2.065642	-0.0692637
		(3.278546)	(2.062575)
Hansen J-statistic	13.92237	13.98068	13.47805
Prob(J-statistic)	0.125113	0.123014	0.127545
AR1 (p-value)	0.0086	0.0037	0.0029
AR2 (p-value)	0.3621	0.2461	0.3431

Source: own

According to Table 4, the relationship between CEO inside debt and bank distance to default remains positive and significant at the 1% level. This finding confirms the notion that inside debt improves bank stability by increasing bank distance to default probability (reducing bank risk)[2].
Future empirical studies may wish to use a non-financial firm's sample to analyse the effect of CEO inside debt holding on firm default risk or focus on non-CEO executives. Moreover, future studies might usefully explore the connection between the default risk and a change in CEO position or the impact of CEOs leaving the job in relation to inside debt compensation.

CONCLUSION

Incentives from equity-based compensation have been the focus of several empirical studies, and the literature commonly discusses how equity-based compensation mitigates managers' risk aversion and aligns managers' incentives with those of shareholders. Debt-based compensation is expected to align managers' interests with debtholders' interests and thus to discourage risk-taking. This study therefore examined how CEOs inside debt holding influences bank default risk. The empirical evidence presented in this study supports the view that inside debt compensation increases managers' risk aversion and suggests that inside debt encourages CEOs to make more conservative choices. Evidence of a positive and significant impact from inside debt compensation on bank distance to default was observed, with more inside debt associated with lower default risk. Awarding the CEO inside debt compensation lowers bank insolvency risk, making CEO inside debt compensation a channel through which to mitigate excessive risk-taking.

The empirical evidence provided in this study highlights the usefulness of inside debt as part of the CEO optimal compensation contract, which should be noted by regulators and stakeholders. Finally, this study supports the theory that debt-based compensation is an effective tool to reduce the agency cost of debt, concluding that inside debt helps to increase bank stability. The study also highlights how managerial compensation plays a clear role in shaping managerial incentives, offering empirical support to policymakers interested in enhancing bank stability by shaping managerial incentives.

[2] Following Ozili (2017), year 2008 bank-observations were excluded for robustness check and to rule out that the last credit crisis is not driving the main results of this study. The results obtained after doing this are very similar. Theses results are not reported for the sake of brevity.

REFERENCES

Arellano, M., Bover, O. (1995), "Another look at the instrumental variable estimation of error-components models", *Journal of econometrics*, Vol. 68, No. 1, pp. 29-51.

Belkhir, M., Boubaker, S. (2013), "CEO inside debt and hedging decisions: Lessons from the US banking industry", *Journal of International Financial Markets, Institutions and Money*, Vol. 24, pp. 223-246.

Bennett, R.L., Güntay, L., Unal, H. (2015), "Inside debt, bank default risk, and performance during the crisis", *Journal of Financial Intermediation*, Vol. 24, Vol. 4, pp. 487-513.

Bhabra, G.S., Hossain, A.T. (2024), "Do CEO risk-reducing incentives affect operating leverage? Evidence from CEO inside debt holdings", *Meditari Accountancy Research*, Vol. 32, No. 3, pp. 693-720.

Bhagat, S., Bolton, B. (2014), "Financial crisis and bank executive incentive compensation", *Journal of Corporate Finance*, Vol. 25, pp. 313-341.

Blundell, R., Bond, S. (1998), "Initial conditions and moment restrictions in dynamic panel data models", *Journal of econometrics*, Vol. 87, No. 1, pp. 115-143.

Borah, N., James, H.L., Park, J.C. (2020), "Does CEO inside debt compensation benefit both shareholders and debtholders?", *Review of Quantitative Finance and Accounting*, Vol. 54, No. 1, pp. 159-203.

Boyallian, P., Ruiz-Verdu P. (2018), "Leverage, CEO risk-taking incentives, and bank failure during the 2007–10 financial crisis", Review of *Finance*, Vol. 22, No. 5, pp. 1763-1805.

Cassell, C.A., Huang, S.X., Sanchez, J.M., Stuart, M.D. (2012), "Seeking safety: The relation between CEO inside debt holdings and the riskiness of firm investment and financial policies", *Journal of Financial Economics*, Vol. 103, No. 3, pp. 588-610.

Coles, J.L., Daniel, N.D., Naveen, L. (2006), "Managerial incentives and risk-taking", *Journal of financial Economics*, Vol. 79, No. 2, pp. 431-468.

Duong, K.T., Banti, C., Instefjord, N. (2021), "Managerial conservatism and corporate policies", *Journal of Corporate Finance*, Vol. 68, 101973.

Edmans, A., Liu, Q. (2011), Inside debt", *Review of finance*, Vol. 15, No. 1, pp. 75-102.

Eisdorfer, A., Giaccotto, C., White, R. (2015), "Do corporate managers skimp on shareholders' dividends to protect their own retirement funds?", *Journal of Corporate Finance*, Vol. 30, pp. 257-277.

Erkan, A., & Nguyen, T. (2021), "Does inside debt help mitigate agency problems? The case with investment inefficiency and payout policies", *Finance Research Letters*, Vol. 39, 101560.

Freund, S., Latif, S., Phan, H.V. (2018), "Executive compensation and corporate financing policies: Evidence from CEO inside debt", *Journal of corporate finance*, Vol. 50, pp. 484-504.

Gropp, R., Vesala, J., Vulpes, G. (2006). Equity and bond market signals as leading indicators of bank fragility. *Journal of Money, Credit and Banking*, 399-428.

Jiang, Y., Shruti, R., Gupta, J. (2024), "Does CEO inside debt enhance firms' access to trade credit?", *Review of Quantitative Finance and Accounting*, Vol. 64, No. 1, pp. 1-33.

Kabir, R., Li, H., Veld-Merkoulova, Y. V. (2013), "Executive compensation and the cost of debt", *Journal of banking & finance*, Vol. 37, No. 8, pp. 2893-2907.

Kato, P., Hagendorff, J. (2010), "Distance to default, subordinated debt, and distress indicators in the banking industry", *Accounting & Finance*, Vol. 50, No. 4, pp. 853-870

Lee, C.F., Hu, C., Foley, M. (2021), "Differential risk effect of inside debt, CEO compensation diversification, and firm investment", *Review of Quantitative Finance and Accounting*, Vol. 56, No. 2, pp. 505-543.

Li, H., Zhao, J. (2020), "Inside debt and firm risk-taking: Evidence from the UK pension reform", *Journal of Business Finance & Accounting*, Vol. 47, No. 9-10, pp. 1316-1364.

Milidonis, A., Nishikawa, T., Shim, J. (2019), "CEO inside debt and risk taking: Evidence from property–liability insurance firms", *Journal of Risk and insurance*, Vol. 86, No. 2, pp. 451-477.

Minhat, M., Abdullah, M. (2016), "Bankers' stock options, risk-taking and the financial crisis", *Journal of Financial Stability*, Vol. 22, pp. 121-128

Ozili, P.K. (2017), "Discretionary provisioning practices among Western European banks", *Journal of Financial Economic Policy*, Vol. 9, No. 1, pp. 109-118.

Rogers, D.A. (2002), "Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivatives usage", *Journal of Banking & Finance*, Vol. 26, No. 2-3, pp. 271-295.

Sheikh, S. (2019), "CEO inside debt, market competition and corporate risk taking", *International Journal of Managerial Finance*, Vol. 15, No. 4, pp. 636-657.

Vallascas, F., Hagendorff, J. (2013), "CEO bonus compensation and bank default risk: evidence from the US and Europe", *Financial Markets, Institutions & Instruments*, Vol. 22, No. 2, pp. 47-89.
Van Bekkum, S. (2016), "Inside debt and bank risk", *Journal of Financial and Quantitative Analysis*, Vol. 51, No. 2, pp. 359-385.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Rsaldin, Y., Tleubayeva, A., Trusheva, S. (2026), "International Experience in the Development of Digital Tourism and Its Influence on Kazakhstan", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 169-187.

International Experience in the Development of Digital Tourism and Its Influence on Kazakhstan

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ARTICLE INFO

Received February 18, 2025
Revised from March 18, 2025
Accepted April 18, 2025
Available online April 15, 2026

JEL classification: L83, Z32, 033, 031

DOI: 10.14254/1800-5845/2026.22-2.14

Keywords:

Digital tourism,
digital transformation,
competitiveness,
digital technologies,
sustainable development,
tourism community.

ABSTRACT

The need for qualitative improvements in the process of tourist service delivery in the context of digital transformation drives the relevance of this study. The effective use of digital technologies, which enable the automation, acceleration, and modernization of these processes, will positively impact the development of tourism in the country. This research aims to identify how the efficient use of digital technologies can influence the country's tourism development level, including its competitiveness and economic contribution. Given global trends in tourism, which are increasingly based on digitalization and the adoption of new technologies, this study is particularly relevant, as it allows the country to keep pace with global standards and the expectations of tourists. The analysis of digital tourism development, with the implementation of international best practices in the Republic of Kazakhstan, is not only timely but also strategically significant for maintaining and enhancing the country's status within the global tourism community. The objective of this study is to analyze the current state and development trends of digital tourism to identify key factors influencing the competitiveness of the tourism industry. Additionally, it aims to develop recommendations for optimizing the use of digital technologies to stimulate economic growth and enhance the tourist experience. Research Hypothesis: digital technologies in Kazakhstan's tourism sector are a key factor in enhancing the country's competitiveness in the global tourism market, meeting the needs of modern tourists, and driving economic growth. The more the state invests in innovative financing, the greater the development of digital tourism will be. Research Results: the author examined the relationship between digital tourism and the system of indicators reflecting the inclusivity of technological development in Kazakhstan's tourism industry. An extrapolation forecast of the indicator "Enterprises with Innovations" for 2023–2024 was conducted, demonstrating the innovative activity of enterprises in the tourism industry. This analysis highlights the trend that innovative financing in tourism can have a significant impact on the development of digital tourism by providing resources for the implementation of new digital technologies and supporting innovative projects.

INTRODUCTION

The increasing demand for online services for booking hotels, flights, excursions, and other travel-related services continues to rise. The development of digital tourism in Kazakhstan, as in other countries, is closely linked to the adoption of new technologies and the evolving needs of modern tourists. The study of digital tourism development is highly relevant for several reasons:

- In the context of global digitalization, tourists increasingly prefer using online platforms for planning and booking their trips. The advancement of digital technologies in tourism is crucial for attracting modern travelers and ensuring their convenience.
- Tourism is a vital sector of the economy, contributing to GDP growth, job creation, and infrastructure development. Digital innovations can enhance the efficiency of the tourism industry, which is essential for the country's economic progress.
- Countries actively implementing digital technologies in tourism become more competitive in the global market. This includes not only the development of online platforms but also the use of data analytics, virtual technologies, artificial intelligence, and other innovations.
- Modern tourists expect convenience and easy access to information in digital formats. Analyzing the development of digital tourism will help assess how well the country meets the expectations and requirements of digital consumers.
- Digital technologies can be leveraged to ensure tourist safety and effectively manage visitor flows, which is particularly important in the post-pandemic world.
- Research on digital tourism will identify current trends and innovations in the industry, providing valuable insights for developing strategies and attracting investors.
- Analyzing digital tourism development can serve as an important tool for shaping government policies in tourism, including initiatives aimed at supporting innovation and digital transformation.

Overall, this study will not only provide an overview of the current state of digital tourism in Kazakhstan but will also serve as a foundation for developing strategies for the further growth of this key economic sector.

1. LITERATURE REVIEW

Tourism, as an important component of economic growth and recovery, has a significant impact on various aspects of public and economic activity. Recent studies, such as the work of T.Dogru and U. Bulut (2018), emphasize that tourism resources play a key role in successfully attracting tourists and investors. The availability of attractive locations and facilities can contribute to an increase in tourist flow, which, in turn, benefits economic development (Li et al., 2019). In her research, E. Shumakova (2019, p. 400) focusing on the peculiarities of innovations in the hotel industry, primarily emphasizes organizational and managerial innovations and the development of innovative hotel infrastructure.

The issues of innovative development in the hotel industry have been given considerable attention by scholars such as: A. Abozhina (2017), J. Hao & Y. Liu (2013), R. Musavengane (2019), M. Myratdurdiev & Y. Doroshenko (2017), A. Tanina et al. (2020). The development of digital platforms has increased the diversity and quantity of tourism products, services and experiences, accelerating the pace of economic transactions, market awareness and feedback. These transformations have enabled all sectors of the tourism industry to better meet consumer demand, while promoting the development of new markets, opening up new opportunities for the long-term development of the tourism industry (Dredge et al., 2019).

Existing studies have proven the feasibility of using modern technologies in the exploration, extraction, monitoring and protection of tourism resources, and the application of remote sensing, GIS, databases and other technologies can provide a strong impetus for the prosperity of tourism (Ying, et al., 2024).

An important aspect of the relationship between tourism and digital technologies is the effective management of financial resources in the tourism industry. Studies conducted by W. Chen et al. (2023) and J. Tian et al. (2021) emphasize that optimal distribution and smart allocation of financial resources contribute to more efficient use of social resources. Proper financial management in the tourism industry can lead to increased revenue and improved quality of tourist services. The effectiveness of utilizing innovative

potential, according to A. Kulmagambetova et al. (2019, p. 57) is determined not only by the level of scientific research and development but also by a combination of corresponding technical, production, organizational, marketing, and financial operations included in innovation processes.

In light of the digital transformation of tourism, these financial management principles can also be directed toward the implementation of digital innovations. Investments in digital technologies, such as virtual tours, mobile applications, online booking, and other digital services, can not only increase the attractiveness of tourism resources but also optimize business processes, ultimately contributing to the overall development of the tourism industry. Digital tourism can complement and enrich various types of tourism, providing tourists with convenient and interesting options for interaction with different aspects of travel in Kazakhstan and influencing various types of tourism (Table 1).

Table 1. Types of Tourism in Kazakhstan According to the Tourism Sector Product Matrix

	Health and Wellness Tourism	*Business Tourism*	*Sports Tourism*	*Religious Tourism*	*Educational Tourism*	*Social tourism*	*Cultural-Cognitive Tourism*	*Adventure Tourism*	*Congress Tourism*	*Eco tourism*
MICE-tourism		■							■	
Beach tourism	■		■					■		■
Short-term recreation	■		■	■	■	■	■	■		■
Mountain and Lake Recreation	■		■		■	■	■	■		■
Adventure recreation			■			■		■		■
Cultural tourism				■	■	■	■			■

Source: Compiled by the author

Digital tourism influences various types of tourism in the following ways:

- Cultural Tourism – Digital technologies can offer virtual tours of cultural and historical sites, attracting those interested in cultural landmarks.
- Nature Tourism – Mobile applications and digital guides can provide information on natural attractions, hiking routes, ecological factors, etc.
- Extreme Tourism – Digital platforms can offer information on locations for extreme recreation, as well as simplify booking processes.
- Business Tourism – In the business tourism sector, digital technologies can facilitate virtual conferences, webinars, and other business events.
- Medical Tourism – In the field of medical tourism, digital platforms can enable online consultations and advance bookings for doctor appointments.
- Gastronomic Tourism – Digital platforms can provide information on restaurants offering local cuisine, as well as reviews and ratings.

The article by Gretzel, et al. (2015) provides the foundation and development of the concept of "smart tourism," discussing how information and communication technologies transform the tourism industry. In the work of D. Buhalis & A. Amaranggana, A. (2015), the authors explore how "smart" tourist destinations can enhance the traveler experience through service personalization using digital technologies. Y. Li et al. (2017) present the concept of "smart tourism" in the context of tourist information services, discussing its components and impact on the industry. C. Koo, et al. (2015) propose a conceptual model of the competitiveness of "smart" tourist destinations, emphasizing the role of technologies in enhancing the attractiveness of destinations. The article by U. Gretzel et al. (2015) examines the conceptual foundations for understanding the ecosystems of "smart tourism," including the interaction between various stakeholders and technologies.

These works collectively provide valuable insights into how digital and smart technologies are reshaping tourism, from enhancing experiences to improving destination competitiveness. Would you like help analyzing or summarizing any of these studies in more detail? Based on the study of literature sources on the implementation of international experience in Kazakhstan, the problems of digital tourism development have been identified (Table 2).

Table 2. Problems of Implementing International Experience in the Development of Digital Tourism in Kazakhstan

№	*Problem*	*Justification*	*Result*
1	Inadequate digital infrastructure	In Kazakhstan, especially in rural and remote regions, there is a lack of necessary digital infrastructure, such as high-speed internet.	This significantly limits the opportunities for the development of digital tourism.
2	The low level of digital literacy	Many representatives of the tourism industry and service users are insufficiently prepared to use modern technologies.	This reduces their ability to effectively use digital platforms and tools.
3	Data fragmentation	The lack of a unified platform for managing tourism information and coordinating between stakeholders.	It hinders the creation of integrated digital solutions.
4	Limited funding	Investments in tourism digitalization are insufficient, which hinders the implementation of innovative technologies and the adaptation of best international practices.	
5	Legal and regulatory barriers	The legal framework for digitalization of tourism in Kazakhstan needs modernization.	Incomplete regulation of the use of big data, artificial intelligence, and digital platforms limits the potential of the industry.

Source: compiled by the author

Therefore, a comprehensive approach is required, combining infrastructure development, staff training, modernization of the legislative framework, and attracting investments. Given the unique geographical and cultural characteristics of the country, the digitalization of tourism can become a key driver of economic growth and international attractiveness for Kazakhstan as a tourist destination.

2. RESEARCH METHODS

To construct the trend model, the least squares method (LSM) was used, which minimizes the deviations between the original data and the theoretical function. Based on the developed model, point and interval forecasts of the number of enterprises with innovations in the tourism sector were made, considering confidence intervals to assess potential fluctuations. To identify the key factors influencing the dynamics of the number of enterprises with innovations, the principal component analysis (PCA) method was applied. This method helped reduce the data's dimensionality without losing significant information and allowed for the identification of key trends. The data were visualized to:

- Identify trends, seasonal and cyclical fluctuations;
- Check the adequacy of the model by comparing calculated and actual values;
- Present forecast values as point and interval graphs.

The comprehensive application of these methods allowed for an in-depth study of the dynamics of enterprises with innovations, identification of significant patterns, and the development of a reliable forecasting model. It also ensured a high-quality analysis and interpretation of the results, necessary for making strategic decisions.

3. MAIN PART

The business world is constantly changing under the influence of technologies, trends, and global events. In this sense, the digital sphere is one of the most dynamic and key trends, with marketing playing an increasingly central role and becoming more deeply integrated into the business structure, including the tourism industry. Tourism companies, operating within the current economic and political system, are under intense pressure due to fierce competition to maintain and improve their market position. In such conditions, only companies with high competitiveness can remain stable and have the opportunity to

grow—competitiveness being an integral characteristic that includes both financial and non-financial indicators, such as new technologies, innovative business methods, etc.

According to a survey by Euromonitor International, *Voice of the Industry: Travel Survey* conducted in 2022, the immediate business priorities for companies are focused on brand development and finding new growth areas, whether through new sales channels, mergers and acquisitions, or innovations. These were indicated by 53% and 44% of respondents, respectively. Investing in new technologies was chosen by 33% of respondents in 2022, compared to 38% in 2021. This decrease is likely due to the fact that during the pandemic, companies already invested significantly in the development of online channels, accelerating the digitalization of the industry by several years. Now, the focus has shifted more towards the consumer and the quality of the product. Globally, the share of online bookings has increased from 59% in 2019 to 65% in 2022. The stress that the tourism sector faced has led many companies to adopt various consumer-oriented innovative and digital solutions, as well as multi-channel strategies for interacting with customers (Figure 1).

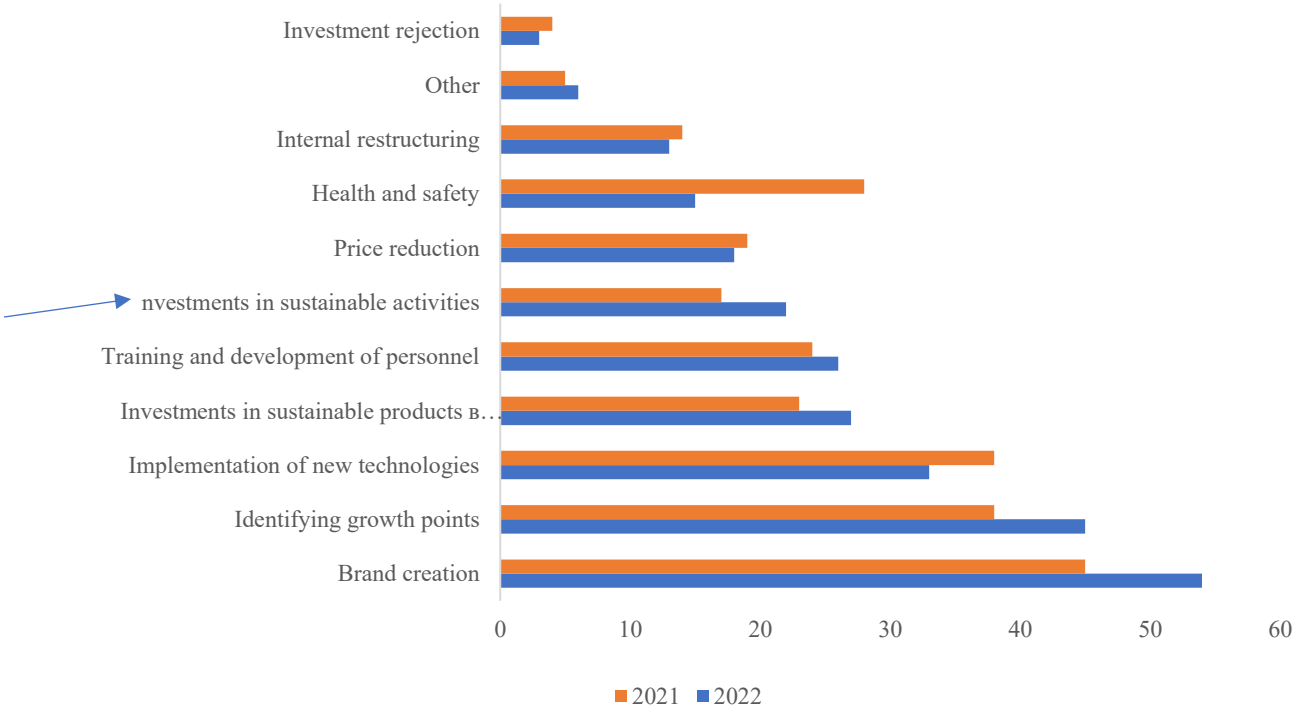

Figure 1. Business Goals of Tourism Companies in 2021-2022
Source: Compiled based on the source: https://tourismonline.kz/

In the modern tourism industry, companies are striving to master a variety of innovative and digital solutions, as well as implement multi-channel strategies for interacting with consumers. The main areas of development in this field are illustrated in Figure 2.

The use of innovative and digital solutions helps tourism companies not only attract new clients but also improve the satisfaction and loyalty of existing ones. When choosing between priorities for the next 3-5 years, 58% of respondents indicate the need to improve the customer experience, while 48% highlight the implementation of new technologies in 2022, compared to 53% and 52%, respectively, in 2021. Furthermore, the interest in creating loyalty holds significantly less weight compared to flexibility and personalization, as consumers increasingly expect tourism companies to understand and meet their individual needs at the right time. Additionally, 38% of respondents consider investments in sustainable products and services as one of the main priorities for the next 3-5 years (Figure 2).

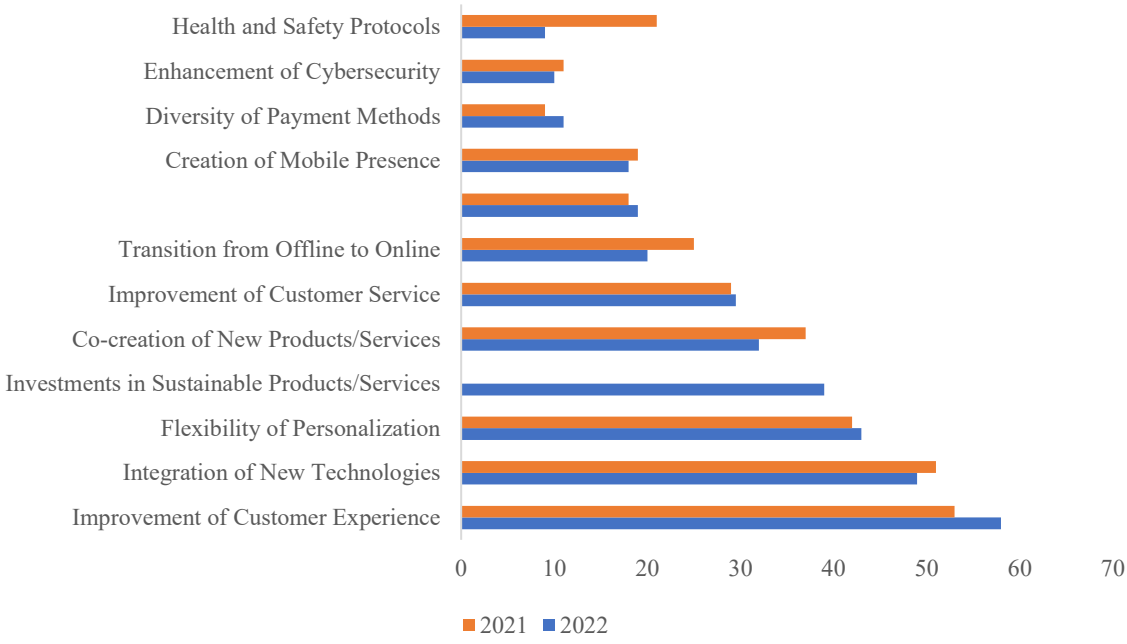

Figure 2. Business Goals of Tourism Companies for the Next 3-5 Years
Source*:* compiled by the authors according to https://tourismonline.kz/

Consumers are showing increasing engagement in sustainable travel, and companies are adopting a comprehensive approach to developing their activities in line with sustainable development goals. They aim to meet the changing expectations and preferences of consumers. Let's explore some key aspects:

A. Sustainability and Environmental Responsibility:

- Developing strategies aimed at reducing the environmental impact is becoming an integral part of companies' operations, especially in the aviation industry.
- The use of more eco-efficient fuels and innovative concepts such as electric aviation demonstrates a commitment to reducing the carbon footprint.

B. Innovative Payment and Subscription Models:

- The introduction of new payment models like "Buy Now, Pay Later" allows customers to manage their finances more flexibly, especially when planning trips.
- Subscription models offered by airlines provide convenience and predictability for customers, allowing them to use services at a fixed cost.

C. Personalized Experience and Dynamic Travel:

- The development of personalized options is crucial for attracting and retaining customers. Companies strive to offer unique and tailored services that meet the individual needs of each customer.
- On-demand service ordering options enhance the travel experience, giving customers the ability to choose and control their journey.

D. E-wallets and Convenient Financial Tools:

- The implementation of internal e-wallets and innovative financial tools reflects the effort to ensure the convenience and security of financial transactions for clients in the tourism industry.

E. Contingency Solutions for Potential Problems:

- Given the current pandemic situation, providing Covid-19 insurance has become an important element of reassurance for travelers.

These innovations emphasize companies' efforts to meet the growing expectations of modern consumers, who are increasingly focused on convenience, personalization, and sustainability when planning their travels. The main technologies companies plan to invest in over the next five years are big data and analytics and artificial intelligence, selected by 66% and 49% of respondents, respectively (Figure 3).

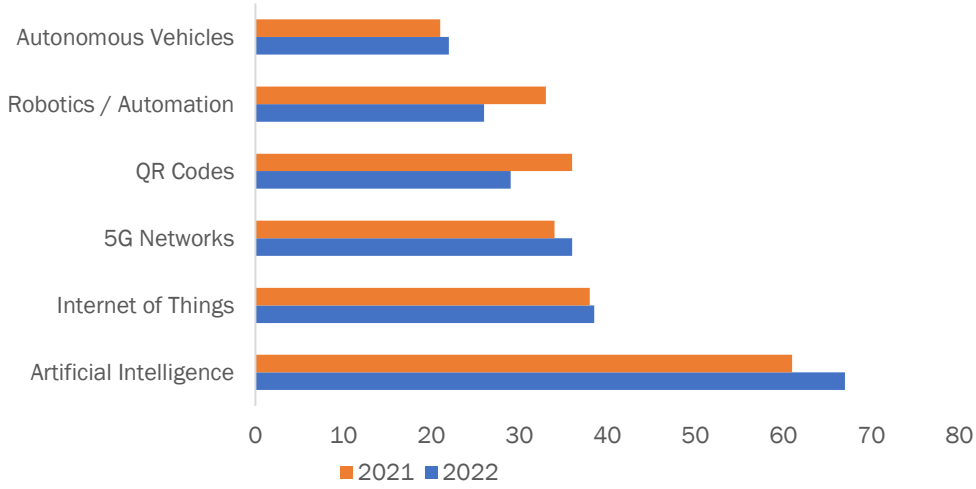

Figure 4. Technologies Influencing the Tourism Business in the Next 5 Years
Source*:* compiled by the authors according to https://tourismonline.kz/

Moreover, cloud solutions play an important role in enhancing customer experience and personalization. Meanwhile, the long-term importance of artificial intelligence, 5G networks, geospatial data, and QR codes has decreased. This is likely due to the fact that these technologies have already reached their critical mass and are no longer seen as innovative. These trends reflect the evolving priorities of companies in the context of technological transformation. Let's consider some aspects related to investments in various technologies (Table 3).

Table 3. Technological transformation of travel companies

№	*Technologies (Innovations)*	*Features*
1	Big Data and Analytics	Investments in Big Data and analytics remain a priority, as these technologies enable companies to process and analyze large volumes of data to make more informed strategic decisions.
		Data analytics is highly significant for the tourism industry, allowing companies to better understand customer preferences and optimize their services.
2	Artificial Intelligence (AI)	AI continues to be a focal point as companies seek ways to automate processes, enhance personalization, and create more intelligent systems.
		In the tourism industry, AI can be applied to provide personalized recommendations, manage bookings, and predict customer needs.
3	Cloud Solutions	Cloud technologies remain a crucial factor for ensuring flexibility, scalability, and accessibility of data and applications.
		In the tourism industry, cloud solutions allow companies to manage bookings, analyze data, and provide real-time access to information.
4	5G Networks	While interest in 5G may decrease over the next five years, this technology will remain a key element for providing high-speed and stable internet in the future.
		5G can play a crucial role in enhancing the quality of connectivity and improving the travel experience, including the use of virtual and augmented reality.
5	Geospatial Data and QR Codes	The reduced interest in geospatial data and QR codes may be due to the fact that these technologies are already widely used and have become standard practices.
		They will continue to be important for providing accurate location-based information and facilitating interaction with services.

Source: Compiled by the author

These technological directions are balanced and combined to ensure a comprehensive approach to enhancing customer experience and optimizing operations in the tourism industry. AI plays a significant role in the transformation of the tourism industry, providing an improved and innovative experience for travelers (Figure 4).

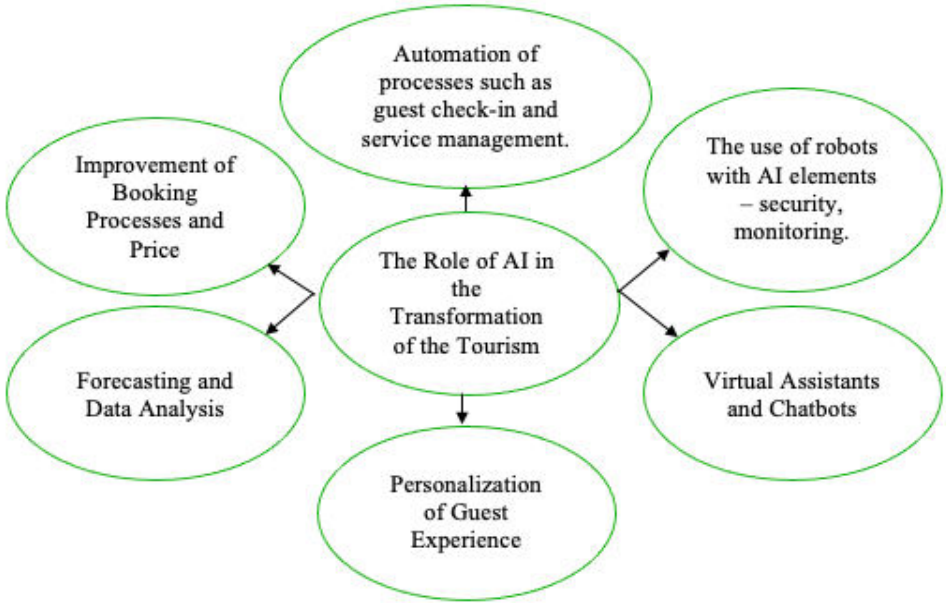

Figure 4. The Role of AI in the Transformation of the Tourism Industry
Source: Compiled by the author.

The use of artificial intelligence in tourism improves business process efficiency, enriches the customer experience, and contributes to a more innovative and competitive industry landscape. For example, the CityPass Kazakhstan project is an equivalent of the globally recognized tourist card practice, launched in Kazakhstan in 2017. This tourist card is currently operating successfully in the cities of Astana, Almaty, and Burabay, with a joint card for tourists in the cities of Turkestan and Shymkent, called the Silk Way Pass, planned for launch this year. CityPass provides free access to all attractions, museums, and tours included in the program, and the validity of the online card begins upon activation at the first visited location.

Personalization and a consumer focus can become an important solution for creating niche products and services for different groups of travelers. For instance, the Wheel the World booking platform is designed for people with disabilities. By collaborating with partners, the company offers accommodation services, tours, and events that meet the unique needs of consumers through personalized service.

Although the tourism and travel industry is expected to reach pre-pandemic levels no earlier than 2024, it is essential to shift from a quantity-driven model to a quality-driven one. Today, companies have access to digital tools that not only help create new products and build emotional connections with consumers but also achieve climate and sustainability goals.

Due to its geopolitically favorable location, natural recreational resources, and world-class cultural and historical heritage, Kazakhstan has the potential to develop new tourist products and can become one of the main players on the global tourist map, as it meets all the necessary basic conditions. As a result, new businesses are opening in the restaurant, sports, cultural, souvenir, and retail sectors.

The development of the tourism industry and related infrastructure is identified as a key direction within the framework of the State Program for the Development of the Tourism Industry of the Republic of Kazakhstan for 2019-2025. However, the tourism sector in Kazakhstan remains a weak link in the overall development of the country despite various attempts to improve it.

Meanwhile, according to the report on the results of monitoring the implementation of budget programs (subprograms) of the Ministry of Culture and Sports of the Republic of Kazakhstan, the volume of

services provided by accommodation establishments in the regions has shown an increasing trend (Figure 5). In the regional context of tourism development and the corresponding volume of services provided, the following regions stand out:

- Almaty: 25,710,759.7 thousand KZT
- Astana: 22,829,527.6 thousand KZT
- Aktobe Region: 12,843,773.9 thousand KZT
- East Kazakhstan Region: 5,889,224.5 thousand KZT
- Atyrau Region: 5,371,264.6 thousand KZT

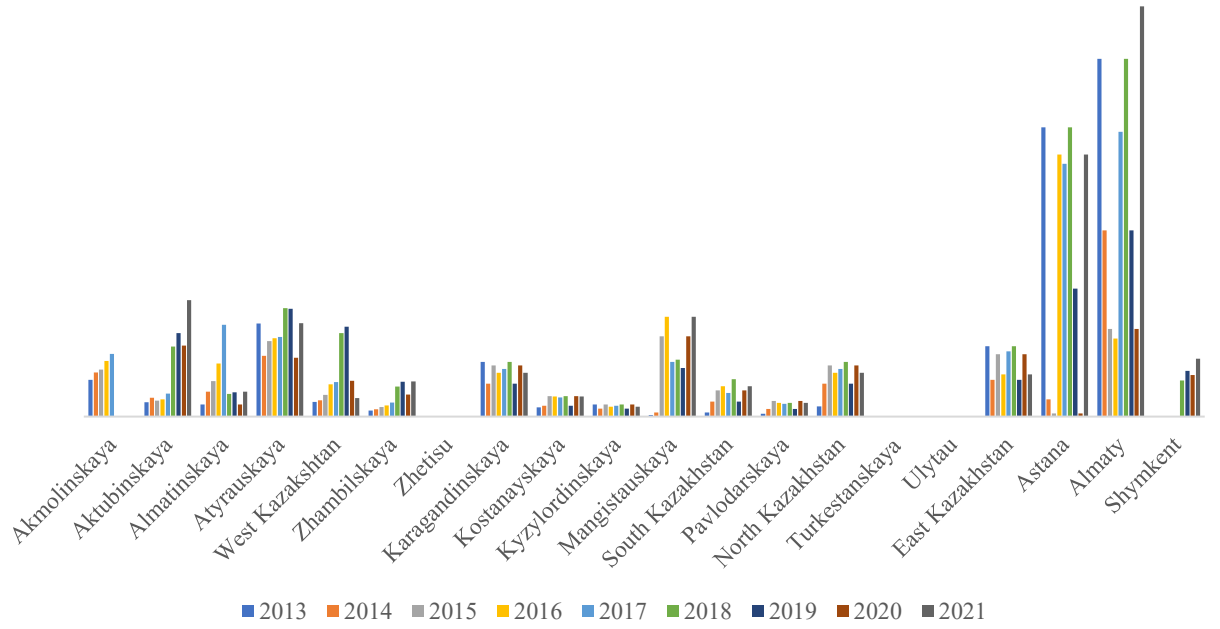

Figure 5. Volume of services provided by accommodation establishments across regions of the Republic of Kazakhstan, in thousand tenge
Source: Compiled based on data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for 2013-2021. [Electronic resource] URL: https://www.stat.gov.kz

In the context of digital tourism development, these regions—Almaty, Astana, Aktobe Region, East Kazakhstan Region, and Atyrau Region—offer certain prospects and opportunities (Table 4).

Table 4. Prospects and Opportunities for the Development of Digital Tourism

Region	Volume of services provided, thousand tenge	Prospects and Opportunities
Almaty	25710759,7	- Development of digital platforms for virtual tours of historical and natural landmarks in the region
		-Implementation of mobile applications with geolocation for the convenient movement of tourists around the city
Astana	22829527,6	-Creation of digital information platforms for hosting virtual conferences and business events
		- Development of mobile applications for tourists with interactive maps and recommendations for gastronomic and cultural tourism
Aktubinskaya	12 843773,9	- Use of digital platforms for promoting eco and nature tourism in the region
		- Development of online platforms for booking tours and services within regional nature reserves
East Kazakhstan region	5889224,5	- Implementation of virtual reality technologies to create interactive tours of historical sites and natural corners of the region
		- Development of online platforms for booking various types of tourist services

Atyrauskaya	5 371 264,6	- Implementation of digital systems for managing tourism infrastructure to optimize the services provided
		- Creation of mobile applications providing information about local cultural events and gastronomic offerings

Source: Compiled by the author based on the source

The combination of these initiatives and innovations in the sphere of digital tourism across these regions can stimulate tourist interest by providing a more convenient and interactive experience while fostering the sustainable development of Kazakhstan's tourism industry. Kazakhstan possesses significant tourism potential; however, no single region is currently capable of becoming a fully attractive and accessible tourist destination that enjoys high popularity among international tourists. Therefore, a concentrated effort to enhance the national strategic management system in the tourism sector is necessary, considering modern innovative solutions in digital tourism. Digital technologies in tourism should be developed and utilized in a way that ensures equal access and meets the needs of diverse tourist audiences, thereby contributing to the inclusive development of the industry in Kazakhstan. The author analyzed the relationship between digital tourism and the system of inclusivity indicators for the technological development of the tourism industry in the Republic of Kazakhstan (Table 5 - URL:/https://www.stat.gov.k).

Inclusivity of technological indicators refers to how accessible and applicable these technologies are to various population groups, including people with disabilities, individuals from different social strata, and more. Digital technologies in tourism can promote inclusivity by providing access to information, services, and travel opportunities for all categories of tourists. The ease of using online platforms and mobile applications supports the inclusion of groups that might face challenges when using traditional booking methods. Digital technologies in tourism can make travel information more accessible and simplify the processes of booking and interacting with services for diverse categories of tourists. In the context of digital tourism, the opportunities provided by Kazakhstan's recreational zones and historical and cultural heritage can be effectively leveraged to promote digital tourism and strengthen domestic tourism within the country:

- Digital virtual tours
- Digital guides and applications
- Interactive online events
- Online booking platforms
- Social media and marketing
- Educational resources

All these measures can create an innovative digital environment that enhances Kazakhstan's attractiveness as a tourist destination, thereby ensuring sustainable growth in domestic tourism and stimulating the development of related sectors of the economy.

Table 5. System of indicators for the inclusivity of technological development in the tourism industry of the Republic of Kazakhstan

Indicator	*01.2014*	*01.2015*	*01.2016*	*01.2017*	*01.2018*	*01.2019*	*01.2020*	*01.2021*	*01.2022*	*01.2023*
Hotel occupancy rate per bed, %.	27,35	23,13	22,80	22,70	25,00	23,20	23,70	17,3	22	24,5
Number of rooms in accommodation facilities, units	41197,00	49128,00	53126,00	60427,00	65791,00	71858,00	75913,00	77131	79820	84416
Level of innovative activity of enterprises across all types of innovations, %.	8,0	8,1	8,1	9,3	9,6	10,6	11,3	11,5	10,5	12,0
Number of visitors served by accommodation facilities for inbound tourism (non-residents), persons.	586 038	679 018	692 213	722 515	891 911	830 922	979 781	252 726	329 754	609 803
Volume of services provided by accommodation facilities, thousand tenge.	59714164,2	72401941,1	72597228,3	82853434,6	108359760,4	103948256,9	120527162,1	66860328,5	109027262,7	129183176,7
Indicators of ICT usage, %.	6,7	7,1	11,5	4,4	1,5	1,6	5,4	7,4	8,5	9,3
Accommodation and catering services, million tenge.	36 218	49 373	48 336	80 780	129 496	192 132	148 385	143 236	173 730	182325
Arts, entertainment, and recreation, million tenge	97 796	113 523	113 630	68 779	75 132	104 210	155 896	351 043	264 499	364000

1. Average Value (Mean):

- The mean is calculated as the sum of all observations divided by the number of observations:

$$\text{Mean} = \frac{\Sigma^{n} i=1\ xi}{n}$$

where:

xi – represents each individual observation;
n - is the total number of observations..

For the indicator hotel occupancy (bed capacity utilization) (%):

$$\text{Mean} = \frac{27{,}35+23{,}13+22{,}80+22{,}70+25{,}00+23{,}20+23{,}70+17{,}30+22{,}00+24{,}50}{10} = 23{,}168.$$

2. Standard deviation (StdDev):

- The standard deviation shows how much values deviate from the mean:

$$\text{StdDev} = \sqrt{\frac{\Sigma^{n} i=1\ (xi-\text{Mean})^{2}}{n}}$$

where:

xi – indicator value;
Mean – mean value
n – number of observations.

$$\text{StdDev} = \frac{(27{,}35-23{,}168)^{2}+(23{,}13-23{,}168)^{2}+\cdots+(24{,}50-23{,}168)^{2}}{10} =$$

3. Minimal value (Min):

- The minimum value is defined as the smallest of all values in the dataset:

$$\text{Min} = \min(x1, x2,\ldots,xn)$$
$$\text{Max} = \max(x1, x2,\ldots,xn)$$

Min = 17.3, Max = 27,35

4. The calculations for all indicators are as follows (Table 6):

$$\text{Mean} = \frac{41197+49128+53126+\cdots+84416}{10}$$

$$\text{StdDev} = \sqrt{\frac{\Sigma^{10} i=1\ (xi-\text{Mean})^{2}}{10}}$$

Min = 41197, Max = 84416

Table 6. Calculations for all indicators

Indicator	*Mean*	*StdDev*	*Min*	*Max*
Hotel occupancy rate (beds) , %	23,168	2,561621882063523	17,3	27,35
Number of rooms in accommodation facilities, units	65880,7	14465,19617756895	41197,0	84416,0
Level of innovation activity of enterprises across all types of innovations , %	9,9	1,5025903559446192	8,0	12,0
Number of visitors served by accommodation establishments for inbound tourism (non-residents), persons	657468,1	229352,9447895875	252726,0	979781,0
Volume of services provided by accommodation establishments, thousand tenge	92547271,55	24522806,21330199	59714164,2	129183176,7

ICT usage indicators , %	6,340000000000001	3,204580055691124	1,5	11,5
Accommodation and food services, million tenge	118401,1	59690,039205232 74	36218,0	192132,0
rts, entertainment, and recreation, million tenge	170850,8	112885,83784297796	68779,0	364000,0
Note –				

Source. Compiled based on the calculations made

The application of innovative methods in the tourism industry is a key factor for its sustainable development and competitiveness. Innovations in the tourism industry not only enrich the experience of tourists but also contribute to the sustainable and long-term development of the sector as a whole. The implementation of modern technologies and creative approaches helps the industry remain relevant and attractive to contemporary consumers. In the context of globalization and the digitalization of the economy, the government focuses on creating incentives for innovation in supporting SMEs. In this regard, the author conducted an analysis of the indicator for enterprises that have innovations (Figure 6).

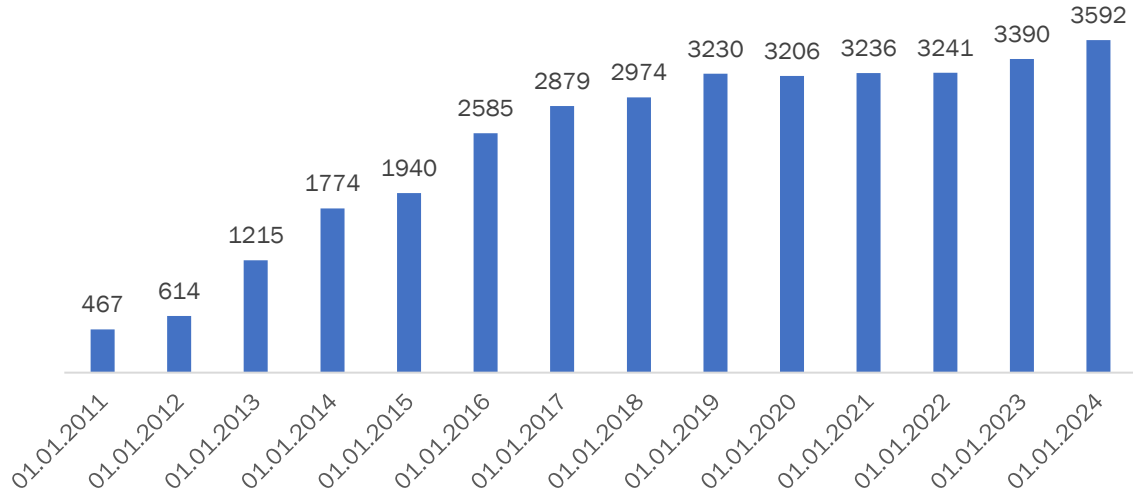

Figure 6. Dynamics of enterprises with innovations, units
Source: Compiled by the author based on the source: Electronic resource: Data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan //www.stat.gov.kz

Initially, using the Irwin criterion, it was verified that the original time series did not contain anomalous observations (Table 7- https://www.pwc.com/kz).

Table 7. Checking for the presence of anomalous observations in the time series of enterprises with innovations

№	*Year*	*Observed value of the Irwin criterion*
1	01.01.2011	
2	01.01.2012	0,1402
3	01.01.2013	0,5732
4	01.01.2014	0,5331
5	01.01.2015	0,1583
6	01.01.2016	0,6151
7	01.01.2017	0,2804
8	01.01.2018	0,0906
9	01.01.2019	0,2442
10	01.01.2020	0,0229
11	01.01.2021	0,0286

12	01.01.2022	0,0047
13	01.01.2023	0,1404
14	01.01.2024	0,1903

Source: Compiled by the author based on the calculations made

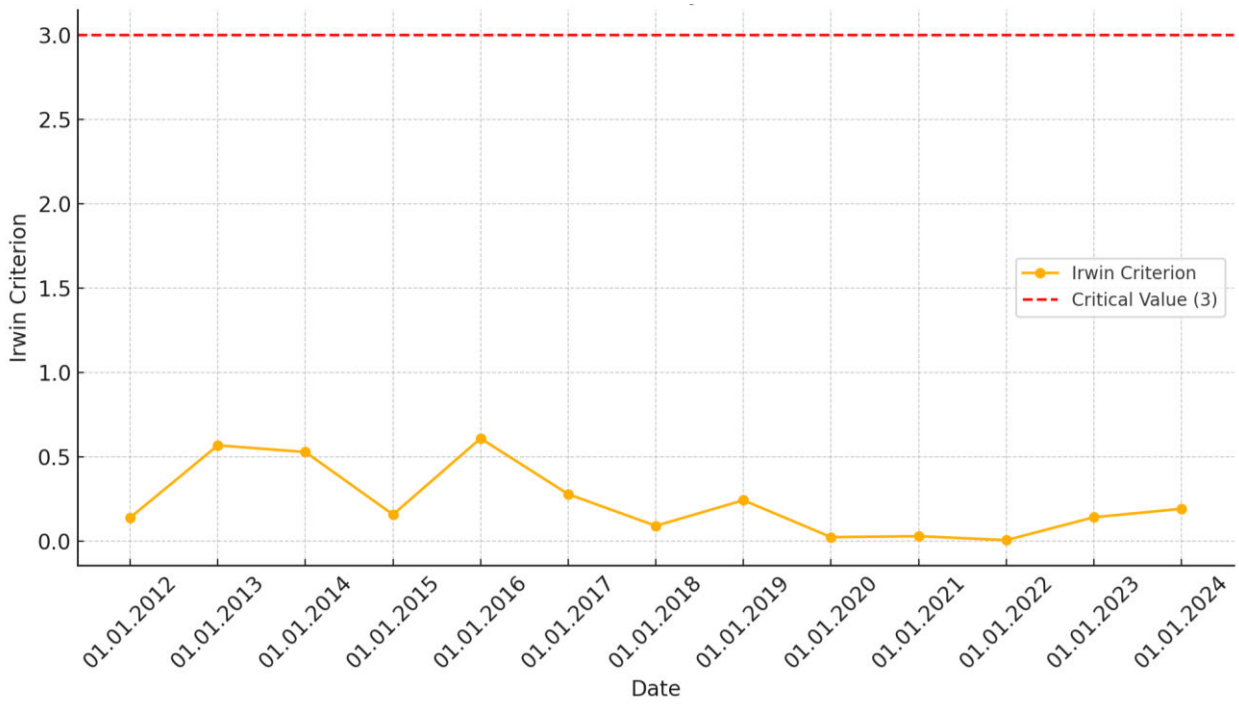

Figure 7. Irwin Criterion Analysis Over Time
Source: compiled by the authors

The graph demonstrates the changes in the observed values of the Irwin criterion over time. The red dashed line represents the critical value (3), above which points may be identified as anomalies. The observed value of the Irwin criterion is calculated using the formula:

$$\lambda_t = \frac{|y_t - y_{t-1}|}{\sigma_y}, \; t = \overline{2,15} \qquad (1)$$

Critical value of the Irwin criterion $\lambda_t < 3$ (All observed values of the Irwin criterion are below the critical value), indicating the absence of anomalous observations. Using the criterion of 'ascending' and 'descending' series, it was found that the series has a trend component:

- General form of the 'ascending' and 'descending' series criterion (to identify a trend, it is sufficient to violate at least one inequality):
- $\nu(n) > \left[\frac{2n-1}{3} - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$ at the calculated value with the probability of error $0{,}05 < \alpha < 0{,}0975$ = 3 < 4;
- $K_{\max} < [K_0(n)]$ at the calculated value with the probability of error $0{,}05 < \alpha < 0{,}0975$ = 8 > 5.

Using the method of least squares, which minimizes the distance between the function graph and the original data, the approximation of the original data was performed. As a result, the following linear trend model was obtained:

$$y_t = 910{,}3714 + 237{,}3385t$$

This model shows that the indicator increases by 237.3385 with each time step. To assess the adequacy of the model, an analysis of the residuals was conducted, taking into account the following characteristics: checking the equality of the expected value to zero, the randomness of the residuals, and their compliance with the normal distribution law:

A. The 'peaks' (turning points) criterion gave a value of 4 > 2, which confirms the adequacy of the model;

B. Property being tested – normality: RS criterion $RS = \frac{e_{max} - e_{min}}{S}$ With the obtained value of 3.115 (boundary 2.67-3.69) – it corresponds.

C. Property being tested – equality of the expected value of the residuals to zero: t-statistic $t_{набл.} = \frac{|\bar{e}|}{S}\sqrt{n}$

With the obtained value of 0 – it corresponds, confirming the adequacy. To assess the accuracy of the model, the mean relative approximation error was calculated:

$$E_{отн.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t} \cdot 100\% = 22{,}15\%,$$

The value of which indicates an acceptable level of model accuracy. This model is quite reliable and suitable for forecasting. The results of point and interval forecasting for 2024-2026 are presented in Figure 8.

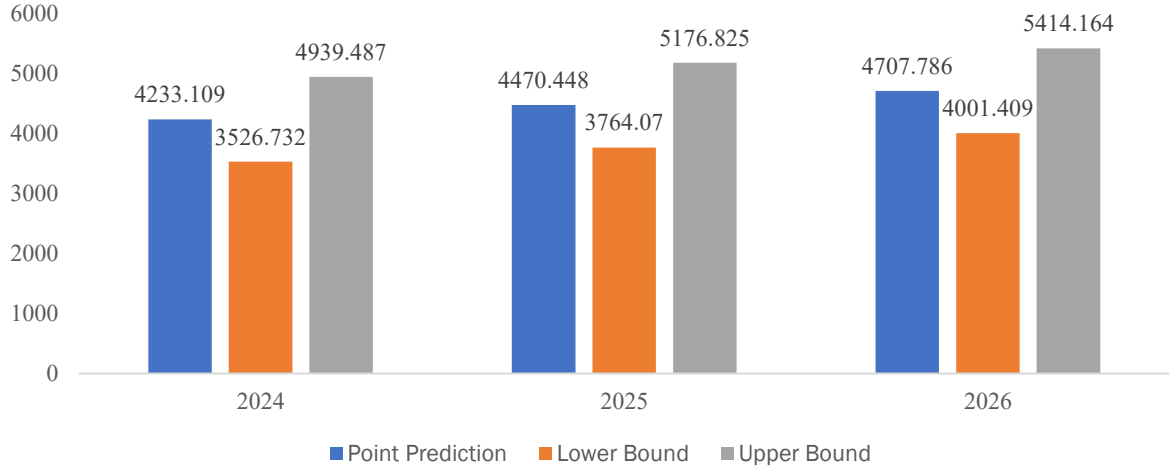

Figure 8. Point and interval forecasts of the number of enterprises with innovations for 2024-2026.
Source: Compiled by the author based on the calculations made.

Innovation funding in tourism can have a significant impact on the development of digital tourism, providing resources for the implementation of new digital technologies and supporting innovative projects (Figure 9).

Figure 9 - Methods of innovation funding that contribute to the development of digital tourism
Source: Compiled by the author

According to Figure 8, the methods of innovation funding that contribute to the development of digital tourism show the following trends:

A. Research and Development (R&D):
- Innovation financial instruments can be directed towards funding research and development projects in the field of digital technologies for tourism.
- Grants and investments can stimulate the creation of new digital solutions such as apps, virtual tours, and virtual reality technologies.

B. Startups and Incubators:
- Funding for startups specializing in innovative technologies for tourism can foster the emergence of new players in the industry.
- Incubators and accelerators supported by investments can stimulate the development of tech startups in the tourism sector.
- Infrastructure and Services:
- Funding for the creation and modernization of digital infrastructure in tourist areas, including high-speed internet, mobile applications, and electronic platforms.
- The development of digital services for tourists, such as online booking, mobile guides, and platforms for information exchange.
- Training and Professional Development:
- Investments in the training of tourism industry workers in digital skills.
- Support for professional development programs for tourism enterprises aimed at the effective use of digital tools.
- Marketing and Promotion:
- Funding for digital marketing campaigns to promote tourist destinations through online channels.
- Investments in the use of innovative advertising methods, such as virtual and augmented reality.

Innovation funding becomes a key driver for the development of digital tourism, promoting the implementation of new technologies, improving the tourist experience, and creating competitive advantages for the tourism industry. The more the government invests in innovation funding, the more digital tourism will develop in Kazakhstan (Gretzel et al., ????).

State investments in innovation funding in the field of digital tourism can bring numerous benefits and stimulate the development of the tourism industry. Here are several reasons why large government investments can positively impact the development of digital tourism:

- Large investments can contribute to the creation and implementation of advanced digital technologies in tourism, such as virtual reality, artificial intelligence, interactive apps, and other innovative solutions.
- Funding can be directed towards the development of high-speed internet connections, the creation of digital information platforms, and the provision of modern digital infrastructure in tourist areas.
- Investments in education and training programs for tourism industry workers on the use of digital tools can improve professional skills and service levels.
- Funding for startups and innovative projects in digital tourism can stimulate the emergence of new ideas and solutions, enhancing the competitiveness of the industry.
- Government investments create favorable conditions for industry development, which can increase the global competitiveness of the tourist destination.
- Innovation funding can stimulate private companies and entrepreneurs to invest in the development of digital tourism, increasing the overall volume of investments.
- Investments allow for the creation of digital tools that enhance the tourist experience, such as mobile apps, interactive maps, virtual tours, and other digital services.

Large government investments in innovation funding create favorable conditions for the transformation of tourism, making it more technological, accessible, and competitive on the global stage. The survey results among investment companies in Kazakhstan's tourism sector highlight the importance of engaging with digital technologies. The frequency of attracting investments in this sector is high, with many companies attracting investments twice a year or even more often. This may indicate that companies in Kazakhstan's tourism sector actively recognize the role and importance of digital innovations. Investments are likely directed towards the development and implementation of digital solutions such as mobile apps, online services, virtual tours, and other technologies that improve the tourist experience and business process efficiency (Figure 10).

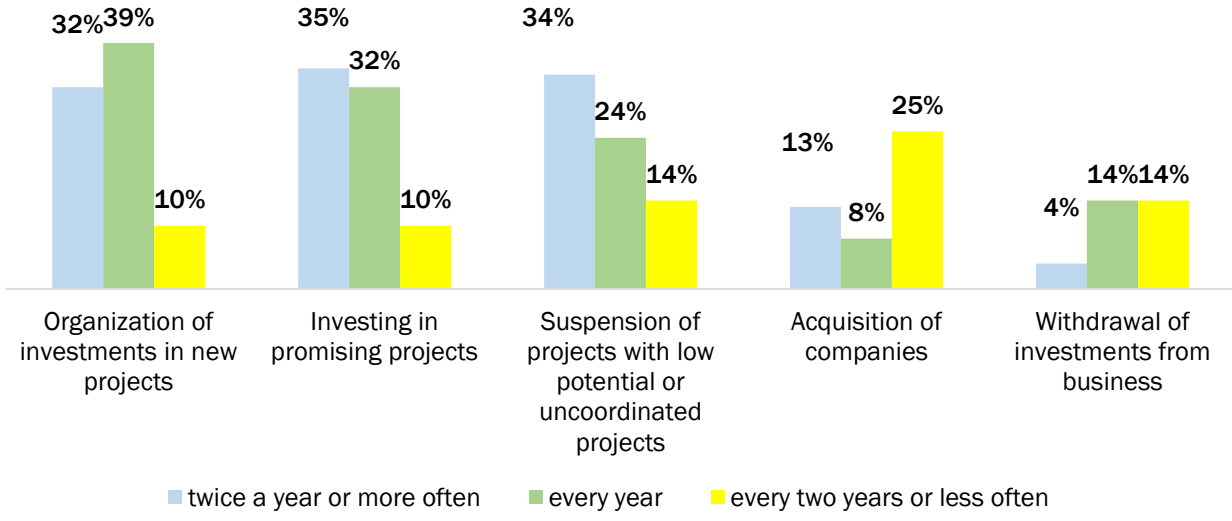

Figure 10. Companies attracting investments in the tourism industry
Source: compiled by the authors according to https://www.pwc.com/kz

This active pace of investment indicates the desire of companies in the tourism industry to be at the forefront of the digital environment, which, in turn, can contribute to the development of digital tourism. Thus, the effectiveness of managerial decisions aimed at developing digital tourism depends on the level of development of the hotel industry, infrastructure, and the service sector. The hypotheses of the study were confirmed:

– The successful integration and use of digital technologies in the tourism sector of the Republic of Kazakhstan contribute to increasing its competitiveness in the global tourism market.
– Digital innovations in Kazakhstan's tourism industry meet the expectations and needs of modern tourists, providing them with convenience, accessibility, and a personalized experience.

– The effective use of digital technologies in tourism contributes to the development of the country's economy by increasing the volume of tourist visits, creating new jobs, and developing related sectors.

CONCLUSION

In recent decades, due to the globalization of the economy and the informational openness of the global community, interest in the theoretical and methodological aspects of organizing tourism activities has increased. As suggestions for further development of digital tourism with the implementation of foreign experience in the context of Kazakhstan, the following can be proposed (Table 8).

For the successful implementation of foreign experience in Kazakhstan, a comprehensive approach is needed, combining infrastructure development, staff training, modernization of the legislative framework, and investment attraction. Considering the unique geographical and cultural features of the country, the digitalization of tourism can become a key driver of economic growth and Kazakhstan's international appeal as a tourist destination.

Despite the effectiveness of many mechanisms and models tested in other countries, the peculiarities of the socio-economic structure of our country require the development of managerial approaches to stimulating the innovative activity of enterprises, including the tourism sector. In a market economy, tourism organizations increasingly recognize the importance of creating new products and services to achieve economic benefits. Thanks to its unique natural and cultural potential, as well as significant interest from tourists from various countries, including distant and nearby regions, Kazakhstan has all the prerequisites for the innovative development of its tourism industry.

REFERENCES

Abozhina, A.A. (2017), “Analysis of international brands of apart-hotels”, *Economy and Society*, No.3, Vol. 34, pp. 1769-1775. https://doi.org/10.26140/anie-2019-0803-0093

Buhalis, D., Amaranggana, A. (2015), “Smart tourism destinations enhancing tourism experience through personalisation of services”, *Information and Communication Technologies in Tourism*, pp. 377-389. DOI: 10.1007/978-3-319-14343-9_28

Chen, W., Du, X., Lan, W., Wu, W., Zhao, M. (2023), “How can digital economy development contribute to quality economic development?”, *Technological and Economic Development of Economy*, Vol. 29, No. 4, pp. 1-27. https://doi.org/10.3846/tede.2023.18784

Dogru T., Bulut U. (2018), “Is tourism an engine of economic recovery?”, *Theory and empirical evidence from Tourisme*, Vol. 67, pp. 425-434. https://doi.org/10.1016/j.tourman.2017.06.014

Dredge, D., Phi, G.T.L., Mahadevan, R., Meehan, E., Popescu, E. (2019), “Digitalisation in Tourism: In-depth analysis of challenges and opportunities”, Executive Agency for Small and Medium-sized Enterprises (EASME), European Commission. https://ec.europa.eu/docsroom/documents/33163/attachments/1/translations/en/renditions/native

Gretzel, U., Sigala, M., Xiang, Z., Koo, C. (2015), “Smart tourism: foundations and developments”, *Electronic Markets*, Vol. 25, pp. 179-188. DOI: 10.1007/s12525-015-0196-8

Gretzel, U., Werthner, H., Koo, C., Lamsfus, C. (2015), “Conceptual foundations for understanding smart tourism ecosystems”, Computers in Human Behavior, pp. 558-563. DOI: 10.1016/j.chb.2015.03.043

Hao, J.X. Liu, Y.P. Exploratory (2012), “Study on the Development of Combination of Hotel and Apartmen”, *Advanced materials research, Health structure material and environment*, Shenzen, Dec, 2013, http://www.iberchina.org/files/2017/economic_growth_china_anu.pdf

Koo, C., Shin, S., Gretzel, U., Hunter, W. C. (2015), “Conceptualization of smart tourism destination competitiveness”, *Asia Pacific Journal of Information Systems*, Vol. 25, pp. 99-122. DOI: 10.14329/apjis.2015.25.1.099

Kulmaganbetova, A.S., Dubina, I.N., Rakhmetulina, Z.B. (2019), “Component-wise assessment of the innovative potential of small and medium-sized businesses: the experience of Kazakhstan”, *Economics, Profession. Business*, No. 3, pp. epb201934. https://doi.org/10.14258/epb201934 (in Russian)

Li, B., Qin, H., Yu, J. (2019), “Competitiveness assessment and evolution of the structure of China's provincial tourism resources”, *Economic Geography*, Vol. 39, No. 9, pp. 232-240 https://doi.org/10.1186/s12886-019-1233-8

Li, Y., Hu, C., Huang, C., Duan, L. (2016), “The concept of smart tourism in the context of tourism information services”, *Tourism Management*, pp. 293-300. DOI: 10.1016/j.tourman.2016.03.014

Musavengane, R. (2019), “Small hotels and responsible tourism practice: Hoteliers’ perspectives”, *Journal of Cleaner Production*, Vol. 220, pp. 786-799. https://www.sciencedirect.com/journal/journal-of-cleaner-production/articles-in-press#aip-note DOI:10.30892/gtg.26322-410

Myratdurdyev, M., Doroshenko, Y.A. (2017), “Practice of forming the space of apart-hotels”. Current scientific research in the modern world, Vol. 32, No. 12-9, pp.9-11. https://doi.org/10.26140/anie-2019-0803-0093 (in Russian)

Shumakova E. V. (2019), “Apart -hotel as an innovative from of organization of a hotel business”, *Azimuth of Scientific Research: Economics and Administration,* Vol. 8, No. 3(28), pp. 400-402 DOI: 10.26140/anie-2019-0803-0093

Tanina A.V., Kalmykova S.V., Mudrova E. B. (2020), “Problems and prospects of development of the apartment market in St. Petersburg”, *Business. Education. Law*, No. 3, pp. 139–146. DOI: 10.25683/VOLBI.2020.52.302.

Tian J., Tang K., Jin J. (2021), “Can digital finance improve misallocation of resources?”, *Journal of Financial Economics*. Vol. 4, pp. 49-60. https://doi.org/10.1186/s11671-021-03505-2

Ying, L., Zi Yi, K., Shizhuan, H., Yan, L., Tongqian, Z. (2024), “The development of digital tourism in China”. *Persuasive Social Sciences*, Vol. 10, No. 1, pp. 2347013. https://doi.org/10.1080/23311886.2024.2347013

* https://tourismonline.kz/

**Official resource of the Data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, https://www.stat.gov.k

*** https://www.pwc.com/kz

ELIT
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Research Podgorica

Montenegrin Journal of Economics

For citation:

Rodionov, D., Zaytsev, A., Konnikov, E., Dmitriev, N., Barua, M.K. (2026), "Analytical Modeling and Genetic Algorithms in the Development of Adaptive Strategies for Optimizing Energy Efficiency of the Fuel and Energy Complex (Case of the Regions of China, Russia and India)", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 189-205.

Analytical Modeling and Genetic Algorithms in the Development of Adaptive Strategies for Optimizing Energy Efficiency of the Fuel and Energy Complex (Case of the Regions of China, Russia and India)

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ARTICLE INFO

Received September 28, 2024
Revised from October 27, 2024
Accepted November 27, 2024
Available online April 15, 2026

JEL classification: O11, F62, R58

DOI: 10.14254/1800-5845/2026.22-2.15

Keywords:

BRICS economy,
fuel and energy complex,
energy sector management,
energy consumption optimization,
energy saving, and efficiency,
genetic algorithms.

ABSTRACT

This study is devoted to the development of an algorithm for analyzing and optimizing energy efficiency indicators in the fuel and energy complex (FEC) based on state statistics of the leading BRICS economies (China, Russia and India). The research methodology includes formalization of key factors influencing energy saving targets, construction of econometric models, cleaning variables from statistically insignificant factors and application of genetic algorithms to determine optimal parameters. The final optimization function implements mathematical formalization of the compromise between increasing energy efficiency targets and minimizing changes in input factors, which makes the results suitable for practical implementation. The algorithm provides solutions that minimize costs and ensure compliance with the specified constraints within the modeling framework. The final data are presented in the form of text reports and infographics, allowing for a detailed statistical and analytical review of the indicators by region of the countries considered. This aspect allows integrating the obtained results into the process of making economically sound strategic decisions aimed at modernizing and improving the efficiency of the energy sector. The developed approach is focused on current tasks of strategic management, including data systematization, development of long-term programs for modernization of the fuel and energy complex and increasing the sustainability of the energy system to external factors. The results obtained have a high degree of universality and can be applied to optimize individual processes within the energy sector and to develop national and interstate energy saving strategies.

INTRODUCTION

The fuel and energy complex (FEC) is a fundamental component of the socio-economic development of modern states, playing a decisive role in ensuring their economic stability and industrial growth. Growing energy consumption, increasing international competition and limited natural resources pose challenges for the energy sector that require an integrated approach, including increasing the efficiency of energy use, reducing dependence on imported equipment and technologies, and developing strategies to optimize energy consumption. The economic significance of the FEC is determined by its impact on macroeconomic indicators, such as GDP growth rates, energy independence, profitability of production processes and investment attractiveness of the industry. The introduction of innovative technologies, infrastructure modernization, digitalization of processes and the transition to renewable energy sources are becoming priority areas of strategic development, helping to reduce the energy intensity of the economy and improve its competitive position.

1 LITERATURE REVIEW

Research on the fuel and energy sector addresses a wide range of issues, including assessing its sustainability, risk management, and adaptation to modern economic challenges. For example, Orlova et al. and Ilyinykh et al. focus on risk insurance in the energy sector and the need for digitalization of processes (Orlova et al., 2018; Ilyinykh et al., 2023). The article Zhen Yang et al. analyzes the possibility of achieving simultaneous economic growth and environmental protection in China (Zhen Yang et al., 2022). Using night-light data and the environmental pressure index, the authors conduct a decomposition analysis, showing that a number of Chinese provinces have managed to achieve a "win-win" situation between economic development and reducing environmental impact. In particular, the article Qihang Feng et al. analyzes the sustainability of China's economic growth in the face of global challenges that affect economic development trajectories (Qihang Feng et al., 2024).

The review Zhencheng Fan et al. examines current advances in AI and DL and their application to achieve sustainable development goals, including in the field of renewable energy and building energy management (Zhencheng Fan et al., 2023). The study Kedong Yin et al. examines the impact of AI development on green technology innovation in China (Kedong Yin et al., 2023). Panel data analysis shows that AI contributes to the improvement of green technology efficiency, especially in western regions of China. The authors identify nonlinear threshold effects due to the intensity of environmental regulation and R&D investment. The study Tianhao Zhao et al. analyzes the relationship between green energy adoption, economic growth and innovation in OECD countries (Tianhao Zhao et al., 2024). Using a random forest model, the authors find that the transition to green energy has a significant impact on the human development index. The authors emphasize the importance of developing integrated approaches to efficiency assessment, including the use of analytical tools. At the same time, the environmental aspects of the fuel and energy complex, as noted in the study Pashkevich et al., require the development of methods for monitoring and preventing man-made risks (Pashkevich et al., 2006).

The impact of sanctions pressure on the modernization of the Russian fuel and energy complex is one of the topical research topics reflected in the works Dmitrievsky et al. and Lebedeva et al. (Dmitrievsky et al., 2016; Lebedeva et al., 2024). Scientific attention is focused on the tasks of import substitution and localization of production capacities, which contribute to strengthening technological independence and minimizing foreign economic risks. Within the framework of these studies, strategies for diversifying capital sources and developing national mechanisms for financial support of modernization projects are presented. One of the promising areas is the creation of algorithms for optimizing interactions between economic entities and counterparties in conditions of increased uncertainty of the market environment. For example, the study Zaytsev et al. proposes a game algorithm built on the basis of game theory, which uses indices of mutual influence and payment matrices (Zaytsev et al., 2024). The model is designed to increase the stability of interactions, minimize risks and form balanced cooperative and competitive strategies. The investment attractiveness of the energy sector, as emphasized Loktionov, should be assessed in terms of its impact on systemic stability, reducing the likelihood of power supply failures and increasing the

efficiency of resource use, which requires the development of analytical approaches that take into account regional characteristics and institutional constraints (Loktionov, 2013).

The article Lagutenkov, A.A. et al. proposes a conceptual model of transition to a "green" economy, including stages from theoretical understanding to the introduction of practical implementation mechanisms (Lagutenkov, A.A. et al., 2022). The analysis focuses on the institutional and technological drivers that form the basis for environmentally oriented models of economic growth. Particular emphasis is placed on the importance of international cooperation and the adaptation of economic management strategies to national specifics. In particular, the study Jia et al. discusses the prospects for improving the energy efficiency and environmental sustainability of the Chinese steel industry in the context of tightening environmental requirements and growing international obligations (Jia et al., 2022). The application of an integrated approach to the analysis of the effectiveness of environmental initiatives is carried out through the study of the introduction of energy-efficient technologies and the modernization of technological processes. The authors present strategies that ensure a balance between achieving economic goals and reducing the environmental burden, and also propose mechanisms for integrating these solutions into national economic policy.

In recent years, the issues of increasing energy efficiency in the fuel and energy sector of various countries, including the BRICS states, have been actively studied in the international scientific literature. Research focuses on the development of mathematical models and optimization algorithms aimed at reducing energy consumption and reducing carbon dioxide emissions. For example, the work Dahir et al. analyzes the determinants of energy efficiency and their impact on environmental indicators in the BRICS countries (Dahir et al., 2022). The authors conclude that the integration of renewable energy sources and increased energy efficiency provide a significant reduction in the carbon footprint and improve environmental performance in the long term. This approach is of particular relevance in the context of managing the resource potential of regions, since it allows taking into account the relationships between socio-economic processes and energy parameters.

The article Zaytsev et al. develops a methodological approach to diagnosing the resource potential of regions, aimed at assessing their contribution to ensuring socio-economic development (Zaytsev et al., 2023). The study considers quantitative indicators of resource potential and their integration into the regional planning process. This approach allows formalizing the strategic aspects of energy resource management, taking into account regional and national characteristics. In another study Wang et al., an improved fuel efficiency optimization model based on fractional programming methods is proposed (Wang et al., 2023). The model is designed to minimize fuel consumption in power systems by optimally distributing the load between generators and energy storage systems. The results show that the use of this approach reduces both operating costs and overall energy consumption, improving the efficiency of power systems.

The use of analytical modeling and genetic algorithms is becoming an integral part of energy efficiency improvement strategies in the energy sector. In the study Nacef et al., a genetic algorithm is presented for selecting the optimal energy transmission route taking into account energy losses occurring during conversion and transportation (Nacef et al., 2023). The model demonstrates the ability to explore a multidimensional solution space while minimizing time and space costs, which improves the functional efficiency of smart grids and the energy internet. In another study Khan et al., a hybrid ensemble machine learning model combined with a genetic algorithm is proposed for the optimal selection of energy consumption forecasting parameters (Khan et al.,2020). This approach improves the accuracy of energy demand estimation and provides more efficient energy distribution management. The authors emphasize that the use of integrated approaches to forecasting helps to increase the sustainability of energy systems and minimize operational risks.

The work Zaytsev et al. analyzes the impact of resource potential on the sustainability of socio-economic development of regions, with an emphasis on energy security and reducing environmental risks (Zaytsev et al, 2023). The authors examine approaches to integrating strategic energy policy and environmental monitoring aimed at improving the efficiency of natural resource use. The study developed analytical models that allow formalizing resource management processes, which helps optimize their distribution and use. The study Zaytsev et al. examines the economic aspects of renewable energy development, including its importance for ensuring long-term energy independence and reducing the negative impact on

the environment (Zaytsev et al, 2022). The authors conduct a quantitative analysis of the economic benefits and costs associated with the introduction of renewable energy technologies, assess their impact on restoring ecological balance and the sustainability of national economies. The model approach used in the work demonstrates the possibilities of an optimal combination of economic and environmental priorities in strategic planning.

Analysis of the fuel and energy complex requires consideration of macroeconomic, regional and institutional factors. The BRICS countries — China, Russia and India — present different approaches to the modernization of their energy systems, due to their unique resource base, national energy policy goals and specific economic models. In this context, the development of energy efficiency strategies involves the use of mathematical and econometric methods, including regression modeling and optimization algorithms. These approaches provide opportunities for a quantitative assessment of the influence of determining factors on energy saving indicators, as well as for the formation of scientifically based recommendations for improving their values.

The use of analytical tools, such as regression analysis, helps to identify dependencies between energy indicators and economic determinants. Optimization algorithms, including genetic and neural network methods, provide an opportunity to develop adaptive strategies for managing energy flows and minimize technological losses, which allows for the formation of flexible and efficient energy consumption models that can be integrated into strategic planning processes at the national and regional levels.

1.2 Purpose and direction of work

The aim of this study is to develop an algorithm for analyzing and optimizing the energy efficiency of the fuel and energy complex using mathematical modeling methods, which can be used to formulate long-term energy saving management strategies. The results of the work are aimed at integrating modern analytical approaches into the decision-making process aimed at increasing the competitiveness of the energy sector and ensuring sustainable economic growth. The object of the study is the processes of managing energy saving and energy efficiency in the fuel and energy complex, as well as economic and technological factors affecting their parameters. The subject of the study is mathematical models and algorithms for analyzing and optimizing the energy efficiency of the fuel and energy complex, including regression analysis methods, genetic algorithms and their practical application for forming energy sector management strategies.

2. RESEARCH METHODOLOGY

2.1 Analysis of the spectrum of the fuel and energy complex situation in the BRICS countries

Modern economies are faced with the task of comprehensively assessing the efficiency of the fuel and energy complex both at the national and regional levels. It is proposed to use the energy saving indicator as a universal efficiency indicator, which reflects the degree of optimal use of energy resources and their economic return. Energy saving forms the basis for reducing total costs in the energy sector. Optimization of energy consumption is achieved by reducing operating costs for the production and transportation of energy resources, which is becoming especially significant in the context of volatility in world oil and gas prices, as well as increased competition in global markets. In addition, the development of energy saving strategies is an integral part of strengthening energy security, as it reduces dependence on hydrocarbon production and equipment imports.

The implementation of energy saving programs serves as a driver for the introduction of innovative technologies and the modernization of technical infrastructure, contributing to an increase in the technological efficiency of the industry. For example, the use of smart grids and modern materials leads to a reduction in process losses, an increase in overall productivity and an improvement in the competitiveness of energy systems both domestically and internationally. Energy conservation has a significant impact on socio-economic development, as it increases the availability of energy in remote regions, which stimulates an improvement in the quality of life of the population, contributes to the modernization of infrastructure

and creates new jobs associated with the introduction, operation and maintenance of energy-efficient technologies.

The growth of global energy consumption necessitates the development of energy conservation strategies, which become a tool for adapting to the challenges associated with increasing energy demand, changing resource availability and tightening international environmental standards. Energy conservation can be considered as an indicator of the maturity of the industry and its readiness to implement innovations, which determines the prospects for its long-term growth and sustainable operation. The economies of the BRICS countries (China, Russia, India) demonstrate a variety of approaches to the development of the fuel and energy complex, which is due to the historical, resource and economic characteristics of each state. These differences determine the specifics of national energy conservation strategies, which are aimed at achieving sustainability and efficiency of energy systems, taking into account local and global challenges. The key features of the energy systems of the BRICS countries are analyzed below, focusing on their institutional structure, economic models and strategies for increasing energy efficiency.

2.2 China: Centralized Control and Leadership in Energy Conservation

China is an example of a country where energy conservation has become a strategic direction of state policy (Table 1). The beginning of active development of the fuel and energy complex falls on the middle of the 20th century, when coal became the main source of energy. Since the 1990s, China has begun to modernize infrastructure, introduce energy-efficient technologies and actively develop renewable energy. The main focus was on reducing the energy intensity of the economy, which became one of the key factors of economic growth.

Table 1. Key Features of China's Energy Conservation Policy

Characteristics	*Description*
Centralized management	State-owned companies such as the State Grid Corporation play a leading role in implementing national energy conservation and infrastructure modernization strategies.
Implementation of innovative technologies	China is a world leader in the production and use of energy-efficient equipment, including smart grids and energy management systems.
Energy saving policy	The five-year plans are aimed at reducing the energy intensity of the economy, which is achieved through the introduction of technologies to improve the efficiency of energy production and transportation.

Source: own

Energy conservation in China has a significant impact on the economy, helping to reduce dependence on coal energy resources, reduce environmental impact and strengthen the country's position as a world leader in renewable energy. China's policy combines centralized management, technological innovation and long-term planning, which ensures a high degree of sustainability of the energy system and its adaptation to modern challenges.

The transition to energy-efficient technologies and the development of renewable energy sources reflects China's strategic focus on reducing the carbon footprint and increasing the sustainability of economic growth. The approaches used in China's energy sector demonstrate an example of a successful combination of management, technological and environmental solutions to achieve high efficiency in the fuel and energy sector.

2.3 Russia: Focus on hydrocarbon exports and slow modernization of the fuel and energy sector

The Russian fuel and energy complex is characterized by a historically established export focus and high dependence on hydrocarbon resources (Table 2). The Soviet legacy ensured the presence of a large-scale infrastructure, including an extensive pipeline network and large oil and gas fields. However, priority attention was given to the export of raw materials for a long time, which affected the low rate of implementation of energy-saving technologies.

Table 2. Main characteristics of the Russian fuel and energy complex

Characteristics	*Description*
Export focus	The main focus is on the extraction and transportation of hydrocarbons, which determines the energy intensity of the system and its dependence on world oil and gas prices.
Slow modernization	Despite the launch of energy saving programs, infrastructure modernization is complicated by its wear and tear, insufficient investment and a high level of dependence on hydrocarbons.
Energy saving in new projects	Innovative technologies aimed at reducing process losses and increasing energy efficiency are being introduced at Arctic fields such as Yamal LNG.

Source: own

Russia's energy policy focuses on improving energy efficiency and reducing process losses. Production process modernization programs are aimed at increasing the competitiveness of the energy sector and reducing the impact of external economic factors, such as sanctions and price fluctuations on world markets. Despite significant potential, Russia is still inferior to other major economic players in the field of energy conservation, which is explained by the high share of outdated technologies and the structural dependence of the fuel and energy complex on hydrocarbon resources. However, the gradual introduction of innovative solutions, such as energy-saving technologies in Arctic projects, can help strengthen the country's position in the energy sector. Energy projects aimed at increasing energy efficiency are becoming the basis for creating a sustainable energy system capable of meeting the challenges of the global economy and adapting to changes in international markets.

2.4 India: Growing Energy Demand and Need for Energy Conservation

India, being one of the most dynamically developing economies in the world, faces increasing energy demand due to population growth and industrial production scale (Table 3). The development of the country's fuel and energy complex is accompanied by challenges related to ensuring sustainable energy consumption and minimizing the negative impact on the environment. Energy conservation is a strategic task that integrates economic, technological and environmental aspects.

Table 3. Key Features of India's Power System

Characteristics	*Description*
Coal Dependency	The main source of energy is coal, which leads to high energy intensity of production and significant losses during production and transportation of energy resources.
Renewable Energy Development	Active investment in solar and wind energy aimed at reducing dependence on hydrocarbons and increasing energy efficiency.
Energy Saving Initiatives	Programs such as UJALA stimulate the mass adoption of energy-efficient technologies, such as LED lamps, and the modernization of the power grid to reduce losses.

Source: own

Energy conservation is an economic tool and a factor ensuring energy availability in regions with low electrification. Modernization of infrastructure, transition to renewable energy sources and development of intelligent energy management systems form the basis for increasing the technological efficiency of the

energy sector. The programs implemented by the Government of India, such as improving energy infrastructure and stimulating the use of energy efficient solutions, help reduce the energy intensity of the economy and reduce environmental risks. The combination of economic incentives and technological innovations allows not only to meet the growing energy demand, but also to minimize costs and environmental costs. Thus, energy conservation in India is becoming an integral part of the strategic management of the energy sector, forming long-term prospects for the sustainable development of the national economy.

3. METHODOLOGY

3.1 The Importance of the Fuel and Energy Complex for Interethnic Cooperation Based on the BRICS Association

The fuel and energy sector plays a key role in the development of economic, political and strategic cooperation between the BRICS countries, which unite the world's largest developing economies: Brazil, Russia, India, China and South Africa. Energy cooperation allows countries to strengthen their positions in the international arena, develop strategies to improve energy security and ensure economic growth (Table 4).

Table 4. Key aspects of the importance of the fuel and energy sector within BRICS

Aspect	*Description*
Energy base for economic growth	Joint work in the energy sector helps countries meet the growing demand for energy needed for industrial production, transport and social security.
Resource diversity and complementarity	Each country has unique resources, which creates opportunities for synergy. For example, Russia is a major exporter of oil and gas, while India and China are active energy importers.
Promotion of energy efficiency and renewable energy sources	Joint efforts are aimed at developing energy efficiency standards, financing renewable energy projects and sharing advanced technologies.
Geopolitical significance	Coordination of actions in the fuel and energy sector allows countries to strengthen strategic positions, resist fluctuations in global energy prices and respond to sanctions pressure.
Energy conservation as a priority	Reducing the energy intensity of the BRICS economies through joint initiatives accelerates the implementation of energy efficient solutions, which is especially important for large economies such as Russia and China.
Investment cooperation	The fuel and energy sector is becoming a platform for attracting investment in projects, including cross-border infrastructure initiatives, energy transmission networks, resource extraction and processing.

Source: own

BRICS energy cooperation promotes the integration of technologies and knowledge, the development of long-term energy conservation strategies and the transition to more sustainable resource consumption models, which allows countries to minimize economic and environmental risks associated with fluctuations in global markets. BRICS energy cooperation should be aimed at further developing a systemic approach to energy resource management, strengthening the coordination of scientific research and the implementation of integration projects. Of particular importance are energy conservation initiatives that allow countries to efficiently allocate resources, minimize losses and strengthen energy independence. Thus, the fuel and energy complex within BRICS acts as a platform for the implementation of comprehensive initiatives aimed at ensuring sustainable growth, increasing competitiveness and strengthening positions in the global energy market. The authors of the study propose a methodology for determining key indicators from an array of all indicators presented in processed form on Internet resources (repositories) of official state statistics of the relevant BRICS countries. The convenience of the presented information, its openness and accessibility, as well as the scale of the economies and the degree of involvement in international projects determined the choice of China, Russia and India as the objects of the study.

The algorithm for determining the key indicators (indicators) of state statistics that have the greatest impact on the level of energy efficiency of the fuel and energy complex in the context of individual regions of the three largest BRICS economies is divided into several key stages:

- Determination of target indicators Y. This is carried out using expert assessments and auxiliary neural network tools. If such are available in the array of relevant state statistics, preference was given to direct components of the fuel and energy complex.
- Determination of five factors influencing each Y. Similarly, this is carried out using expert assessments and auxiliary neural network tools. Here, the possibilities for choosing indicators directly related to the fuel and energy complex are limited by the content of the statistical arrays, however, as already discussed above, the fuel and energy complex has a direct or indirect impact on a wide range of spheres and areas.
- Approximate estimate of the limits of annual growth of target indicators Y. This step is necessary for constructing mathematical models in subsequent stages. This step was carried out using the analysis of historical data and the opinions of subject observers. The list of target factors Y selected as a result of the first three steps with a country breakdown and the rationale for the approximate forecast is presented below.

3.2 China

China has demonstrated sustainable momentum in its energy sector, supported by long-term government strategies and infrastructure upgrades (Table 5). The focus on renewable energy and rural energy efficiency is helping to reduce the carbon footprint and promote economic diversification. Particular attention is paid to investments in upgrading power generation capacity and integrating modern technologies. Projected growth rates indicate continued focus on increasing productivity and optimizing the use of natural resources.

Table 5. Key indicators and forecasts for the development of China's energy system

Indicator	*2023 data*	*2024 Outlook*	*Annual growth limit*
Rural Electricity Consumption	Increased by 12.6% to 1.172 trillion kWh. Rural grid modernization continues and electric vehicle use grows.	Growth of 10-12%, driven by infrastructure development and renewable energy deployment.	12%
Installed Electric Power Capacity	Increased by 202.98 GW (to 2,922.24 GW), led by renewable energy (solar: +55.2%, wind: +20.7%).	Growth of 7-8% (200-230 GW), driven by ambitious renewable energy capacity expansion plans.	8%
Investments in Fixed Assets of the Electric Power Industry	Increased by 30.1% to RMB 967.5 billion. Modernization of energy infrastructure and transition to renewable energy.	Growth slowing to 10-15%, given a five-year plan that includes a 25% increase in investment in 2023-27.	15%
Investments in the Energy Sector	*Increased by 13% ($271 billion). Almost on par with OECD countries. Renewable energy sector growth.*	*Growth forecasted at 10-15%, driven by continued strong deployment of renewable energy.*	*15%*
Daily Tap Water Consumption Per Capita	*Stable (less than 610 billion cubic meters). Efficient use of water thanks to modern technologies.*	*Growth of 1-2%, driven by limited growth trends and water management measures.*	*2%*

Source: own

3.3 Russia

The energy system of Russia continues to demonstrate trends aimed at modernizing the infrastructure and improving the profitability of production. The main emphasis is on increasing investment in the energy sector, including renewable energy projects. However, high dependence on hydrocarbons and significant wear and tear of equipment limits the possibilities for a significant increase in energy efficiency (Table 6).

Investment policy aimed at modernizing energy facilities contributes to a gradual decrease in the energy intensity of the national economy. However, additional measures are needed to achieve long-term sustainability, including the development of programs to support innovative technologies and increased coordination between market participants. Russia, with its significant potential in the field of energy efficiency, is able to strengthen its position in the global energy market through the implementation of strategies aimed at reducing dependence on hydrocarbons and increasing the sustainability of the energy sector.

Table 6. Key indicators and forecasts for the development of the Russian energy system

Indicator	*Data for 2023*	*2024 Outlook*	*Annual growth limit*
Proportion of total area equipped with gas	The predominance of natural gas in electricity production is due to significant reserves and availability of the resource.	A slight increase in the share of gas-fired power plants due to constraints related to the development of renewable energy sources and modernization of capacities.	0.5%
Investments in fixed capital of electric power industry	Increase in capital investments related to infrastructure modernization and renewable energy development.	A growth of 5%, limited by high project implementation costs and economic uncertainty.	5%
Investments in fixed capital in general	Investment growth in Q3 2024 was 5.1%.	An average annual growth forecast is 4%, taking into account the impact of economic factors and market fluctuations.	4%
Provision of electricity to private property	Growth in the electrification of private homes and an increase in the number of households.	A moderate increase of 1%, limited by infrastructure and economic conditions.	1%
Profitability of electricity provision	The indicator, which depends on tariff policy and production costs, shows stable growth.	An increase of 2% due to measures to improve production efficiency and stable demand for electricity.	2%

Source: own

3.4 India

India, as one of the fastest growing economies, demonstrates a commitment to increasing production capacity and optimizing the employment structure of the population. Government incentive programs such as “Make in India” contribute to the creation of new jobs, modernization of industrial infrastructure and attraction of investments (Table 7). The growth in the number of households reflects the processes of urbanization, and the decrease in their average size is associated with changing social norms. These trends create demand for energy and infrastructure, stimulating the development of the energy sector. Economic and demographic indicators confirm India’s potential for sustainable development of its industrial and energy sectors, as well as the need to implement long-term strategies aimed at improving energy efficiency and ensuring energy security.

Table 7. Key indicators and forecasts for the development of industry and energy sector in India

Indicator	*2023 Data*	*2024 Forecast*	*Annual growth limit*
Number of factories (Y)	Sustained growth of 5-7% driven by industrial development and the Make in India initiative.	Expected to increase by 5-7% due to investment in the manufacturing sector and an 8-10% increase in steel demand.	7%
Distribution of employed population by industry	The indicator is changing slowly, growing by 1-2% per annum, depending on economic development and government policies.	Gradual increase of 1-2% due to changes in the structure of the economy and labor migration.	2%
Estimated number of households, average household size and sex ratio	The average household size is about 4.4 persons. There is an increase in the number of households by 1-2% per	Expected increase in the number of households by 1-2% and a gradual decrease in the average household size.	2%

	annum, while their average size is declining by 0.5-1%.		
Employment rate of population (WPR)	The employment-to-population ratio (WPR) for persons above 15 years was 58.2%, an increase of 2.2 percentage points compared to the previous year.	Projected growth of 2-3 percentage points depending on educational programs and employment initiatives.	3%
Net regional product at current prices (NSDP)	Real GDP growth was 8.2%. Adjusted for inflation, nominal growth could be higher.	Expected growth of 10-12% due to consumer spending and investment activity.	12%

Source: own

4. ANALYTICAL MODELING

After defining the growth boundaries of the target parameters Y, as well as after compiling five analytical datasets with data from state statistics on certain indicators for all three BRICS countries selected for the study, the analytical modeling stage begins. For each row corresponding to one state/region/province of one of the countries, represented by one target indicator Y and 3-5 indicators X, a linear regression model is built, which expresses the dependence of the target variable (energy saving indicator) on factors X1, X2, ..., Xn, the process continues with the optimization of the factor values using a genetic algorithm. For each data row (region or province), a linear regression model is built:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon, \quad (1)$$

Where Y is the target variable reflecting the level of energy efficiency;

X1,X2,...,Xn are the factors influencing YYY;
β0,β1,...,βn are the regression coefficients;
ε is the random error distributed normally (ε∼N(0,σ2).

After estimating the regression parameters using the least squares method, the target variable is expressed through the predicted function:

$$Y_{\text{predicted}} = \widehat{\beta_0} + \widehat{\beta_1} X_1 + \widehat{\beta_2} X_2 + \cdots + \widehat{\beta_n} X_n, (2)$$

The next stage is optimization of the obtained models. It begins with clearing the model of parameters with low statistical significance (p-value > 0.1), until no more than four X factors remain. This is necessary to facilitate modeling by eliminating the least significant factors. As the main optimization parameter, an original metric is proposed, derived as follows:

For each observation (data row), optimization of factors is aimed at:

A. Minimizing changes in factors:

$$\Delta X = \sum_{i=1}^{n} \left| X_i^{new} - X_i^{original} \right|, \quad (3)$$

where X_i^{new} — is the optimized value of the factor, X_i^{original} — is its initial value.

B. Maximization of the growth of the target variable Y, provided that:

$$\mathrm{Y}_{\mathbf{optimized}} \leq \text{coef\_of\_rise} \cdot \mathrm{Y}_{\text{original}}, (4)$$

where coef_of_rise – is the obtained coefficient of the estimated annual growth of Y.

C. Satisfaction of constraints on factors X equal to the absolute minimum and maximum of the indicator in the sample:

$$X_i^{\min} \leq X_i \leq X_i^{\max}, (5)$$

Thus, the objective function of the genetic algorithm takes the form:

$$F(\mathrm{X}) = \frac{\Delta Y}{\lambda \cdot \Delta X}, (6)$$

where $\Delta Y = \left|\mathrm{Y}_{\mathrm{optimized}} - \mathrm{Y}_{\mathrm{original}}\right|$ — change of target variable;

λ — coefficient that controls the effect of changes in factors on the fitness value.

The analysis of the objective function $F(X)$ reveals several fundamental aspects that determine its significance in the process of optimizing energy efficiency parameters.

First, the value of ΔY reflects how significantly the algorithm managed to increase the initial target indicator. Maximizing the growth of the target variable is a key goal, since it determines the main meaning of optimization - improving the studied parameter (efficiency, energy saving of the fuel and energy complex).

Second, the presence of the multiplier λ and dependence on ΔX ensures a balance between aggressive improvement of the target indicator and minimizing changes in input factors. The introduced coefficient λ plays the role of a strictness regulator, which allows the model to manage the trade-off between the maximum benefit and the degree of adjustment of the initial conditions. If λ is small, then it is possible to achieve large improvements in ΔY at the cost of a significant restructuring of the factors. If λ is increased, the algorithm will have to be "more careful" about changes, trying to find a more delicate option for improving the target indicator with minimal corrections.

Thirdly, the final function shows not just a local improvement, but rather the effectiveness of intervention in the system. If we imagine that factors X act as controlled parameters of a technological process or economic policy, then ΔX characterizes the "costs" or "efforts" required to achieve the result ΔY. Thus, F(X) can be interpreted as a certain indicator of the "profitability" of changes: how many units of the target increase do we get for one unit of deviation of the factors.

Fourthly, when analyzing the final function, it becomes possible to assess the sensitivity of the system to changes in factors. A high value of F(X) will indicate that relatively small changes in factors lead to a significant increase in the target parameter. A low value indicates that even significant corrections of factor variables give only an insignificant increase, which may indicate the need to revise the selected model or optimization parameters.

Finally, it should be emphasized that the final function in this context becomes a tool not only for choosing optimal options for changes, but also for the subsequent analysis of the sustainability and effectiveness of the decisions made. By considering the obtained values of F(X) in combination with the constraints on the factors, the researcher can determine the ranges of acceptable changes, assess the system's limits, and understand under what conditions the optimal balance between the goal (improving energy efficiency Y) and cost (changes in X) is achieved.

4.1 Genetic algorithm

The use of a genetic algorithm is a key stage of optimization aimed at maximizing energy saving targets while minimizing changes in factors. The algorithm combines analytical modeling and evolutionary search methods to find the optimal balance between the system's goals and the constraints set by economic, physical and technological frameworks.

Algorithm operation stages:

A. Initialization of the initial population:

– Generation of the initial population of individuals: $\mathrm{X}^{(\mathrm{j})} = \{x_1^{(j)}, x_2^{(j)}, \ldots, x_n^{(j)}\}$, where j=1,2,...,N, a N — population size.

– Each value $X_i^{(j)}$ generated randomly within acceptable limits $\left[X_i^{\min}, X_i^{\max}\right]$ by adding random noise.

B. Evaluation of individuals:

– For each individual, the objective function is calculated$F\left(\mathrm{X}^{(\mathrm{j})}\right)$.

– The predicted value of the target variable is calculated $Y_{\mathrm{predicted}}$ using the equation:

$$Y_{\text{predicted}} = \widehat{\beta_0} + \sum_{i=1}^{n} \widehat{\beta_i} X_i^{(j)}, (7)$$

– The fulfillment of the constraints on the growth of the target variable is checked:

$$Y_{\text{optimized}} \leq \text{coef\_of\_rise} \cdot Y_{\text{original}}, (8)$$

– The changes in the factors ΔX and the target variable ΔY are calculated.

C. Genetic algorithm operators:

– Selection: The tournament method is used to select individuals with the highest values $F(\mathrm{X}^{(\mathrm{j})})$.
– Recombination (crossover): New offspring are created by linear combination of parent individuals:

$$X_i^{\text{new}} = \alpha X_i^{(j_1)} + (1-\alpha) X_i^{(j_2)}, \quad \text{where } \alpha \in [0,1], (9)$$

Mutation: For each offspring, a random change is added with a given probability:

$$X_i^{\text{new}} = X_i^{\text{new}} + \delta, \quad \text{where } \delta \sim \mathcal{U}(-\eta, \eta), (10)$$

where η — mutation parameter.

Limit Check: Values Out of Bounds $X_i^{\text{new}} \in \left[X_i^{\min}, X_i^{\max}\right]$, are brought to the nearest acceptable limit.

D. Iterations:

– The process is repeated for a given number of generations. At each step, the population is updated, optimizing the values of the factors.
– After the iterations are completed, the individual with the maximum value of F(X) is selected, which represents the optimized solution.

The final optimization problem is thus represented as:

$$max(Y_k) \frac{|Y_0 - Y_k|}{\lambda \cdot \sum_{i=1}^{n} \left| X_i^{\text{optimized}} - X_i^{\text{original}} \right|}, (11)$$

Subject to restrictions:

$$X_i^{\min} \leq X_i \leq X_i^{\max}; Y_{\text{optimized}} \leq \text{coef\_of\_rise} \cdot Y_{\text{original}}; Y_{\text{optimized}} \geq 0.$$

The final function formalizes the mathematical assessment of the relationship between the increase in target indicators (ΔY) and the adjustments of factors (ΔX). It serves as a tool for analyzing the efficiency and profitability of the changes made, providing a quantitative expression of the optimality of the achieved results. Considered as a metric of the profitability of adjustments, the function allows us to determine the most effective transformation strategies in terms of minimizing costs and maximizing results.

The increase in target indicators calculated on the basis of the proposed optimization function strictly corresponds to the realistic constraints formulated for the energy systems of the fuel and energy complex. The developed algorithm generates text and graphical analytical materials intended for practical use in the strategic planning process. These materials contain data on possible improvements and the benefits associated with them, which contributes to more informed decisions in the field of increasing energy efficiency.

The applied approach is highly adaptable and takes into account the specific features of the functioning of energy systems, which creates a solid foundation for improving analytical tools and further developing optimization methodologies. The developed algorithm includes two key stages: building a regression model and using a genetic algorithm. At the first stage, a linear regression model is formed that reflects the quantitative dependence of the target variable on the factors, which allows identifying the most

significant factors and providing a mathematical description of the relationships in the system. The results of the regression analysis serve as the basis for the next stage.

At the second stage, a genetic algorithm is used to find optimal values of the factors. Constraints associated with physical, economic and technological parameters are taken into account. The algorithm is aimed at minimizing adjustments to the factors, provided that a significant increase in the target variable is achieved. This approach is especially effective for complex systems with multiple constraints.
The output data of the algorithm include:

- Optimized values of factors and targets representing balanced solutions.
- Information on changes for each observation (region, state or province).
- Full statistical data of the regression model for interpreting the results and analyzing the influence of factors.

The use of the algorithm facilitates informed management decision-making, minimizes risks and ensures the feasibility of proposed changes. The integration of analytical and optimization approaches makes the algorithm a universal tool for strategic planning in the field of energy saving and improving the efficiency of the fuel and energy complex.

The algorithm facilitates the development of management decisions based on detailed analytical and optimization approaches, minimizing risks and ensuring consistency of changes with the realities of the target system. The presented methodological tool has significant potential in strategic planning of complex systems, including addressing issues related to improving energy efficiency in the fuel and energy complex of the BRICS economies.

The final and intermediate results of modeling are generated using an automated cycle based on cascading command calls to a locally deployed neural network of the open-source Mistral_7B model. For each optimized model and its results, detailed text reports are created, supplemented by graphical analytics. The reports present data in various formats, including tables, charts and graphs, which ensures ease of interpretation and decision-making based on the information provided. Figure 1 shows the complete structure of the process – from identifying factors X that affect energy saving indicators Y to generating the final report. This diagram illustrates the stages of the algorithm's operation, including data preparation, building regression models, applying the genetic algorithm for optimization, and creating results suitable for practical use.

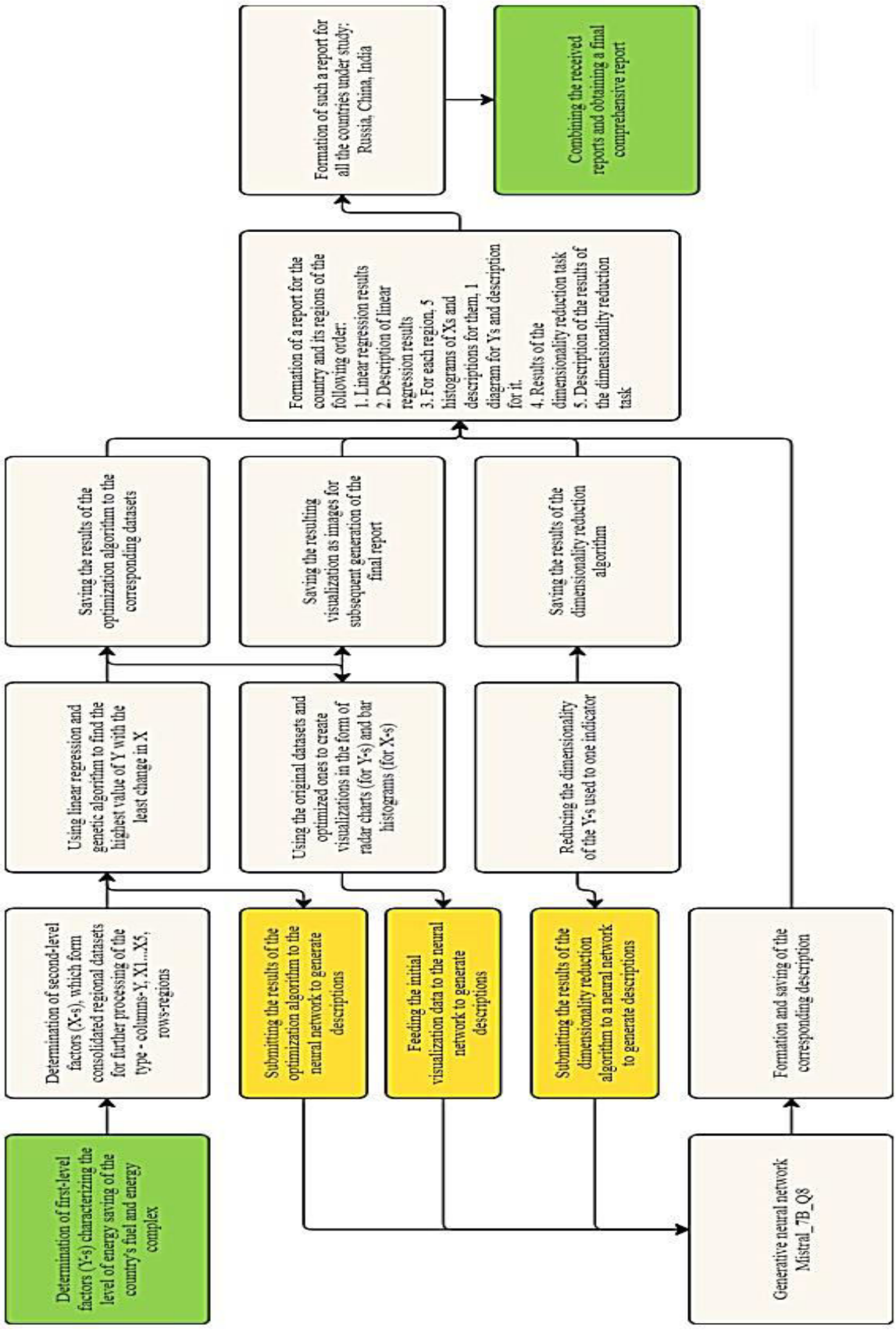

Figure 1. Block diagram of the full cycle of the developed algorithm
Source: own

The proposed algorithm can be adapted to specific conditions of the fuel and energy complex operation, taking into account regional and industry specifics. Its application allows for the formation of balanced management strategies aimed at achieving significant improvements in energy efficiency with minimal deviations from the initial conditions. Thus, this approach opens up new prospects for improving the efficiency of the fuel and energy complex operation in the conditions of the modern economic environment.

CONCLUSION

The conducted research is based on the study of the key role of the fuel and energy sector in ensuring economic growth and social development, especially within the largest BRICS economies: China, Russia and India. Global challenges such as increasing energy consumption, limited natural resources, as well as sanctions pressure and changes in global energy markets, require a strategic approach to improving energy efficiency. An analysis of the national strategies of the BRICS countries demonstrated the difference in approaches due to unique economic conditions and the structure of the resource base. China invests significant resources in the development of renewable energy sources and the introduction of innovative technologies, which helps reduce the energy intensity of the economy and strengthen its leadership position in the global market. Russia, focused on hydrocarbon exports, is taking steps to modernize infrastructure and improve energy efficiency, especially within the framework of new Arctic projects. India, seeking to meet the growing demand for energy, focuses on the development of renewable energy and providing electricity to all segments of the population, which is important for its industrial growth

The methodology for assessing the efficiency of the fuel and energy complex proposed in the work, based on the use of the energy saving indicator, includes several successive stages aimed at systematizing and optimizing processes:

- Determination of target indicators (Y). Based on expert assessments and neural network tools, key indicators related to the efficiency of the fuel and energy complex were identified.
- Determination of influencing factors (X). Indicators that have a significant impact on target parameters were identified. A wide range of data reflecting the impact of the fuel and energy complex on related industries was used in the accounting process.
- Forecasting growth boundaries. Based on the analysis of historical data and expert opinions, projected annual growth boundaries for target indicators were established.
- Analytical modeling. Linear regression models were built describing the dependence of target indicators on factors, with subsequent optimization of parameters using a genetic algorithm.
- Optimization. The use of a genetic algorithm allowed us to determine the optimal values of factors, minimizing deviations from the initial conditions and maximizing the growth of target indicators.

The modeling results showed significant potential for increasing the energy efficiency of the fuel and energy complex while maintaining minimal changes in factors, which confirms the need for a strategic approach to planning. The data obtained demonstrate the high efficiency of integrating analytical and optimization tools in the decision-making process at the level of public policy and interstate cooperation.

Thus, the developed approach meets modern challenges, providing a comprehensive toolkit for analyzing and optimizing energy saving in the fuel and energy complex. Its implementation contributes to achieving sustainable development of the energy sector and creating long-term strategies for increasing the competitiveness of the fuel and energy complex at the national and international levels.

ACKNOWLEDGEMENTS

The article is based on the results of a study conducted with the financial support of the Russian Federation represented by the Ministry of Science and Higher Education of Russia in the process of implementing the project “Management of Sustainable Development of Industrial Structures within the Concept of Water-Energy-Food” (Agreement no. 075-15-2024-673).

REFERENCES

Dahir, M. Mahi, M. (2022), "Does energy efficiency improve environmental quality in BRICS countries? Empirical evidence using dynamic panels with heterogeneous slopes", *Environmental Science and Pollution Research*, Vol. 29, pp. 12027–12042. https://doi.org/10.1007/s11356-021-16410-z.

Dmitriev, A.N., Komkov, N.I., Krotova, M.V., Romantsov, V.S. (2016), "Strategic alternatives of import substitution of energy equipment for the oil and gas complex", *Studies on Russian Economic Forecasting*, No. 1(154), pp. 18–35.

Fan, Z., Yan, Z., Wen, S. (2023), "Deep Learning and Artificial Intelligence in Sustainability: A Review of SDGs, Renewable Energy, and Environmental Health", *Sustainability*, Vol. 15, No. 18, p. 13493. https://doi.org/10.3390/su151813493.

Feng, Q., Dmitriev, N., Kryzhko, D., Kuporov, Y. (2024), "The Sustainability of China's Economic Growth in an Era of Global Turbulence", *Sustainable Development and Engineering Economics*, No. 2, pp. 59–78. https://doi.org/10.48554/SDEE.2024.2.4.

Ilyinykh, I.I., Voskerichyan, R.O. (2023), "Assessment of innovation activity of energy sector enterprises", *Economics: Yesterday, Today, Tomorrow*, Vol. 13, No. 3-1, pp. 251–256. https://doi.org/10.34670/AR.2023.66.32.027.

Lagutenkov, A.A., Rodionov, D.G. (2022), "Stages of evolution and development of the 'green' economy", *Bulletin of the Academy of Knowledge*, Vol. 49, No. 2, pp. 142–151.

Lebedeva, N.E., Arzumanyan, A.E. (2024), "Mechanisms of managing financial resources of material and technical support companies under sanction pressure", *Bulletin of the Altai Academy of Economics and Law*, No. 5-1, pp. 87–92. https://doi.org/10.17513/vaael.3417.

Loktionov, V.I. (2013), "Investment attractiveness of the energy sector of the region as an aspect of energy security", *National Interests: Priorities and Security*, Vol. 9, No. 18(207), pp. 44–49.

Nacef, A., Mechta, D., Louail, L., Harous, S. (2023), "Genetic Algorithm-Based Path Selection for Power-Efficient Energy Routing in Smart Grids and Energy Internet", *2nd International Engineering Conference on Electrical, Energy, and Artificial Intelligence (EICEEAI*), Zarqa, Jordan, pp. 1–6. https://doi.org/10.1109/EICEEAI60672.2023.10590502.

Orlova, A.F., Shcherbakova, N.S., Petrochenko, P.A. (2018), "Risk mitigation through insurance programs for Russian energy companies", *Management of Economic Systems: Electronic Scientific Journa*l, No. 6(112), pp. 1-15 (in Russian).

Pashkevich, M.A., Petrova, T.A. (2006), "Development of an optimal structure for monitoring technogenic impact of hazardous energy sector facilities", *Mining Information-Analytical Bulletin*, No. 8, pp. 139–144.

Wang, T., Liu, J. (2023), *Fractional programming approach for optimizing fuel efficiency in energy systems*, arXiv. https://arxiv.org/abs/2310.17913.

Yang, Z., Gao, W., Li, J. (2022), "Can Economic Growth and Environmental Protection Achieve a 'Win–Win' Situation? Empirical Evidence from China", *International Journal of Environmental Research and Public Health*, Vol. 19, No. 16, p. 9851. https://doi.org/10.3390/ijerph19169851.

Yin, K., Cai, F., Huang, C. (2023), "How Does Artificial Intelligence Development Affect Green Technology Innovation in China? Evidence from Dynamic Panel Data Analysis", *Environmental Science and Pollution Research*, Vol. 30, pp. 28066–28090. https://doi.org/10.1007/s11356-022-24088-0.

Zaytsev, A., Dmitriev, N., Alferyev, D. (2024), "Optimization of Interaction with Counterparties: Selection Game Algorithm under Uncertainty", *Mathematics*, Vol. 12, No. 13, p. 2079. https://doi.org/10.3390/math12132079.

Zaytsev, A., Dmitriev, N., Barykin, S. (2023), "Resource Potential of Socio-Economic Development in the Regional Sustainability Context: the Role of Energy Security and Environment", *IOP Conference Series: Earth and Environmental Science*, Vol. 1275, p. 012041. https://doi.org/10.1088/1755-1315/1275/1/012041.

Zaytsev, A., Dmitriev, N., Sebbaggala, T. (2022), "Economic aspects of green energy development in the context of maintaining strategic sustainability and environmental conservation", I*OP Conference Series: Earth and Environmental Science*, Vol. 1111, p. 012080. https://doi.org/10.1088/1755-1315/1111/1/012080.

Zhao, T., Shah, S.A.A. (2024), “Green Energy, Economic Growth, and Innovation for Sustainable Development in OECD Countries”, *Sustainability*, Vol. 16, No. 22, 10113. https://doi.org/10.3390/su162210113.
Zhencheng, F., Yan, Z., Wen, S. (2023), “Artificial Intelligence in Renewable Energy Systems: Challenges and Opportunities”, *Journal of Energy Management*, Vol. 15, pp. 198–204.
Zhen, Y., Gao, W., Li, J. (2022), “Innovative Strategies for Integrating AI in Green Technology”, *Energy Innovations Journal*, Vol. 14, pp. 312–320.
Zhen, F., Wang, L., Liu, Y. (2023), “Sustainability Metrics for Renewable Energy Systems”, *International Journal of Sustainability Studies*, Vol. 18, pp. 56–71.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Lukpanova, Z., Jumabekova, A., Kazhmukhametova, A., Dairabayeva, A., Bekzhanova, T. (2026), "Analysis of Inclusive Governance for Public Authorities Within the Framework of a Human-Centered Model of Public Administration", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 207-219.

Analysis of Inclusive Governance for Public Authorities Within the Framework of a Human-Centered Model of Public Administration

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ARTICLE INFO

Received April 14, 2025
Revised from May 15, 2025
Accepted June 15, 2023
Available online April 15, 2024

JEL classification: H75, H76

DOI: 10.14254/1800-5845/2026.22-2.16

Keywords:
inclusive growth,
sustainable development,
public policy,
human-centered management,
public services,
public administration

ABSTRACT

The transition to inclusive and sustainable growth is a key strategic goal of the state policy of the Republic of Kazakhstan and is consistent with the country's international commitments in the field of sustainable development. Inclusive growth is aimed not only at achieving high rates of economic growth, but also at ensuring its quality in terms of social impact, justice and equal access to opportunities for all citizens. Particular attention is paid to vulnerable and socially disadvantaged groups of the population, whose interests should be taken into account in the process of forming state policy. The implementation of an inclusive model requires the introduction of principles of good governance, including transparency, accountability, citizen participation, as well as effective digital transformation of public services, creating the prerequisites for the formation of a socially oriented economic system in which each person has equal conditions for realizing their potential and achieving well-being. The purpose of the study is to identify and quantify the impact of socio-economic and digital factors on the development of inclusive governance in the public administration system of the Republic of Kazakhstan in the context of the transition to a human-centered model. Research hypothesis. Socioeconomic and digital factors, such as the

level of youth employment in public administration, salaries of civil servants, the volume of electronic services provided and the level of digital infrastructure, have a significant impact on the development and quality of public services, and also contribute to the formation of an inclusive and human-centered model of public administration. The result of the study is the fact that, based on statistical and factor analysis, key determinants have been identified that contribute to increasing the accessibility, efficiency and fairness of public services, as well as the development of recommendations for the implementation of inclusive approaches to governance, taking into account digitalization and the needs of various groups of the population. The results of the study confirmed the significant influence of socioeconomic and digital factors on the development of inclusive governance within the framework of a human-centered model of public administration. It was revealed that such indicators as the level of salaries of civil servants and the volume of electronic services provided play a key role in ensuring the accessibility, quality and equality of public services for all categories of the population.

INTRODUCTION

Modern processes of public administration transformation are aimed at enhancing its openness, adaptability and efficiency in the context of rapid social, economic and technological changes. At the center of these transformations is a human-centered model of public administration, focusing on the needs, rights and interests of citizens as the main goal and resource for development. One of the key components of this model is inclusive governance, which involves the active involvement of all groups of the population, including vulnerable and marginalized segments of society, in decision-making processes, the formation of public policy and control over its implementation. Inclusive governance ensures equal access to participation in governance processes, promotes social justice, increases the level of trust in government institutions and promotes sustainable development. However, the implementation of the principles of inclusiveness requires not only regulatory consolidation, but also institutional changes, the development of feedback mechanisms, digital solutions and the readiness of government agencies for intersectoral interaction. The purpose of this study is to analyze practices and approaches to inclusive governance in the context of a human-centered model of public administration, identify barriers and opportunities for greater citizen involvement in governance at various levels, and offer recommendations for improving the effectiveness and inclusiveness of public policy.

In the context of public administration modernization, the Republic of Kazakhstan is actively implementing a human-centered approach aimed at meeting the needs of citizens, ensuring their rights and freedoms, as well as involving society in the processes of developing and implementing public decisions. Kazakhstan's path from poverty reduction to inclusive growth demonstrates significant achievements, but also highlights the importance of targeted policies to address persistent imbalances. Improving the quality of education, especially for vulnerable groups, is critical to leveling the playing field and preparing Kazakhstan's workforce for future opportunities.

Economic progress between 2006 and 2021 significantly improved living standards and reduced poverty in Kazakhstan. However, since 2014, economic growth has slowed and the pace of poverty reduction has fallen. The COVID-19 pandemic has exacerbated the problems, highlighting the need for sustainable and inclusive economic strategies. Kazakhstan actively demonstrates its commitment to the Sustainable Development Goals (hereinafter - SDGs), integrating them into the State Planning System and striving to achieve 88 national SDG indicators by 2030, aligned with national projects and regional development programs. However, the success of the state depends not only on institutional and legislative decisions, but also on adequate financing. Kazakhstan is taking steps to expand public participation mechanisms, develop digital feedback platforms, create conditions for intersectoral interaction and involve citizens in public administration. However, these processes are accompanied by a number of challenges - limited institutional maturity, underrepresentation of vulnerable groups, low levels of digital literacy in certain regions and weak coordination between different levels of government.

1. RESEARCH METHODS

The study is based on the integration of an interdisciplinary approach that combines elements of public policy, digital transformation, economics and human resource management. The study used both qualitative and quantitative methods of analysis aimed at a comprehensive assessment of the factors influencing the development and effectiveness of public administration services in the context of a human-centered and inclusive approach.

A. Analysis of statistical data

B Correlation and regression analysis:

- the multiple linear regression method was used to determine the degree of influence of various factors (X1–X6) on the volume of public administration services (Y);
- the regression model allowed us to identify significant predictors, as well as to assess the strength and direction of relationships between variables

C. Factor analysis (PCA) - the principal component analysis was used to reduce the dimensionality of the data and identify hidden latent factors reflecting groups of interrelated variables:

- socio-economic scale (wages, employment, ICT costs);
- digital accessibility (electronic services, Internet infrastructure).

D. Visualization and conceptual modeling

E. Interpretive and comparative-analytical approach:

- comparative analysis of data by years allowed to identify dynamics and trends;
- qualitative interpretation of factors within the framework of a human-centered model of public administration was carried out, taking into account the principles of accessibility, transparency, participation and motivation.

2. LITERATURE REVIEW

Certain governance issues continue to impede sustainable economic growth in the long term, including excessive centralization of power, politicized decision-making, limited powers of regional authorities, lack of transparency and corruption. In line with the global push for inclusive and sustainable growth, Kazakhstan has adopted national and regulated development programs and strategies to pave the way for sustainable development, laying the institutional and legal foundations for the transition to green growth in Central Asia, adopting a number of legislative documents, including:

- Law on Environmental Protection dated 9th of January 2007 No. 212. Repealed by the Code of the Republic of Kazakhstan dated 2nd of January 2021 No. 400-VI (Law);
- Law on Support of the Use of Renewable Energy Sources dated 4th of July 2009 №165-IV, (with amendments and additions as of 07.03.2022) (Law);
- The Concept of Transition to a Green Economy (Decree of the President).

The transition to green growth requires effective coordination between government agencies, national and international investors and society as a whole. There is a clear gap in a holistic and reliable framework for analyzing sustainable development performance in order to measure and improve sustainability indicators. The study by Chrisovalantis Malesios, Debashree De Andreas Maursellas, Prasanta Kumar Dey, Konstantinos Evangelinos (2021) addresses this knowledge gap by addressing two research questions - what practices and performance criteria are considered for sustainability performance analysis in a broad environmental, economic and social context, how are they related and what methods are used to determine the relationship between sustainable development practices and performance.

The effectiveness of the state depends on a well-functioning bureaucracy, in which competent civil servants are motivated to carry out their duties (Bertrand et al., 2021; Matei & Camelia, 2015). In Europe, sustainable development policy is the subject of numerous initiatives, as reflected in the Water Framework Directive 60/2000/EC (Karasaki et al., 2023). Lucendo-Monedero et al. (2018), Ruiz-Rodríguez et al. (2018) focus their research on the digital divide, which indicates the global scale of this phenomenon and

its impact on various economic scenarios. Recently, the consideration of the impact of information technology on the effectiveness of public administration in the Republic of Kazakhstan has gained particular importance in the context of digitalization development (Orazgalieva & Tazhieva, 2023). Digital platforms providing public services are essentially a portal with wide and unlimited access at any time of the day (Panova, 2020).

Digitalization in the public sector contributes to the achievement of sustainable development goals, based on the assumption that the use of digital technologies can lead to improved efficiency of public services and, therefore, contribute to sustainable development (Fleron et al., 2021). B. Bokayev et al. (2021) analyze the digitalization policy in Kazakhstan in the context of the introduction of e-government, with special attention to the role of citizens and their satisfaction with the quality of services provided.

S. Orazgaliyeva et al. (2023) examine the role of e-government in improving the efficiency of public administration in Kazakhstan, analyzing its current state and offering recommendations for further development. In world practice, various indicators are used to assess the development of human capital, including the human development index (hereinafter referred to as HDI) or the human development index (hereinafter referred to as HDI). The increasing importance of human capital as a driving factor in economic development has led to the emergence of the concept of sustainable development, within the framework of which the formation of a human capital management strategy becomes one of the key factors in development (Sukharev, 2017).

The solution to practical problems of assessment and formation of a systems approach in the structure of human-centered public administration, a reasonable choice of the necessary methods, techniques and technologies directly depends on the methodology taken as a basis, which contains the basic principles of the study, taking into account its essence and content, forms of manifestation in behavior, characteristics of personnel and the results of its interaction. The formation of such a system is necessary so that it becomes service and customer-oriented. In this regard, it is necessary to ensure de-bureaucratized and unhindered access of citizens to government services.

The introduction of a ban on the request for information available in information systems has made it possible to exclude certain reference services over the past three years. In foreign science, various issues of digital public administration in the interests of sustainable development are devoted to scientific works: S. Burlacu et al. (2021). Of significant interest was the study of the works of H. Seo and S. Myeong (2020), devoted to the topic of priority factors in building a government as a platform with an analytical hierarchical analysis of processes.

Public participation is a key element of modern public administration, and its importance is emphasized in a number of international and national strategic documents, including the SDGs. The study allows us to conclude that the transition to an inclusive and human-centered model of public administration in the Republic of Kazakhstan is not only timely, but also objectively necessary in the context of increasing social, demographic and technological transformation.

A modern state should not just provide services, but act as a partner for citizens, ensuring equal access to opportunities, taking into account the interests of all social groups, especially vulnerable categories - youth, the elderly, people with disabilities, residents of remote regions. However, the most important condition for the implementation of an inclusive model is not only the availability of resources, but also the presence of political will and institutional flexibility that allow the governance system to be adapted to the expectations of society.

According to the authors, inclusive public administration cannot be implemented solely through digitalization or process reform. It requires a cultural reorientation of the entire system: from a hierarchical, departmental-closed approach to open, dialogic and human-oriented interaction. Inclusivity should not be viewed as an additional element of modernization, but as a basic principle of state thinking, built into all stages: from policy design to its implementation and feedback with society. Therefore, it is important:

- to develop mechanisms for public participation (through digital platforms, councils, surveys);
- to strengthen the transparency and accountability of government agencies;
- to stimulate youth participation and intergenerational continuity in governance;

– to build a governance system based on the values of equality, openness and trust.

3. ANALYSIS

In the context of sustainable development of the state apparatus, systematic improvement of business processes is of crucial importance. It not only improves work efficiency, but also promotes more rational use of resources, which is an important factor in the implementation of the principles of sustainable development. Modern trends in human resource management (HRM), aimed at increasing the efficiency of human capital, include the implementation of the principle of human-centeredness, taking into account the characteristics and needs of each employee with the formation of a favorable organizational environment.

The state planning system, taking into account the introduction of new and reboot of existing documents, has retained a three-level hierarchical system that ensures the implementation of the Strategy "Kazakhstan-2050" in modern conditions and with existing trends in global development. The Strategy "Kazakhstan-2050" remains the key document of the country (or a document of the highest level), defining the long-term vision of the state's development, where the national priorities are such areas as:

– the well-being of citizens;
– the quality of institutions;
– a strong economy. The main principles of public administration are:
– a listening state - people first;
– an effective state - focused on achieving results, not progress;
– an accountable state - information openness, accessibility and accountability to society;
– a professional state - continuous improvement of the state apparatus and readiness for change;
– a pragmatic state - long-term and sustainable development, rational use of resources, total digitalization.

A fairly significant increase in Kazakhstan's position in the sustainable development rating is associated with the launched public administration reform. In 2020, as part of the President's address "Kazakhstan in the New Reality: Time for Action", an appeal was announced to mobilize the population around the state planning system. During the year, the Concept for the Development of the Public Administration System and the National Development Plan of Kazakhstan until 2025 were launched, where the transition to an inclusive, "human-centric" economic model was announced. Over the past year, Kazakhstan has made no progress in achieving the UN Sustainable Development Goals (SDGs), which our country joined in 2015.

The new UN Sustainable Development Report 2024 states that Kazakhstan ranked 66th out of 167 countries in the SDG index in 2023. Kazakhstan’s success in achieving the SDGs has a significant impact on its international status. At the beginning of 2024, the country ranked 66th out of 163 in the SDG ranking. This trend is due to the fact that problems persist in areas such as malnutrition (SDG 2), clean energy (SDG 7), climate change (SDG 13), terrestrial ecosystems (SDG 15), peace and justice (SDG 16), and sustainable partnerships (SDG 17- Figure 1).

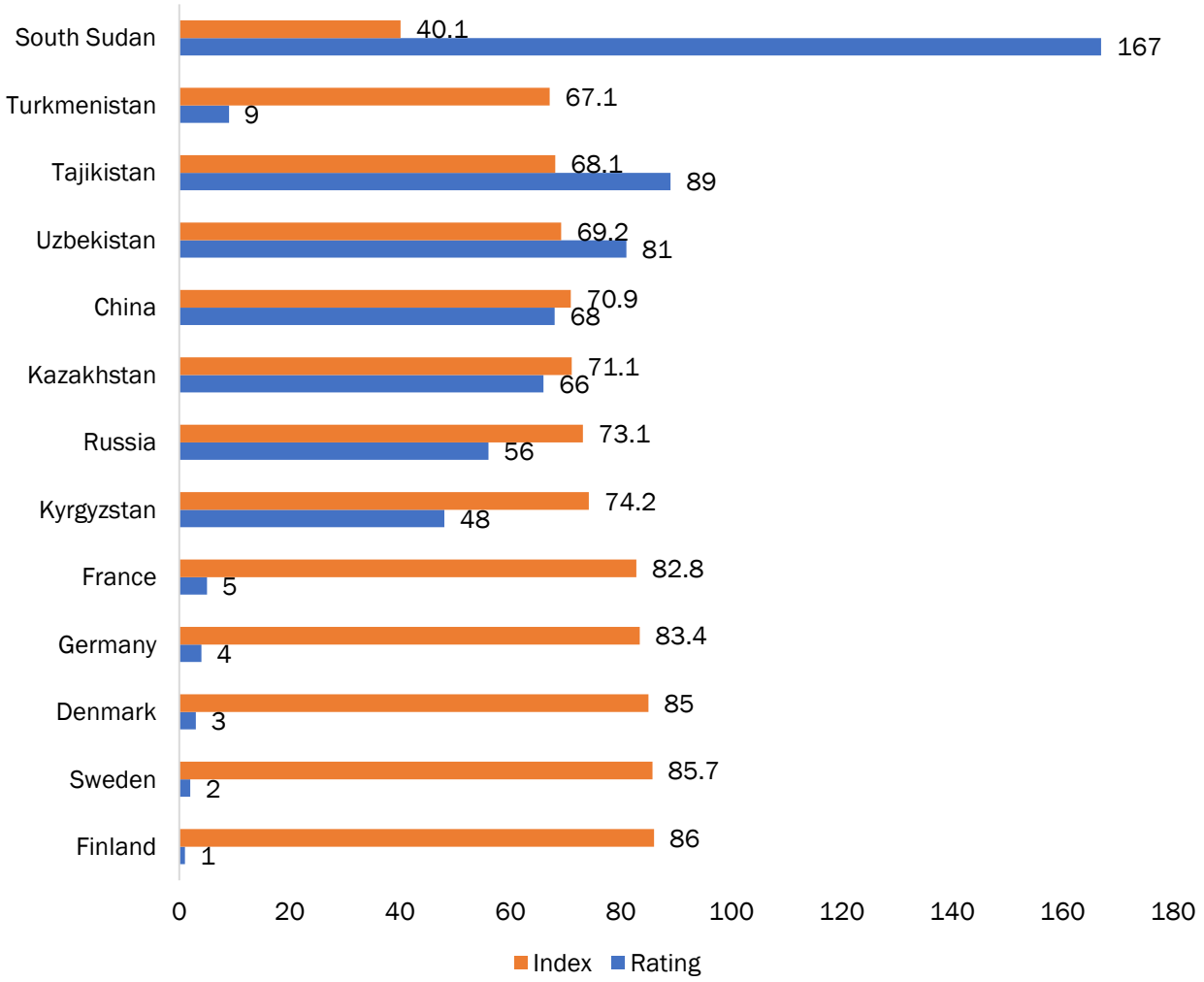

Figure 1. Rating of countries by SDG index, at the beginning of 2024, points
Source: compiled by the authors according to https://ranking.kz/reviews/world/kazahstan-ne-prodvinulsya-v-dostizhenii-tseley-ustoychivogo-razvitiya.html

Prioritizing SDG-oriented budgeting is critical to Kazakhstan's sustainable development by promoting coherence, accountability, and efficiency in resource allocation, bringing the country closer to achieving the SDGs and fulfilling its sustainable development commitments. Therefore, the following recommendations are proposed to strengthen SDG-oriented budgeting in Kazakhstan (Figure 2).

Figure 2. Recommendations for strengthening SDG-oriented budgeting in Kazakhstan

Source: compiled by the authors according to https://www.undp.org/ru/kazakhstan/stories/platforma-cur-dlya-centralnoy-azii-finansiruemaya-evropeyskim-soyuzom-sodeystvie-byudzhetirovaniyu-cur-v-kazakhstane

Kazakhstan’s overall assessment of SDG achievement over time is shown in Figure 3.

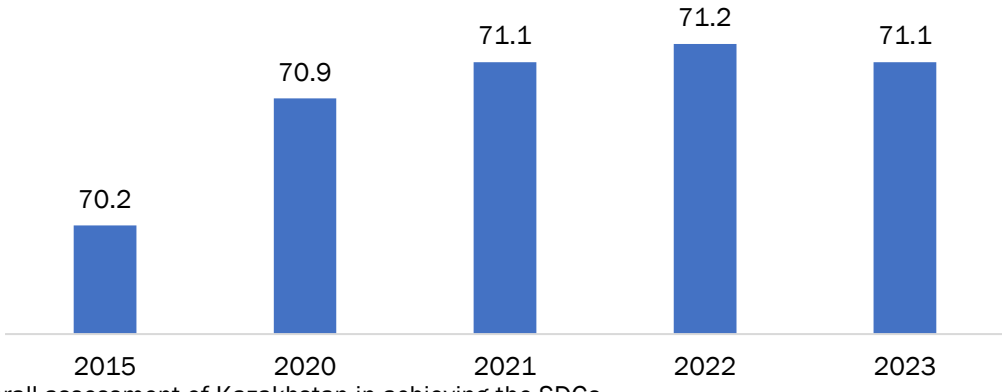

Figure 3. Overall assessment of Kazakhstan in achieving the SDGs

Source: compiled by the authors according **to** https://ranking.kz/reviews/world/kazahstan-ne-prodvinulsya-v-dostizhenii-tseley-ustoychivogo-razvitiya.html

To assess progress in achieving the SDGs, UN experts have made a country review for each state. All SDGs are divided into four categories based on their proximity to achieving the global target by 2030. They are marked in different colors:

- the best option is green - indicating that the country is close to achieving the goal. Kazakhstan has only one of the seventeen goals in the green zone, which is "Eradication of Poverty";
- in the yellow zone, which characterizes the lack of progress, Kazakhstan has only two SDG indicators - "Quality Education" and "Reduced Inequality";
- the intermediate orange zone indicates that the country is moving towards its goals, but it still has many unresolved problems. Kazakhstan has almost half of its goals in the orange zone;
- the most problematic is the red zone. It includes SDGs whose results are far from the indicators set by the UN.

4. RESULTS

For factor analysis of inclusive governance in the context of the human-centered model of public administration in Kazakhstan, it is possible to use indicators reflecting different aspects of citizen participation, accessibility and efficiency of public services, as well as institutional openness. Using factor analysis, the author identified several key factors influencing the resulting feature, which can explain the complex relationships between variables and contribute to the development of a strategy for their management (Table 1).

Table 1. Factors influencing the development and quality of public administration services in the context of resource provision, load on the system, level of demand for services and human capital

Coefficients	*Variable*	*Possible impact on government services*
X1	Average annual population, people	The larger the population, the higher the burden on government services, requiring more institutions and digital solutions
X2	GDP at current prices	Indicates the economic potential of the state - affects the financing of public services
X3	Demographic indicators (natural population growth)	Population growth = growth in demand for services (health care, education, social support)
X4	Average monetary expenditure of the population per capita, tenge	An indirect indicator of the standard of living that may correlate with expectations of the quality of public services
X5	Number of hospital organizations, units	Reflects the availability of one of the key public services - healthcare. Can be a proxy indicator of the breadth of service coverage
X6	Labor force, thousands of people	Reflects potential economic activity and employment of the population - affects the need for services related to employment, education, taxes, etc.
X7	Employed population, thousands of people	May indicate the stability of the social structure and the required level of support from government agencies
X8	Education level index, %	Directly affects digital literacy, the ability to use electronic government services, and participate in decision-making

Source: compiled by the authors

Indicators required for factor analysis (Table 2).

Table 2. Indicators required for studying the relationship between socio-economic factors and public administration services, million tenge

y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*
1814341,0	17 794 055	54 378 857,8	261 253	46 319	853	8 999	8 553,40	0,809
1948244,8	18 037 776	61819536,4	267 351	51 198	788	9 027	8 585,20	0,817
2316089,2	18 276 452	69532626,5	269 182	55 791	749	9 139	8 695,00	0,822
2564828,8	18 513 673	70649033,2	265 491	59 701	773	9 222	8 780,80	0,84
2678921,3	18 755 665	83951587,9	267 295	67 440	773	9 181	8 732,00	0,817
2660146,0	19 000 987	103765518,2	268 791	77 602	818	9 257	8 807,10	0,83
2755463,2	19 634 983	119442289,7	270 287	87 764	872	9 430	8971,5	0,823

Source: compiled by the authors according to http://www.stat.gov.kz

A table with factor loadings for the two extracted factors shows which variables contribute most to each latent factor (Table 3).

Table 3. Table with factor loadings for two extracted factors

Coefficients	*Variable*	*Socio-economic potential and scale of the system*	*Quality of human capital and infrastructure*
		Factor 1 (X1, X2, X4, X6/X7	*Factor 2 (X8, X5)*
X1	Average annual population, people	0.97744416225525	-0.1951848873762794
X2	GDP at current prices	0.93711347034872	-0.3410383942387499
X3	Demographic indicators (natural population growth)	0.688466218744667	-0.1762943343921437
X4	Average monetary expenditure of the population per capita, tenge	0.95278309905174	-0.302041245190589
X5	Number of hospital organizations, units	0.3158701489625248	-0.3442627627553554
X6	Labor force, thousands of people	0.9996177660276078	0.023094173960792903
X7	Employed population, thousands of people	0.9990318943001893	0.0422473627402008
X8	Education level index, %	0.5347777010690016	0.4778100156851339

Source: compiled by the authors

Factor 1 can be interpreted as the size and economic power of a region or country, which affects the need for public services and the resource base of governance.

Factor 2 can be associated with the level of infrastructure development and the quality of human capital, which affect the availability and efficiency of services.

The graph of factors (two-dimensional projection) is presented in Figure 4.

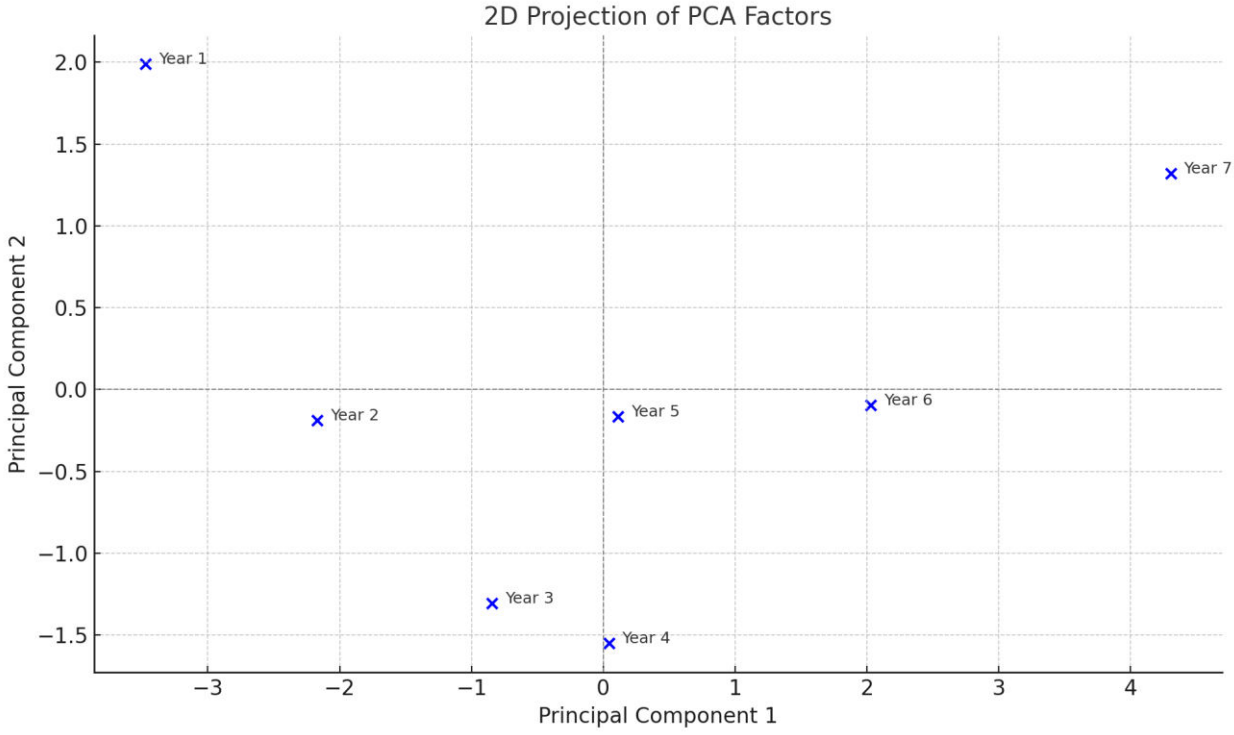

Figure 4. Two-dimensional projection of factors (factor analysis)
Source: compiled by the authors

It is also possible to consider the interpretation of factors and services in the field of public administration in the context of the analysis of inclusive governance within the framework of a human-centred model of public administration, with an emphasis on the principles of digitalization, accessibility, participation and efficiency (Table 4).

Table 4. Factors motivating civil servants taking into account the digitalization of the economy

Year	U, services in the field of public administration, million tenge	X1 Employed youth in the public administration system under 30 years old, thousands of people	X2 Average salary of civil servants, tenge	X3 Employed population in the civil service, thousands of people	X4 Total costs for ICT (including the organization of public administration), million tenge	X5 volume of government services via the Internet, million tenge	X6 organizations using the Internet (including government organizations), units
2010	815065,7	94,7	70437	376,5	147 538,3	54 271,0	45 354
2011	1009479,9	105,8	84987	391,9	214 179,7	65 264,0	48 064
2012	1225449,9	111,4	98293	385,8	309 821,2	69 387,0	49 853
2013	1386994,2	108,3	103467	402,4	220 847,7	71 256,0	58 456
2014	1516375,2	140,2	106000	467,7	237 079,4	73 488,4	52 630
2015	1708422,4	139,5	107924	470,8	375 600,4	39 156,4	65 186
2016	1645153,2	141,7	118868	472,8	269 526,7	80 198,4	75 779
2017	1814341,0	123,2	125247	479,3	349 943,6	70 356,2	79 658
2018	1948244,8	144,2	134835	500,5	305 217,4	136123,0	100 702
2019	2316089,2	123,2	157152	495,3	337 712,7	121153,7	105 531
2020	2564828,8	132,6	184704	489,3	388 928,5	209164,7	110 246
2021	2678921,3	124,5	195256	491,2	443 121,3	247928,6	107 121
2022	2860337.35	125,15	214308.0	489,15	495825.6	311316.05	107916.0
2023	3041753.4	125,8	233360.0	487,1	548529.9	374703.5	108711.0
2024	3223169.45	126,45	252412.0	485,05	601234.2	438090.95	109506.0

Source: compiled by the authors according to http://www.stat.gov.kz

The results of the regression analysis revealed that:

- the most important factor in the growth of public services is the salary of civil servants - it has a positive and statistically significant effect.
- the growth in the volume of Internet services (X5) in this model shows a negative relationship, indi(ICT costs)cating a decrease in the cost of providing services with the growth of digitalization;
- the remaining variables did not show a statistically significant effect (at $p > 0.05$), possibly due to multicollinearity or limited data volume (Table 5).

Table 5. Results of regression analysis

Variable	*Coefficient*	*P-value*	*Meaning*
X2 (average salary of civil servants)	+14,97	< 0.001	Significant positive contribution
X5 (Internet services)	-1,77	0.020	Significant positive contribution
X1 (youth under 30)	-355,74	0.878	It doesn't matter
X3 (employed population)	+2098,36	0.127	Moderate importance
X4 (ICT costs)	+0,31	0.390	It doesn't matter
X6 (organizations with internet)	+0,49	0.802	It doesn't matter

Source: compiled by the authors

$R^2 = 0.998$ Very high degree of explanation of the model - 99.8% variations Y explains X

Adj. $R^2 = 0.996$ Taking into account the number of variables, the model remains very accurate.

F-Statistic = 620.3 ($p < 0.001$) - the model is statistically significant overall.

Within the framework of the human-centric model and inclusive governance, the interpretation of factors reflects the scale and volume of public services provided for inclusiveness:

X1 – Employed youth in public administration under 30, thousand people:

- reflects the degree of youth participation in the decision-making system;
- is an indicator of rejuvenation and renewal of the state apparatus, which is important for long-term adaptability;
- support for youth employment contributes to the inclusion of the new generation in governance, expanding the representation of youth interests.

X2 – Average salary of civil servants, tenge:

- shows the motivation and prestige of working in the public sector;
- higher salaries help retain qualified specialists, which is important for sustainable governance that is oriented towards the needs of citizens;
- reduces the risks of corruption, increasing trust in government.

X3 – Total employed population in the civil service, thousand people:

- reflects the scale of the institutional infrastructure that ensures the provision of public services;
- a higher value indicates a wide coverage, but also requires optimization of personnel management to avoid bureaucratization.

X4 – Total ICT expenditure (including public administration), million tenge:

- an indicator of infrastructure digitalization - an important element of the availability and transparency of public services;
- ICT investments ensure inclusive access to services via the Internet, especially for remote regions and people with limited mobility;
- an increase in ICT expenditure, if implemented correctly, enhances efficiency and feedback with citizens.

X5 – Volume of public services sold via the Internet, million tenge:

- one of the most direct indicators of digital inclusion;
- an increase in volume indicates a reduction in barriers to obtaining services (time, geography, physical limitations);
- Internet services are a key channel for a human-centric approach, where the citizen is an active user and controller

X6 – The number of organizations using the Internet, including government agencies:

- widespread use of the Internet by institutions indicates a deep digital transformation;
- an increase in the indicator reflects the ability of the public sector to be technologically adaptive, enhancing inclusiveness and transparency.

Effective development of public administration services requires a balance between human capital, the level of motivation of civil servants and technological progress. Particular attention should be paid to digital tools, as they allow not only to expand access, but also to optimize costs and increase citizen satisfaction. Regression and factor analysis confirm that salaries, digitalization and competent distribution of ICT investments are key vectors within the framework of inclusive, transparent and human-oriented governance.

CONCLUSION

The conducted study confirmed the high importance of introducing an inclusive approach to the public administration system in the context of a human-centered model focused on the needs, participation and equal opportunities for all categories of citizens. Analysis of quantitative data showed that the key factors influencing the scale and quality of public services are:

- the level of salaries of civil servants, as an indicator of motivation and professionalism;
- digitalization and the volume of services provided via the Internet, as an indicator of accessibility and technological inclusion;
- the personnel composition and employment of young people in the public administration system, as the basis for the sustainability and renewal of the public sector.

Factor analysis made it possible to identify two dominant areas: socio-economic scale and digital transformation, corresponding to the modern priorities of the state policy of the Republic of Kazakhstan.

The practical significance of the study lies in the possibility of applying its results in:

- strategic planning and monitoring of reforms in the field of civil service;
- development of digital infrastructure and Internet services;
- assessment and promotion of the principles of inclusive and transparent governance.

Thus, inclusive governance is inextricably linked with effective human resources policy, digital transformation and a socially oriented system of public services, requiring a systematic approach and constant feedback from citizens as active participants in the public administration process.

ACKNOWLEDGEMENTS

This research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No.BR27100377- "Development of an inclusive governance model for government agencies within the framework of a human-centric model of public administration").

REFERENCES

Bertrand, M., Cortes, P., Olivetti, C., Pan, J. (2021), "Social Norms, Labour Market Opportunities, and the Marriage Gap Between Skilled and Unskilled Women", *The Review of Economic Studies*, Vol. 88, No. 4, pp. 380-410

Bokayev, B., Davletbayeva, Z., Amirova, A., Rysbekova, Z., Torebekova, Z., Jussupova, G. (2021), "Transforming E-government in Kazakhstan: A Citizen-Centric Approach", *The Innovation Journal: The Public Sector Innovation Journal*, Vol. 26, No. 1, pp. 1-21. https://innovation.cc/wp-content/uploads/2021_26_1_2_bokayev_e-gov-kazakhstan.pdf

Burlacu, S., Loredana, M., Diaconu, A. (2021), "Digital Public Administration for Sustainable Development", *European Journal of Sustainable Development*, Vol. 10, No. 4, pp. 33-40. https://ecsdev.org/ojs/index.php/ejsd/article/download/1257/1237

Decree of the President of the Republic of Kazakhstan dated May 30, 2013, No. 577, *Concept of Transition to a Green Economy*, https://adilet.zan.kz/rus/docs/U1300000577

Fleron, B., Pries-Heje, J., Baskerville, R. (2021), "Digital organizational sustainability: the history of Denmark as the most digitalized country", *Proceedings of the 54th Hawaii International Conference on System Sciences*, pp. 2400-2409, https://scholarspace.manoa.hawaii.edu/bitstream/10125/70907/0236.pdf10

Karasaki, S., Goddard, J., Cohen, A., Ray, I. (2023), "Environmental justice and drinking water: a critical review of primary data studies", *WIREs Water*, Vol. 10, No. 5, pp. e1653. https://doi.org/10.1002/wat2.1653

Law on Environmental Protection dated 09.01.2007, No. 212, *Repealed by the Code of the Republic of Kazakhstan dated January* 2, 2021 No. 400-VI. https://adilet.zan.kz/rus/docs/K070000212

Law on Support of the Use of Renewable Energy Sources dated 04.07.2009 No. 165-IV (with amendments and additions as of 09.09.2024), https://online.zakon.kz/Document/?doc_id=30445263

Lucendo-Monedero, A.L., Ruiz-Rodríguez, F., González-Relaño, R. (2019), "Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe", *Telematics and Informatics*, No. 41, pp. 197-217. http://dx.doi.org/10.1016/j.tele.2019.05.002

Malesios, Ch., Moursellas, D.D.A., Dey, P.K., Evangelinos, K. (2021), "Sustainability performance analysis of small and medium sized enterprises: Criteria, methods and framework ", *Socio-Economic Planning Sciences*, Vol. 75, pp. 100993. https://doi.org/10.1016/j.seps.2020.100993

Matei, A., Camelia, G. (2015), "Public Service in Romania and its Role in the Development of the Administrative Capacity", *Procedia Economics and Finance*, Vol. 23, pp. 982–985.

Orazgalieva, S.O., Tazhieva, S.K. (2023), "Assessment of the influence of information technology efficiency of state management", *Bulletin of the University of Turan*, Vol. 2, pp. 234-247. https://doi.org/10.46914/1562-2959-2023-1-2-234-247

Orazgaliyeva, S., Satpayeva, Z.T., Tazhiyeva, S.K., Nurseiytova, G. (2023), "E-government as a tool to improve the efficiency of public administration: The case of Kazakhstan", *Problems and Perspectives in Management*, Vol. 21, No. 2, pp. 578-591. http://dx.doi.org/10.21511/ppm.21(2).2023.53

Panova, A.K. (2020), "National project «digital government management» as a mechanism for assessing the efficiency of state management", *Scientific and practical research*, Vol. 28, No. 5, pp. 63–68

Ruiz-Rodríguez, F., Lucendo-Monedero, A. L., González-Relaño, R. (2018), "Measurement and characterization of the Digital Divide of Spanish regions at enterprise level. A comparative analysis with the European context", *Telecommunications Policy*, Vol. 3, No. 42, pp. 187-211. https://doi.org/10.1016/j.telpol.2017.11.007

Sukharev, M.V. (2017), "Human capital management in the information society", *Economics and management systems management*, Vol. 24, No. 2, pp. 235-243.

Seo, H., Myeong, S. (2020), "The Priority of Factors of Building Government as a Platform with Analytic Hierarchy Process Analysis", *Sustainability*, Vol. 12, No. 14, pp. 5615, https://www.mdpi.com/2071-1050/12/14/5615/htm

* https://ranking.kz/reviews/world/kazahstan-ne-prodvinulsya-v-dostizhenii-tseley-ustoychivogo-razvitiya.html

** https://www.undp.org/ru/kazakhstan/stories/platforma-cur-dlya-centralnoy-azii-finansiruemaya-evropeyskim-soyuzom-sodeystvie-byudzhetirovaniyu-cur-v-kazakhstane

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Sabyrzhan, A., Jazykbayeva, B., Zhumabekova, M., Kapenova, A., Dauletbayeva, L., Omarova A. (2026), "The Impact of Healthcare Financing on Labor Productivity in a Digitalized World". *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 221-236.

The Impact of Healthcare Financing on Labor Productivity in a Digitalized World

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ARTICLE INFO

Received May 20, 2025
Revised from June 20, 2025
Accepted July 21, 2025
Available online April 15, 2026

JEL classification: I15, I38, I39

DOI: 10.14254/1800-5845/2026.22-2.17

Keywords:

finance,
healthcare,
productivity,
digital technologies,
artificial intelligence,
cost efficiency,
sustainable development.

ABSTRACT

Relevance of the Study. Given the digital transformation of the economy and the growing social importance of healthcare, analyzing the efficiency of financial resource use in the sector and its impact on medical personnel productivity is particularly relevant. Increased government and insurance spending, the introduction of mandatory social health insurance, and the rapid development of digital technologies, including artificial intelligence-based solutions, require a rethinking of traditional approaches to assessing the effectiveness of healthcare financing.

The aim of the study is to identify and economically substantiate the relationship between healthcare financing and labor productivity in the context of digital technology implementation.

The results demonstrate that increased healthcare financing, accompanied by the digitalization of processes and the implementation of AI solutions, contributes to increased labor productivity by reducing unproductive labor costs, streamlining clinical and administrative processes, and more efficient use of human resources. It has been established that, given the limited share of healthcare spending in GDP, the key factor in sustainable growth is improving the efficiency of financial resource use, rather than increasing its quantitative growth.

Conclusions. It is concluded that digital technologies and artificial intelligence are important tools for transforming financial resources into increased labor productivity and the sustainability of the healthcare

system. The effect of digitalization is most significant with targeted financing and the comprehensive implementation of digital solutions integrated into the management and performance evaluation system.

INTRODUCTION

With the accelerated digital transformation of the economy and the growing social significance of healthcare, the issue of the efficient use of financial resources in the sector and their impact on medical personnel productivity is becoming particularly pressing. Increased government and insurance spending on healthcare, the expansion of the range of medical services, the introduction of mandatory social health insurance, and the growing burden on the system as a whole are creating new demands on the quality of financial management and labor productivity. Furthermore, further extensive funding increases are encountering objective macroeconomic constraints, necessitating the search for intensive growth factors based on digital technologies.

The relevance of this study stems from the fact that in recent years, funding for the healthcare system in the Republic of Kazakhstan has demonstrated steady growth and a more complex structure of sources. However, this process is not always accompanied by a proportional increase in labor productivity. Amid a shortage of medical personnel, an increasing administrative burden, and the need to improve the accessibility and quality of medical care, digital technologies, including artificial intelligence-based solutions, are becoming a key tool for transforming financial resources into tangible economic and social impact. However, scientific research still pays insufficient attention to analyzing the relationship between healthcare financing, digitalization, and labor productivity as a systemic economic indicator.

The scientific novelty of this study lies in the development of a comprehensive approach to assessing the impact of healthcare financing on labor productivity, taking into account digital technologies. Unlike traditional studies, which focus primarily on analyzing funding volumes or individual performance indicators, this study examines funding in conjunction with digital transformation and the implementation of AI solutions as a factor determining intensive growth in labor productivity. This novelty also stems from the use of a structural analysis of funding sources (budget, guaranteed volume of free medical care, mandatory health insurance) and the comparison of their dynamics with changes in the volume of services provided and labor productivity indicators.

The practical significance of this study lies in the potential application of the findings in the development of public policy in the area of healthcare financing and digitalization. The results can be used by government agencies, health insurance funds, and heads of healthcare organizations to substantiate priorities for the allocation of financial resources, evaluate the effectiveness of digital investments, and develop measures to improve the productivity of medical personnel. The practical value of the work also lies in the fact that the proposed approaches can serve as a tool for monitoring and predicting the sustainability of the healthcare system in the context of digital technologies.

1. RESEARCH METHODS

The study's methodological framework was developed to comprehensively analyze the impact of healthcare system financing on medical personnel productivity in the context of digital

transformation and the implementation of artificial intelligence technologies. The study utilized a combination of general scientific, economic, and economic-statistical methods to ensure the objectivity and validity of the results.

1) Analysis of scientific literature and regulatory documents

A review of current domestic and international scientific publications, as well as regulatory documents in the field of healthcare financing and digitalization, was conducted. This method allowed us to identify theoretical approaches to assessing the effectiveness of financing, labor productivity, and the role of digital technologies, as well as to determine the main directions of public policy in this area.

2) Systemic and structural-functional approaches

A systems approach was used to examine healthcare as a complex socioeconomic system in which financing, digital technologies, and human capital are interconnected. A structural-functional analysis allowed us to assess the structure of funding sources (budget, guaranteed volume of free medical care, compulsory health insurance) and their functional impact on service volumes and labor productivity.

3) Economic and statistical analysis

This was used to study the dynamics of public healthcare spending, the volume of medical and social services provided, and their growth rates. This method calculated absolute and relative indicators, growth rates, structural shares, and indices, allowing us to identify key trends in the industry's development.

4) Labor productivity analysis

Labor productivity was assessed through the ratio of the volume of services provided to the labor force used, as well as through an analysis of unproductive labor costs. This method allowed us to determine the extent to which the growth in service volumes is achieved through increased staffing or through improved labor efficiency in the context of digitalization.

5) Methods of economic, mathematical, and predictive modeling

To assess the prospects for the development of the healthcare system, a linear forecast of service volumes based on actual growth rates was used. This approach allowed us to determine the potential burden on the system and justify the need to transition from an extensive financing model to an intensive one based on increased labor productivity and the implementation of AI solutions.

6) Comparative Analysis

This was used to compare the dynamics of funding and service volumes across different periods, including the pre-crisis, pandemic, and post-pandemic stages. This allowed us to identify the impact of changes in the funding structure and the level of digitalization on labor productivity.

7) Method of Interpreting and Summarizing Results

This was used to formulate conclusions and practical recommendations aimed at improving the efficiency of funding and the implementation of digital technologies in the healthcare system.

2. LITERATURE REVIEW

Research into the relationship between healthcare financing and medical personnel productivity occupies a significant place in modern economic and managerial science. Growing public and insurance spending on healthcare, the increasingly complex structure of funding sources, and the simultaneous tightening of demands on the quality and accessibility of medical services have raised the issue of the efficient use of financial resources in the sector. Given limited budgetary and human resources, analyzing the factors that drive rapid productivity growth is particularly important.

Modern research in healthcare economics increasingly views financing not as an end in itself, but as a tool for achieving sustainable results, including increasing the volume and quality of medical services, optimizing costs, and improving labor efficiency. Furthermore, in recent years, the scientific literature has shown increasing interest in the role of digital technologies, including electronic medical systems, big data, and artificial intelligence-based solutions, which have the potential to transform traditional models of healthcare delivery and industry management.

A significant portion of research is devoted to analyzing the impact of digitalization on clinical and management processes, reducing the administrative burden on medical personnel, and increasing the transparency of financial flows. However, most studies examine these aspects fragmentarily—either in the context of technological innovation or from the perspective of funding volumes—without a comprehensive assessment of their combined impact on labor productivity as a key economic indicator.

Therefore, this literature review aims to systematize scientific approaches to assessing healthcare financing, analyzing labor productivity factors, and identifying the role of digital technologies and artificial intelligence in improving the efficiency of financial and human resource use. This approach allows us to identify existing theoretical and empirical gaps, identify areas for further research, and formulate a conceptual framework for analyzing the impact of healthcare financing on labor productivity in a digitally connected world.

Digitalization facilitates accelerated industry development, effective customer interactions, improved service quality, etc. (Al-Dmour et al., 2020), (Tran et al., 2023), (Yang and Masron, 2023). Digital technologies can significantly reduce operational costs and increase efficiency, but require a serious approach to managing new types of risks (Aguayo and Ślusarczyk, 2020). Cocco, Pinna and Marchesi (2017) also confirm these findings in their study, while, like other researchers of blockchain technology, noting cost reduction as one of the factors (Al Shanti and Elessa, 2022). In addition to digital security, in the process of digitalization, healthcare organizations may face other risks, such as operational vulnerabilities, maintaining client privacy, etc. (Chen et al., 2024), (van Zeeland and Pierson, 2024). Globalization, increasing regulation and the increasing role of FinTech companies are prompting organizations to pay special attention to reducing barriers to digitalization implementation (Boot et al., 2020), (Ulrich-Diener et al., 2023).

Management across various industries requires a strategic approach that takes into account key development directions and is essential for achieving competitive advantage and sustainability

(Wang, 2021). L. Qiu, X. Jie, Y. Wang, M. Zhao (2019) and L.A. Suat (2019) argues that innovation in the field of sustainable development has a strong positive relationship with corporate competitiveness, emphasizing that integrating sustainability aspects into companies' activities contributes to their long-term success and competitiveness (El-Kassar et al., 2019).

In the context of modern economic development trends, the use of innovative methods is becoming essential both in technological processes and in the management system of healthcare organizations. At the same time, key emphasis is placed on the financial component of management, since it is the structure and efficiency of financing that determine the feasibility of implementing digital and intelligent solutions. Modern management models should not only improve management forms and methods, but also flexibly adapt to changes in development strategy, ensuring increased labor productivity and sustainable resource use. The implementation of digital technologies with targeted financial support makes the healthcare system more efficient and competitive. For example, integrating supply chains using digital tools optimizes procurement, reduces excess inventory, and expedites the delivery of medical services, thereby reducing operating costs and increasing return on investment. Demand forecasting based on big data analytics facilitates more accurate financial and workforce planning, minimizing inefficient spending and increasing staff productivity. At the same time, digitalization and innovative development stimulate the creation of new medical services and technologies, strengthening the competitiveness of healthcare organizations and improving the efficiency of investment resources.

In this context, the integration of artificial intelligence into the healthcare system of the Republic of Kazakhstan is particularly important. It is becoming a key area of digital transformation and is directly linked to the goal of increasing the productivity of healthcare workers. Amid staff shortages, increasing pressure on the mandatory social health insurance system, and an expanding range of medical services, the use of AI allows for the redistribution of routine and administrative functions, increasing the accuracy and speed of diagnostic decisions, and optimizing the use of material and human resources. As a result, financial investments in AI are transformed into an increase in the specific labor output per employee and a more rational use of the wage fund.

Despite the progress achieved in recent decades, research shows that many countries around the world still have unmet health care needs (leRoux et al., 2020). The most vulnerable groups—rural residents, low-income individuals, and socially disadvantaged groups—continue to face limited access to health services (McGough et al., 2018). These problems increase the burden on the system and require additional financial resources, making the issue of their effective use particularly pressing.

In this regard, an important aspect of managing the modernization of social healthcare infrastructure is ensuring financial sustainability and increasing labor productivity, rather than simply increasing expenditures. Unequal access to health services remains a key element of social inequality in healthcare, which is largely due to the lack of uniform approaches to assessing accessibility and a simplified understanding of this phenomenon in research. Attempts to eliminate access barriers without considering financial and organizational constraints prove insufficient, resulting in access to healthcare remaining a complex and unresolved issue (Roncarolo et al., 2017; Cabrela-Barona et al., 2017).

Thus, digital technologies and artificial intelligence-based solutions, with adequate funding and effective management, serve as a tool not only for modernizing healthcare but also for

increasing labor productivity, optimizing costs, and reducing inequalities in access to medical services.

An analysis of scientific research and practical approaches suggests that healthcare financing alone does not guarantee increased labor productivity unless accompanied by institutional and technological transformations. Contemporary literature agrees that in the context of the digital economy, it is precisely intensive development factors, primarily digital technologies and artificial intelligence-based solutions, that are becoming the key mechanism for transforming financial resources into sustainable socioeconomic outcomes. At the same time, scientific studies identify a number of systemic issues limiting the impact of funding and digitalization:

- First, a significant portion of the research documents a gap between cost growth and actual labor efficiency, which manifests itself in increased administrative burdens, fragmented digitalization, and duplication of functions;

- Second, uneven digital development across medical organizations and regions is noted, reducing the system-wide impact of technology implementation and exacerbating imbalances in access to medical care;

- Third, the issue of personnel and organizational readiness remains insufficiently addressed: without developing digital competencies among personnel and process reengineering, even modern AI solutions will not deliver the expected increases in labor productivity.

An additional problem is that a number of studies consider labor productivity indirectly—through service volumes or funding indicators—without directly linking it to labor time expenditure, employment structure, and the quality of medical personnel. This complicates the development of universal models for assessing the effectiveness of financing in the context of digital technologies.

According to the author, the further development of the healthcare system should be based not on an extensive expansion of financial resources, but on a qualitative change in the mechanisms for their use. Funding for digital technologies and AI solutions should be viewed as investments in increasing labor productivity, rather than as a separate expense item. Priority should be given to those digital initiatives that directly reduce unproductive labor costs, optimize clinical and administrative processes, and increase the return on human capital.

From a public policy perspective, this implies a transition to a performance-based financing model in which digital investments are assessed based on their contribution to increased labor productivity, system sustainability, and the reduction of inequalities in access to healthcare services. This approach allows us to create an economically sustainable, technologically advanced, and socially oriented healthcare model that meets the challenges of the digital age.

3. ANALYSIS AND RESULTS

The integration of artificial intelligence into the healthcare system of the Republic of Kazakhstan is becoming not only a key area of digital transformation but also a tool for improving the efficiency of financial resources in the sector, directly impacting the productivity of healthcare workers. Amidst a labor shortage, increasing burden on the mandatory social health insurance system, and an expanding range of medical services, the quality and structure of healthcare financing are becoming crucial for the implementation of digital technologies capable of ensuring rapid productivity growth.

Targeted funding for AI solutions enables the redistribution of routine and administrative functions, increases the accuracy and speed of diagnostic decisions, and optimizes the use of material and human resources. As a result, financial investments in digital technologies translate into increased productivity per healthcare worker, ensuring more efficient use of budget and insurance funds and enhancing the sustainability of the healthcare system as a whole (Table 1).

Table 1. Areas of funding for AI solutions in healthcare

	Direction	Application
1	The use of AI in radiology and imaging diagnostics (CT, MRI, X-ray, mammography)	Computer vision algorithms help automatically detect pathological changes and early stages of oncological and cardiovascular diseases, reducing the time it takes to interpret examinations and increasing the accuracy of conclusions, allowing radiologists to focus on complex cases, consulting with clinicians and interdisciplinary collaboration, and reducing the risk of diagnostic errors.
2	Clinical decision support systems (CDSS) - an intelligent decision support system	Based on an analysis of medical records, patient histories, and laboratory data, they generate diagnostic guidelines, treatment options, and complication prevention. In Kazakhstan, such solutions are particularly relevant at the regional and district hospital level, where there is a shortage of specialized specialists and a high workload for general practitioners.
3	Applying AI to Patient Flow and Resource Management	Hospitalization forecasting, bed planning, and smart patient routing between levels of care (primary care, district, regional hospitals, and national centers). Machine learning models analyze disease seasonality, demographic structure, and department workload, reducing waiting lists, more evenly distributing staff workload, and reducing unscheduled overtime, thereby increasing productivity and reducing the risk of burnout.
4	AI solutions in telemedicine and chronic patient monitoring	Remote monitoring systems, wearable data analysis, and automatic alerts about risk factors for deteriorating conditions (for example, cardiovascular disease and diabetes) can reduce the number of preventatively “missed” cases and reduce the volume of emergency care.
5	AI in drug supply and logistics management	Forecasting the need for medications and consumables, optimizing procurement and inventory, and identifying spending anomalies. This directly impacts the efficient use of budget funds and the productivity of administrative and management personnel.
6	AI in HR Analytics and Healthcare Workforce Management	Assessing personnel risks, planning workloads, modeling shift distribution scenarios, identifying factors that contribute to burnout and turnover—allows for more sustainable work schedules, increasing employee satisfaction and, consequently, productivity.
7	Assessment of the quality of medical services and ESG analytics in healthcare	Based on large data sets (volume of services provided, financing structure, complaints, safety indicators, data on resource consumption and waste), integrated indicators of the effectiveness and sustainability of healthcare organizations are formed, creating the basis for risk-scores in ESG areas and scenario analysis, which makes it possible to assess how changes in the structure of services, digitalization of processes or investments in energy efficiency will affect the quality of care, the workload of personnel and financial stability.

Source: compiled by the authors

According to the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, in the first quarter of 2025, the volume of services provided by healthcare organizations in the country amounted to 832,323.4 million tenge, which is 15.6% higher than the first three months of 2024, when the volume of healthcare services provided amounted to 719,830.8 million tenge.

Funding in the first quarter of 2025 was provided by the following sources:
- budget funds – 267,876.8 million tenge (32.2%),
- household funds – 178,981.4 million tenge (21.5%),
- enterprise funds – 82,581.8 million tenge (9.9%),
- funds from the Social Health Insurance Fund (SHIF) – 302,883.3 million tenge (36.4%).

Hospital services accounted for the largest volume of services – 391,575.9 million tenge, or 47% of the total. Of this amount,
158,797.8 million tenge came from the budget,
39,442.2 million tenge came from individuals,
20,046.8 million tenge came from businesses,
173,289.2 million tenge came from the Compulsory Medical Insurance Fund.

Analysis of the healthcare spending structure allows us to identify funding priorities and determine the areas where the system's primary financial burden is concentrated. A significant share of expenditures goes toward medical personnel salaries and associated administrative costs, making the efficient use of financial resources a key factor in the industry's sustainability. With the volume of services growing and budget and insurance funding limited, improving labor productivity is becoming essential for optimizing the cost structure.

In this context, funding digital technologies and artificial intelligence-based solutions is of strategic importance. Targeted investments in AI can reduce unproductive labor costs, optimize administrative and clinical processes, and reallocate costs in favor of increasing the productivity of healthcare workers. The structure of healthcare service expenditures in the first quarter of 2025 is presented in Table 2.

Table 2. Structure of expenditure on healthcare services in the first quarter of 2025

Expenses, thousand tenge	Q1 2025, total	Including at the expense of funds			
		Budget	Population	Enterprises	Social Health Insurance Fund
Total number of healthcare services provided	832 323 378	267 876 838	178 981 432	82 581 796	302883313
Including:					
Hospital services	391 575 941	158 797 804	39 442 154	20 046 829	173 289154
Services of hospital surgical departments	59 400 004	26 897 856	3 852 115	1 327 669	27 322 363
Services of gynecological departments of hospitals and maternity homes	41 524 691	17 849 988	2 145 051	2 249 220	19 280 432
Rehabilitation center services	18 364 802	6 757 928	4 680 829	3 458 793	3 467 252
Psychiatric hospital services	13 879 521	7 122 596	1 396 382	189 206	5 171 337
Other hospital services provided under the supervision of physicians	40 525 560	13 394 052	3 358 335	1 511 237	22 261 936
Services of other hospitals	217 881 363	86 775 384	24 009 442	11 310 704	95 785 833
Services in the field of general medical practice	174 189 659	51 460 603	32 922 926	19 776 968	70 029 162
Services in the field of specialized medical practice	61 948 882	11 091 192	20 250 829	5 994 185	24 612 676
Dental services	60 125 272	1 553 874	52 342 557	2 015 067	4 213 775
Other human health services	144 483 624	44 973 365	34 022 966	34 748 747	30 738 547

Source: compiled by the authors according to https://www.stat.gov.kz

Transforming the cost structure through the implementation of AI not only contributes to increased labor productivity but also to a more efficient use of healthcare system resources, including budgetary allocations and mandatory social health insurance resources.

The profound underfunding of Kazakhstan's free healthcare system is clearly evident in comparison with developed OECD countries. The level of public spending on healthcare relative to GDP in Kazakhstan is more than three times lower than the OECD average (Figure 1).

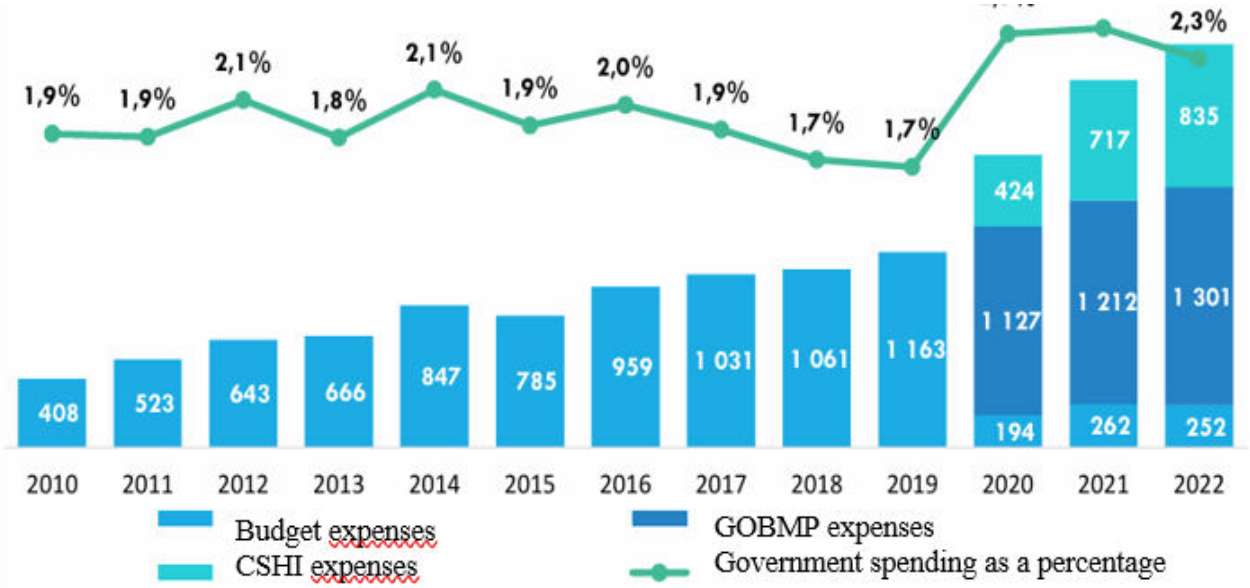

Figure 1. Government Expenditures by Source of Funding, in billion tenge
Source: compiled by the authors according to https://halykfinance.kz/

According to Figure 1:

- the share of the compulsory health insurance system is growing significantly (from 24.3% to 35.0%), indicating a stronger role for insurance financing;
- the guaranteed free medical care remains the largest source (~54–65%), which is logical for the basic guaranteed package;
- the "budget" component in the overall structure is approximately 10–12%

Structure of funding sources (shares), 2020–2022 (in 2010–2019, the budget share = 100% according to the presented graph) (Table 3).

Table 3. Structure of funding sources (shares), 2020–2022

Year	Budget, billion tenge	State Fund for Free Medical Care, billion tenge	Compulsory health insurance, billion tenge	Total, billion tenge	Budget share, %	Share of guaranteed volume of medical care, %	Share of compulsory health insurance, %
2020	194	1127	424	1745	11,1	64,6	24,3
2021	262	1212	717	2191	12,0	55,3	32,7
2022	252	1301	835	2388	10,6	54,5	35,0

Source: own

Until 2019, growth was generally moderate/wave-like, with the share of GDP remaining around 1.7–2.1%. In 2020–2021, there was a sharp jump in total financing (+50% and +25.6%), while the share of GDP rose to 2.5–2.6%. In 2022, growth slowed to ~9%, and the share of GDP decreased to ~2.3% (Table 4).

Table 4. Dynamics of total volume and growth rates (YoY), as well as share in GDP

Year	Total expenses, billion tenge	Growth rate compared to the previous year, %	Government spending as a percentage of GDP
2010	408	-	1,9
2011	523	28,2	1,9
2012	643	22,9	2,1
2013	666	3,6	1,8
2014	847	27,2	2,1
2015	785	-7,3	1,9
2016	959	22,2	2,0

2017	1031	7,5	1,9
2018	1061	2,9	1,7
2019	1163	9,6	1,7
2020	1745	50,0	2,5
2021	2191	25,6	2,6
2022	2388	9,0	2,3

Source: compiled by the authors

Overall, the healthcare system in Kazakhstan is financed largely by public expenditures – 62.0%:

- State budget expenditures – 40.1% of current healthcare expenditures;
- Expenditures in the compulsory health insurance system – 21.6% of current healthcare expenditures.

Private expenditures account for 38% of current healthcare expenditures. Of these:

- Out-of-pocket payments – 30.9%;
- Voluntary health insurance expenditures – 1.0%;
- Employer expenditures (company payments for their employees) – 5.9%;
- Expenditures of non-profit organizations – 0.4%.

According to WHO recommendations, for a properly functioning system with budget financing, the minimum level of healthcare expenditures should be 6–9% of GDP in developed countries and at least 5% of GDP in developing countries (Figure 2).

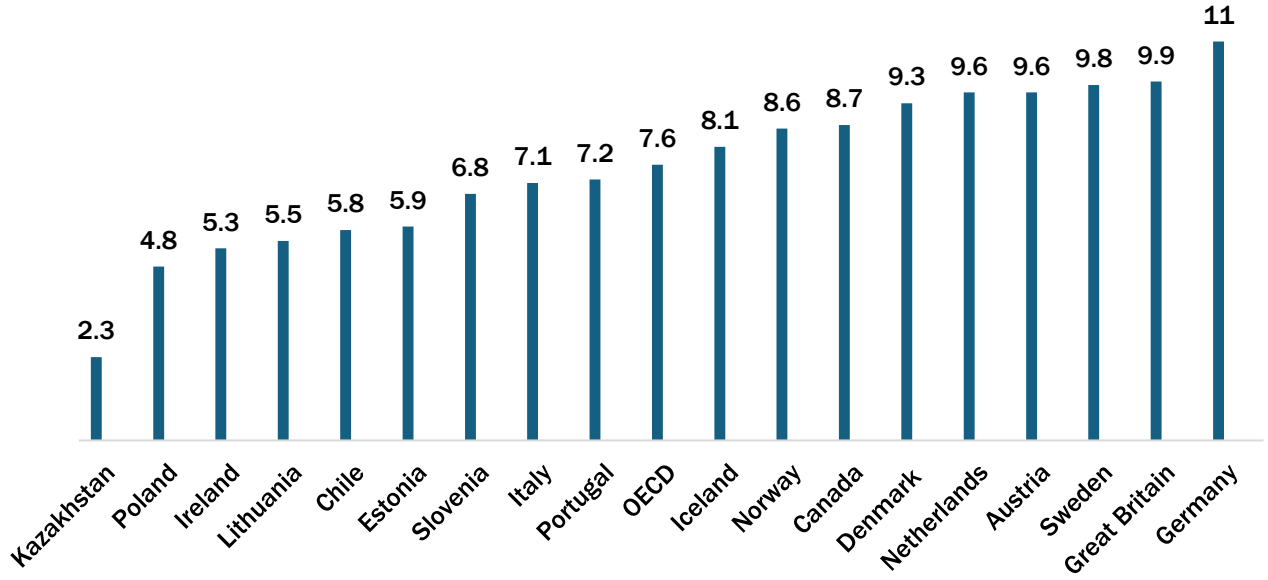

Figure 2. Public Healthcare Expenditures as a % of GDP in OECD Countries
Source: compiled by the authors according to https://halykfinance.kz/

Targeted funding for digital infrastructure and information security ensures the reliability and continuity of management and clinical processes, reducing the risk of failures and data leaks that can lead to additional financial losses. At the same time, investments in developing the digital competencies of medical and management personnel increase the return on investment, ensuring the effective use of information systems and artificial intelligence technologies.

Currently, the healthcare management system is undergoing a digital transformation, including the development of information and communications infrastructure based on new technologies, strengthening information security, and developing the digital skills and competencies of personnel. The implementation of these processes directly depends on the structure and priorities of healthcare financing, as the implementation and maintenance of digital solutions require sustainable budgetary and insurance sources, as well as targeted investment programs (Table 5).

Table 5. Volume of services in the field of healthcare and provision of social services, thousands of tenge

Total	3rd quarter	
	2024	2025
Healthcare services provided	896 710 178	921 454 441
Services provided in the field of social services with accommodation	34 488 265	41 904 271
Services provided in the field of social services without provision of accommodation	14 132 327	15 817 147

Source: compiled by the authors according to https:// www.stat.gov.kz

Digital management transformation serves not only as a technological but also as a financial and economic tool, enabling increased cost effectiveness, labor productivity, and the sustainability of the healthcare system in the digital age.

Analysis of the data in Table 3 reveals a steady increase in the volume of healthcare and social services provided. In the third quarter of 2025, the volume of healthcare services increased to 921.5 billion tenge, compared to 896.7 billion tenge in 2024, reflecting expanded medical activity and increased demand for services. Similar dynamics are observed in the social services sector:
- services with accommodation increased from 34.5 billion to 41.9 billion tenge,
- services without accommodation increased from 14.1 billion to 15.8 billion tenge.

The growth in all categories indicates expanded population coverage, improved process manageability, and the growing role of digital solutions. The increase in the volume of healthcare services provided is directly linked to the industry's active digital transformation, supported by budget and insurance funding, as well as targeted investments in digital technologies and artificial intelligence-based solutions. Given limited financial and human resources, digital tools are becoming a driver of intensive growth, ensuring increased medical staff productivity without a proportional increase in costs.

- First, increased accessibility and speed of service delivery has been made possible by the implementation of digital medical platforms, electronic queuing systems, telemedicine, and mobile patient apps. Funding for these solutions has reduced transaction costs for the healthcare system, shortened wait times, and increased the capacity of medical organizations. As a result, with comparable funding levels, an increase in the number of patients served is achieved, which is reflected in an increase in the specific output per medical worker.

- Second, increased medical staff productivity is achieved through the automation of routine and administrative operations, the implementation of electronic medical records, the integration of laboratory and diagnostic systems, and the use of AI solutions to support clinical and

management decisions. Targeted investments in digitalization allow for the reallocation of physician and nursing staff time toward clinical activities, reducing unproductive labor costs and increasing the efficiency of payroll use.

An important financial and economic benefit of digitalization is increased transparency and accountability in the use of funds, achieved through digital monitoring of medical care quality indicators, patient satisfaction, the publication of open data, and the functioning of feedback systems. This helps reduce errors, improve clinical outcomes, and strengthen public trust in the healthcare system, while also increasing the efficiency of budget and insurance resource allocation. Furthermore, digital technologies and AI solutions help reduce operating costs, as electronic services reduce the need for paperwork, optimize administrative processes, and allow for the forecasting of human and material resource requirements. This reduces the risk of inefficient use and increases the return on investment.

- Third, digital transformation has strengthened coordination between healthcare organizations, ensuring the rapid exchange of data between medical institutions, laboratories, insurance funds, and government information systems. Improving the efficiency of patient routing, accelerating high-tech procedures, and simplifying access to comprehensive medical services enable the healthcare system to deliver greater volumes of services at the same or lower costs, which directly impacts productivity growth and the sustainability of sector financing.

To assess the prospects for the development of the healthcare and social sector, a simple linear forecast of service volumes was conducted based on actual growth rates for 2024–2025. This approach not only identifies short-term dynamics but also correlates projected changes with the sector's funding capacity and potential productivity growth in the context of digital transformation.

The growth in service volumes in healthcare and social services was stable even before 2024, driven by expanded medical coverage, the introduction of electronic services, and increased spending through budget and insurance financing (Table 6).

Table 6. Volume of services in healthcare and social sphere

Year	Health services, total	Social services with accommodation	Social services without accommodation
2019	620 540 000	18 945 000	9 874 000
2020	701 382 000	22 318 000	11 402 000
2021	768 495 000	26 741 000	12 965 000
2022	823 610 000	30 582 000	13 874 000
2023	861 294 000	33 901 000	14 052 000
2024	896 710 178	34 488 265	14 132 327

Source: compiled by the authors according to https:// www.stat.gov.kz

The increase in service volumes was accompanied by increased funding for the healthcare system, primarily through budgetary allocations and mandatory social health insurance funds. However, while traditional organizational models remained in place, this growth led to increased workloads for staff and rising costs. Based on the growth rates for 2024–2025, a linear forecast was calculated, as shown in Figure 3.

Figure 3. Linear forecast based on the 2024–2025 growth rate of the volume of healthcare and social services

Source: Compiled by the authors

The forecast shows steady growth across all areas. To correlate this with funding, it's convenient to add growth rates and structural shares within the overall volume of services (healthcare vs. social services) (Table 7).

Table 7. Growth rates and structure of the projected volume of services

Year	Health services, total	Social services with accommodation	Social services without accommodation	Total services (amount), units
2024	896710178	34488265	14132327	945330770
2025	921454443	41904271	15817147	979175859
2026	946198704	49320277	17501967	1013020948
2027	970942967	56736283	19186787	1046866037
Year	Total growth rate, %	Share of healthcare, %	Share of social services with accommodation, %	Share of social services without accommodation, %
2024	-	94,86	3,65	1,49
2025	3,58	94,10	4,28	1,62
2026	3,46	93,41	4,87	1,73
2027	3,34	92,74	5,42	1,83

Source: compiled by the authors

Rising government spending and the increasingly complex healthcare financing structure (the strengthening of the role of the guaranteed volume of medical care and the mandatory health insurance system in 2020–2022) reflect the expanding system's obligations and increased demands for resource efficiency. Against this backdrop, the forecast for service volume for 2024–2027 demonstrates steady growth, implying a further increase in the burden on medical personnel and infrastructure. Consequently, maintaining the pace of service expansion while limiting expenditures as a share of GDP objectively requires a shift in focus toward increasing labor

productivity through digitalization and the implementation of AI solutions that reduce unproductive labor costs and optimize clinical and administrative processes.

The resulting forecast demonstrates a steady upward trend in all three areas, which is logically interpreted as the result of:
- expanding the range of medical and social services;
- deepening the integration of medical and social care;
- continuing digital transformation of the industry. The growth in the volume of services provided is directly linked to increased financial flows into the healthcare system. However, the projected dynamics point to an important structural shift: further expansion of services is impossible solely through increased expenditure. Given limited budgetary and insurance resources, increasing the productivity of medical personnel becomes a key factor.

It is in this context that digital technologies and artificial intelligence-based solutions acquire strategic importance. Their implementation, with comparable funding levels, allows for:
- serving a greater number of patients;
- reducing administrative and transaction costs;
- increasing the specific output per employee.

Therefore, the projected growth in service volumes should be viewed not only as a quantitative expansion of the system, but also as an indicator of the need to transition to an intensive development model based on digitalization, AI, and more efficient use of financial and human resources.

CONCLUSION

The study concluded that the effectiveness of the healthcare system in the current environment is determined not so much by the volume of funding as by the quality of its use and the degree of digital transformation in the industry. An analysis of the dynamics and structure of funding revealed that in recent years, the Republic of Kazakhstan has seen a steady increase in government and insurance spending on healthcare, accompanied by a more complex set of funding sources and an expanded range of medical and social services. However, increased financial resources do not always lead to a proportional increase in the productivity of medical personnel.

Amid a labor shortage, an increasing burden on the mandatory social health insurance system, and limitations on the share of healthcare expenditures in GDP, further development of the sector requires a transition from an extensive model based on increasing expenditures to an intensive growth model, a key element of which is increasing labor productivity. It has been established that digital technologies and artificial intelligence-based solutions are an important tool for this transformation, helping to reduce unproductive labor costs, optimize clinical and administrative processes, and increase the return on human capital. The results of the analysis and forecasting of service volumes indicate the continued upward trend in healthcare and social services in the medium term. This objectively increases the requirements for the efficient use of financial resources and emphasizes the need to integrate digital and AI solutions into the sector's management system. The implementation of such technologies allows for an increase in the volume and quality of services, while simultaneously increasing the productivity of medical personnel, with comparable funding levels.

Overall, it is concluded that healthcare financing in the context of digital technologies should be viewed as an investment in increasing productivity and system sustainability, rather than as a

collection of operating expenses. A comprehensive combination of targeted funding, digitalization of management and clinical processes, and the development of digital competencies among personnel forms the basis for increased efficiency, reduced inequalities in access to medical services, and the long-term socioeconomic development of the healthcare system in the Republic of Kazakhstan.

ACKNOWLEDGMENTS

The article is funded under the grant of the Committee of Science of the Ministry of Sciences and Higher Education of the Republic of Kazakhstan under the project AP 26197239 " Impact and assessment of artificial intelligence on labor productivity as a driver for the development of the Kazakh economy".

REFERENCES

Aguayo, F.Z., Slusarczyk, B. (2020), "Risks of Banking Services' Digitalization: The Practice of Diversification and Sustainable Development Goals". Sustainability, Vol.12, No.10, pp.1-10. https://doi.org/10.3390/su12104040

Al Shanti, A.M., Elessa, M. S. (2022), "The impact of digital transformation towards blockchain technology application in banks to improve accounting information quality and corporate governance effectiveness". Cogent Economics & Finance, Vol. 11, No. 1, pp. 2161773. https://doi.org/10.1080/23322039.2022.2161773

Al-Dmour, H. H., Asfour, F., Al-Dmour, R.H., & Al-Dmour, A.H. (2020), "Validation of the impact of marketing knowledge management on business performance via digital financial innovation as a mediating factor". Journal of Information and Knowledge Management Systems, Vol.1, pp. 33-56. https://doi.org/10.1108/vjikms-05-2020-0085

Boot, A., Hoffmann, P., Laeven, L., &Ratnovski, L. (2020), "Fintech: What's Old, What's New?" Journal of Financial Stability, Vol. 53, pp.100836. https://doi.org/10.1016/j.jfs.2020.100836

Cabrera-Barona, P., Blaschke, T., Kienberger, S. (2017), "Explaining Accessibility and Satisfaction Related to Healthcare: A Mixed-Methods Approach". Social Indicators Research, Vol. 133, pp.719–739. https://doi.org/10.1007/s11205-016-1371-9.

Chen, Z., Li, H., Wang, T., & Wu, J. (2023), "How digital transformation affects bank risk: Evidence from listed Chinese banks". Finance Research Letters, Vol. 58, pp. 104319. https://doi.org/10.1016/j.intfin.2023.101934

Cocco, L., Pinna, A., Marchesi, M. (2017), "Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology". Future Internet, Vol. 9, No. 3, pp. 25. https://doi.org/10.3390/fi9030025

El-Kassar, A.N., Singh, S.K. (2019), "Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices". Technological Forecasting and Social Change, Vol. 144, pp. 483-498 https://doi.org/10.1016/j.techfore.2017.12.016

le Roux, K.W., Almirol, E., Rezvan, P.H., Le Roux, I.M., Mbewu, N., Dippenaar, E., Stansert-Katzen, L., Baker, V., Tomlinson, M., Rotheram-Borus, M. (2020), "Community health workers impact on maternal and child health outcomes in rural South Africa–a non-randomized two-group comparison study". BMC Public Health, Vol. 20, No. 1, pp. 1–14. https://doi.org/10.1186/s12889-020-09468-w

McGough, P., Chaudhari, V., El-Attar, S., Yung, P. (2018), “A health system’s journey toward better population health through empanelment and panel management”. Healthcare, Vol. 6, No. 66, pp. 1–9. https://doi.org/10.3390/healthcare6020066

Qiu, L., Jie, X., Wang, Y., Zhao, M. (2019), “Green product innovation, green dynamic capability, and competitive advantage: evidence from Chinese manufacturing enterprises. Corporate Social Responsibility and Environmental management, Vol. 27, No. 1, pp. 1-20. https://doi.org/10.1002/csr.1780

Roncarolo, F., Boivin, A., Denis, J.L. (2017), “What do we know about the needs and challenges of health systems? A scoping review of the international literature”. BMC Health Services Research, Vol. 17, pp. 636. https://doi.org/10.1186/s12913-017-2585-5.

Suat, L.A., San, O.T. (2019), “Corporate environmental management: eco-efficiency and economics benefits among manufacturers certified with EMS14001 in Malaysia”, International Journal of Recent Technology and Engineering, Vol. 7, No. 6, pp. 873-886

Tran, P.T.T., Le, T.T.H., Phan, N.H.T. (2023), “Digital Transformation of the Banking Industry in Developing Countries”. International Journal of Professional Business Review, Vol. 8, No. 5, pp. e01503. https://doi.org/10.26668/businessreview/2023.v8i5.1503

Ulrich-Diener, F., Dvouletý, O., Spacek, M. (2023), “The future of banking: What are the actual barriers to bank digitalization?” Business Research Quarterly, Vol. 28, No. 2, https://doi.org/10.1177/23409444231211597

van Zeeland, I., Pierson, J. (2024), “Changing the whole game: effects of the COVID-19 pandemic's accelerated digitalization on European bank staff's data protection capabilities”. Southwestern University of Finance and Economics, Vol. 10, No. 1, pp. 1-28. https://doi.org/10.1186/s40854-023-00533-y

Wang, Z. (2021), “Business Analysis on Sustainable Competitive Advantages”. E3S Web of Conferences, Vol. 235, No. 9, pp. 03009. https://doi.org/10.1051/e3sconf/202123503009

Yang, F., Masron, T. A. (2023), “Does financial inclusion moderate the effect of digital transformation on banks’ performance in China?” Cogent Economics & Finance, Vol. 11, No. 2, pp. 2267270. https://doi.org/10.1080/23322039.2023.2267270

* Official resource oh the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. https:// www.stat.gov.kz

** Electronic resource: https://halykfinance.kz/download/files/analytics/HF_Finansirovanie_zdravohraneniya_apr_2024.pdf

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Montenegrin Journal of Economics

Streimikis, J. (2026), "Economics of Circular Agriculture: Principles, Barriers, and EU Perspectives", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 237-247.

Economics of Circular Agriculture: Principles, Barriers, and EU Perspectives

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ARTICLE INFO

Received March 21, 2025
Revised from April 20, 2025
Accepted May 21, 2025
Available online April 15, 2026

JEL classification: Q01, Q18, Q20

DOI: 10.14254/1800-5845/2026.22-2.18

Keywords:

Circular agriculture;
Circular economy;
Sustainable food systems;
Agricultural policy;
European Union

ABSTRACT

This article explores the theoretical foundations and systemic implications of circular agriculture as a transformative model for sustainable agri-food systems. Building on the principles of the circular economy, circular agriculture emphasizes closed-loop nutrient cycles, waste valorization, and ecological regeneration. The paper contributes to the evolving literature by synthesizing conceptual definitions, identifying key barriers to adoption, and examining enabling policy frameworks with a particular focus on the European Union. It proposes a conceptual model that integrates production-level practices, circular value chains, and institutional mechanisms such as the EU Green Deal, Farm to Fork Strategy, and Common Agricultural Policy. A comparative analysis of related approaches - including agroecology, regenerative agriculture, and the bioeconomy highlights the distinct economic framing of circular agriculture. The research was concluded by suggesting additional works in economic modelling, behavioral incentives, and the creation of circularity indicators, which are a form of sustainability metrics. The goal of the results is to foster interdisciplinary dialogue and durable reconceptualization of agriculture policy frameworks.

INTRODUCTION

Agriculture is facing unprecedented pressure to adapt to climate change, biodiversity loss, and the depletion of natural resources. The existing linear production systems- based on extract, exploit, and dispose - are increasingly incompatible with long-term economic viability and environmental sustainability (Kirchherr, Reike and Hekkert, 2017). Within this context, circular agriculture has emerged as a theoretical and practical framework which aims to transform the agri-food system by integrating circular economy principles into agricultural production, focusing on

waste as a resource, nutrient recycling, and ecological regeneration (Rodino et al., 2023; Streimikis, 2025).

The circular agriculture paradigm not only aims at closing material and energy loops but also at integrating agricultural practices into broader sustainability transitions (Karpavicius, Balezentis, 2025). It transforms traditional supply chain frameworks, pervades new dimensions of business interrelationships and highlights systemic interdependencies between the economy, the environment, and society (Dagevos and Lauwere, 2021). This shift profoundly reshapes economic analysis considering value creation, efficiency, and resilience in food and farming systems.

Recently, the policy of the European Union (EU) has been adopting circular agriculture more closely with the use of the Europe Green Deal, Farm to Fork Strategy, and Common Agricultural Policy (CAP)(European Commission, 2019; 2020). These frameworks try to implement circularity across sectors through the adoption of low-carbon technologies, regenerative and holistic food systems, and integrated food systems. However, the move towards circular agriculture is still impeded by significant economic, institutional, and behavioral obstacles, with increased policy and academic attention being insufficient for such a need (Jesús and Mendonça, 2017). There is often insufficient integration between the principles of a circular economy and agricultural economics.

This paper seeks to contribute to the theoretical foundation of circular agriculture by integrating conceptual insights, identifying key systemic barriers, and examining enabling policy frameworks, with a focus on the EU context. It also introduces a conceptual model that synthesizes the economic dynamics of circular agricultural systems and outlines future research directions to support their development.

The paper is structured as follows: Section 2 reviews conceptual foundations, identifies major barriers, and discusses relevant policy enablers. Section 3 presents a conceptual model of circular agriculture. Section 4 offers a broader discussion of the theoretical and policy implications. Section 5 concludes with final reflections and recommendations for future research.

1. LITERATURE REVIEW

The concept of circularity in economic and environmental thought has evolved as a response to the shortcomings of linear production and consumption systems. The circular economy (CE) paradigm promotes closed-loop systems where materials, energy, and resources are continuously reused, thereby minimizing waste and reducing pressure on natural ecosystems (Kirchherr, Reike and Hekkert, 2017). The CE framework has been increasingly adopted in various sectors - energy, manufacturing, and construction - but its application to agriculture remains a relatively recent and underexplored area of study.

Circular agriculture (CA) is conceptually grounded in CE principles but tailored to the specific dynamics of food and farming systems. It focuses on regenerative use of biological resources, particularly through nutrient recycling, organic waste valorization, and multifunctional land use (Batlles-delaFuente et al., 2022). Definitions of CA vary in emphasis but generally converge around a shared goal of reducing external inputs and environmental impacts while improving resilience and productivity. Unlike industrial applications of CE that often emphasize technological innovation and material engineering, CA is deeply ecological in nature, prioritizing soil health, biodiversity, and closed-loop biological flows (Jayasinghe et al., 2023).

In the academic literature, circular agriculture overlaps conceptually with several other sustainability-oriented frameworks, including agroecology, regenerative agriculture, organic farming, and the bioeconomy (Velasco-Muñoz et al., 2021) . While all these approaches advocate for reduced environmental impact and improved ecosystem services, circular agriculture

distinguishes itself through its direct alignment with CE's material flow logic and economic framing. (Geissdoerfer et al., 2016) argue that CE offers a new sustainability paradigm by integrating economic and ecological dimensions, a perspective that is especially relevant in the case of CA.

A number of sustainability-focused frameworks - such as agroecology, regenerative agriculture, organic farming, and the bioeconomy - share overlapping goals with circular agriculture, including reduced environmental impact, improved resource use, and enhanced ecosystem resilience (Batlles-delaFuente et al., 2022). However, these approaches differ significantly in terms of their theoretical grounding, policy alignment, market integration, and economic orientation. While agroecology and regenerative agriculture prioritize ecological functions and local knowledge systems, they often lack explicit economic frameworks (Jayasinghe et al., 2023). Organic farming, by contrast, is codified through certification and compliance mechanisms but does not necessarily promote circularity in resource flows. The bioeconomy emphasizes biomass-based production and innovation, yet may prioritize growth over ecological limits (Tan and Lamers, 2021). Circular agriculture is unique in its integration of material flow logic, economic efficiency, and systems thinking within a regenerative agricultural framework. Table 1 presents a comparative overview of these approaches, highlighting key conceptual distinctions that inform ongoing theoretical and policy debates.

Table 1. Conceptual Comparison of Circular Agriculture and Related Approaches

Criterion	Circular Agriculture	Agroecology	Regenerative Agriculture	Organic Farming	Bioeconomy
Core Focus	Resource cycling, waste valorization, and system efficiency	Ecological principles in farming; social justice	Soil health and ecosystem regeneration	Avoidance of synthetic inputs; certification standards	Biomass-based production across sectors
Theoretical Basis	Circular economy, systems thinking	Agroecological science, political ecology	Systems ecology, land stewardship	Environmentalism, consumer ethics	Innovation, industrial policy, green economy
Economic Framing	Efficiency, value recovery, closed-loop markets	Often critiques capitalist models	Emphasis on long-term ecological-economic health	Market-based (certification), but limited economic theory	Strong economic framing (growth, innovation, competitiveness)
Technological Emphasis	Medium to high; includes biogas, composting, IoT	Low; emphasizes traditional and local knowledge	Medium; blends traditional and modern methods	Low to medium; technology constrained by organic principles	High; biotechnology and industrial processing
Policy Alignment (EU)	Green Deal, CAP, Farm to Fork Strategy	Supported via agroecological transition (indirect)	Emerging but not formally codified	Long-standing regulation and support via organic labeling	Horizon Europe, Bioeconomy Strategy, Circular Bio-Based Europe
Market Integration	Encourages new circular value chains	Often localized and community-based	Encourages local resilience and regenerative markets	Formalized market via certification (e.g., EU Organic logo)	Industry-oriented; large-scale biomass markets
Critiques	Needs stronger economic integration and metrics	Lacks scalability and economic modeling	Sometimes vague or unstandardized in metrics	Limited systemic thinking; certification doesn't ensure circularity	May prioritize growth over ecological boundaries

Source: compiled by the author based on Jayasinghe et al. (2023), Velasco-Muñoz et al. (2021), Batlles-delaFuente et al. (2022), Tan and Lamers (2021), Pannell, Llewellyn and Corbeels (2013) and Hassan and Faggian (2023)

Despite increasing interest, the literature on circular agriculture remains fragmented. Much of the existing research is either conceptual or policy-oriented, with limited integration into mainstream economic theory. Studies often describe CA as a normative goal or design principle, without clearly articulating its place within established economic models (Pannell, Llewellyn and Corbeels, 2013). For example, there is limited exploration of how CA practices affect marginal productivity, land use efficiency, labor allocation, or pricing mechanisms in agricultural markets. As De Jesus and Mendonça (2018) highlight in their critique of eco-innovation pathways, theoretical alignment and economic rigor are often missing in CE applications.

Furthermore, existing CE literature tends to focus more on technical feasibility and industrial symbiosis than on primary production systems like agriculture. As such, key concepts like systems thinking, feedback loops, and multifunctionality are often referenced in sustainability science and ecological economics, but not well-developed in agri-economic models (Hassan and Faggian, 2023). This theoretical gap presents an opportunity for expanding the economic discourse around agriculture, particularly by incorporating circularity into analyses of cost structures, value creation, and policy effectiveness.

At the same time, emerging EU policy frameworks are beginning to stimulate academic engagement with the economic aspects of CA. The European Green Deal (European Commission, 2019), the Farm to Fork Strategy (European Commission, 2020), and updated CAP mechanisms explicitly promote circular practices and encourage new metrics for agricultural sustainability. These developments signal a growing recognition that circularity is not just an environmental goal but also an economic transition requiring robust theoretical underpinning.

In summary, while the literature has established a foundation for understanding the principles of circular agriculture, significant gaps remain in conceptual clarity, economic modeling, and empirical validation. This paper contributes to addressing these gaps by synthesizing existing knowledge, identifying barriers and policy enablers, and presenting a conceptual model that integrates circular agriculture within a broader economic and institutional framework.

2. BARRIERS AND ENABLERS OF CIRCULAR AGRICULTURE

While circular agriculture holds significant promise as a sustainability-oriented production model, its implementation remains constrained by a range of structural, economic, institutional, and behavioral barriers. These challenges are not unique to agriculture but are particularly acute in this sector due to its embeddedness in ecological cycles, land tenure systems, and historically path-dependent policy frameworks.

From an economic perspective, one of the main barriers is the upfront cost of transition. Investments in composting infrastructure, precision technologies, biogas systems, or regenerative soil management techniques often require significant capital expenditures. Small and medium-sized farms, which dominate many EU agricultural landscapes, frequently lack access to financing mechanisms or are excluded from innovation funding streams (Sellami and Lavini, 2023). Moreover, market structures typically undervalue ecosystem services and circular outcomes—such as nutrient cycling or biodiversity preservation—further discouraging adoption from a cost-benefit standpoint (D'Amato et al., 2017).

Institutional and regulatory barriers also hinder the diffusion of circular practices. Although the Common Agricultural Policy has recently introduced eco-schemes, subsidies and support mechanisms are still heavily oriented toward conventional production, yield maximization, and

monoculture systems (Duquennoi and Martínéz, 2022). Regulatory fragmentation across water, energy, waste, and agricultural domains creates administrative complexity for farms seeking to implement circular systems that span these sectors. In some member states, waste reuse laws or sanitary regulations obstruct the safe and legal application of composted biomass or treated wastewater in agriculture(Chiaraluce, Bentivoglio and Finco, 2021).

In addition, behavioral and informational barriers slow down the systemic transformation required for circular agriculture. Farmers often lack adequate training, peer examples, or localized evidence on the economic viability of circular practices. Risk aversion, tradition-based decision-making, and distrust of public programs can all contribute to resistance, especially in rural areas where knowledge diffusion mechanisms are weak (Rodino et al., 2023). The absence of a shared understanding of what constitutes "circularity" in agriculture further complicates both education and policy design.

Despite these constraints, a growing number of enablers are emerging, particularly within the European Union. The European Green Deal provides an overarching sustainability vision that promotes resource efficiency, emissions reduction, and regenerative land use (Fayet et al., 2022). Its operational arm in the food system, the Farm to Fork Strategy, explicitly supports the reduction of external inputs and the creation of shorter, circular value chains in agri-food systems (European Commission, 2019; 2020). The revised CAP (2023–2027) introduces new tools such as eco-schemes and conditionality frameworks that reward circular and climate-smart practices.

Beyond direct subsidies, EU programs such as Horizon Europe, LIFE, and EIP-AGRI are financing demonstration farms, cooperative innovation platforms, and digital tools that facilitate circular resource use. These initiatives foster multi-actor networks and support participatory governance models, which are essential for overcoming fragmentation and building local capacity. In parallel, new financial instruments - including green bonds, carbon farming credits, and agroecological transition funds - are being piloted to attract private investment into sustainable farming transitions (Lange et al., 2021).

Additionally, technological innovation is increasingly aligned with circular goals. Digital solutions such as remote sensing, blockchain traceability, and precision irrigation are improving the efficiency and transparency of resource flows. At the same time, circular economy business models - such as nutrient exchange platforms, shared machinery services, and closed-loop animal - crop systems - are demonstrating potential for scale-up across diverse farming contexts (Dagevos and Lauwere, 2021).

The diverse and often overlapping nature of these barriers and enablers calls for a systemic perspective. Table 2 summarizes the main obstacles and enabling factors relevant to the adoption of circular agriculture in the EU context, categorized by economic, institutional, behavioral, technological, and market-related dimensions.

Table 2. Key Barriers and Enablers of Circular Agriculture in the EU Context

Category	Barriers	Enablers
Economic	High upfront investment costs for circular technologies and infrastructure	EU subsidies (eco-schemes, CAP), green finance tools, and innovation grants
	Lack of market value for ecosystem services	Growing demand for sustainable and traceable food; carbon and nutrient trading mechanisms

Institutional	Conventional subsidy bias; regulatory fragmentation across sectors	Alignment through Green Deal, Farm to Fork, and CAP; harmonization of agri-environmental regulations
	Legal obstacles for biomass reuse (e.g., compost, treated wastewater)	Evolving EU waste and reuse directives; pilot projects validating safe use
Behavioral/Knowledge	Low awareness or trust in circular practices; risk aversion among farmers	Knowledge-sharing networks (e.g., EIP-AGRI); demonstration farms and peer-learning platforms
	Absence of unified definitions or frameworks for circular agriculture	Increased academic focus; EU policy guidance clarifying principles and outcomes
Technological	Limited access to appropriate tools or local-scale circular innovations	Growth of precision farming, digital traceability, and nutrient recycling technologies
Market Structure	Dominance of linear, input-intensive value chains	Emerging circular business models (e.g., nutrient platforms, equipment sharing, closed-loop systems)

Source: Compiled by the author based on Sellami and Lavini (2023), D'Amato et al. (2017), Duquennoi and Martínéz (2022), Chiaraluce, Bentivoglio and Finco (2021), Rodino et al. (2023), Fayet et al. (2022), Lange et al. (2021) and European Commission (2019; 2020)

Overall, the transition to circular agriculture is not merely a technical or environmental challenge, but a systemic transformation of how agriculture is organized, valued, and supported. Overcoming its barriers will require coordinated policy efforts, institutional adaptation, and inclusive capacity-building at the local level. If adequately enabled, circular agriculture could become a core pillar of a more resilient, regenerative, and economically viable European food system.

3. CIRCULAR AGRICULTURE CONCEPTUAL MODEL

The transition to circular agriculture requires more than isolated practices or technical improvements - it entails a systemic redesign of how agricultural resources are managed, valued, and connected within broader economic and environmental systems. To capture this complexity, we propose a conceptual model that integrates the principles, enablers, and expected outcomes of circular agriculture within a multi-layered framework. The model aims to synthesize theoretical and policy-oriented insights to inform future analysis and policy design. The simpliefied conceptual model is demonstrated in Figure 1 and its detailed description is given below.

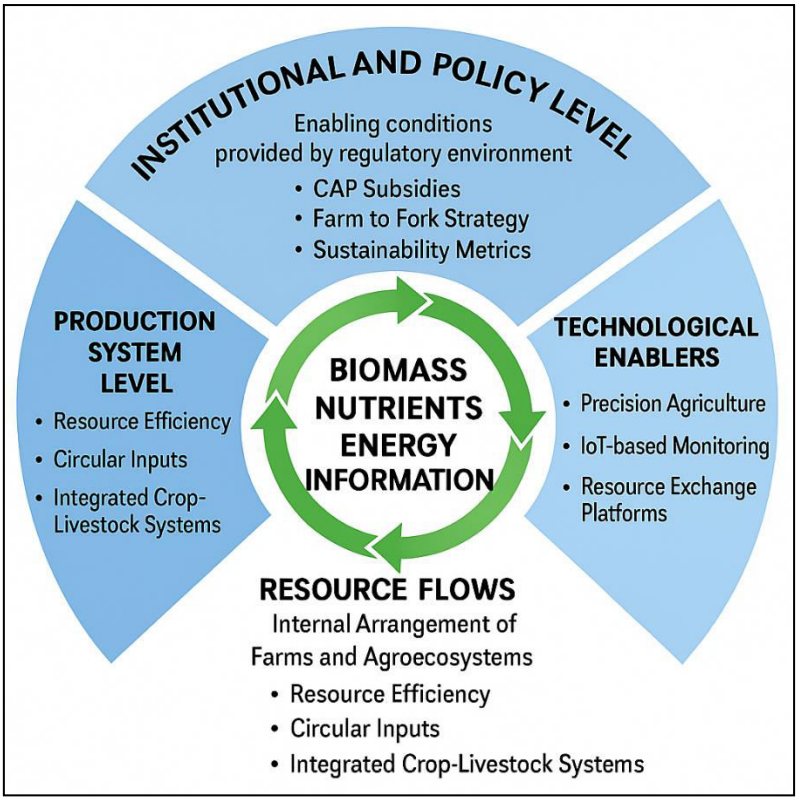

Figure 1. Conceptual Circular Agriculture Model
Source: made by the author

At the core of the model lies the circular flow of biomass, nutrients, energy, and information within and across agricultural systems. Farms are conceptualised not as isolated units but as nodes in regenerative value chains, where waste from one subsystem becomes an input for another. For example, animal manure or crop residues can be converted into compost or biogas, closing nutrient loops and reducing reliance on synthetic inputs. These flows are supported by technological enablers such as precision agriculture tools, IoT-based monitoring systems, and platforms for resource exchange.

The model is structured around four interconnected layers:

1. Production System Level – Focuses on the internal organization of farms and agroecosystems, including resource efficiency, circular inputs, and integrated crop-livestock systems.

2. Resource Flow Management– Involves supply chain actors and circular business models, such as food-waste valorization firms, local composting cooperatives, or shared logistics.

3. Institutional and Policy Level – Encompasses enabling conditions provided by the regulatory environment, including CAP subsidies, the Farm to Fork Strategy, and sustainability metrics that reward ecosystem services.

4. Technological Enablers – It involves precision agriculture, IoT–based monitoring, resource exchange platforms.

These layers interact dynamically. For example, policy instruments such as eco-schemes can incentivise circular practices at the production level, while digital traceability standards can enhance market recognition for circular products at the value chain level. Similarly, financial

incentives from green bonds or EU rural development funds can accelerate investment in infrastructure that supports nutrient cycling or renewable energy integration.

The model also highlights several feedback loops and leverage points. These include knowledge diffusion (e.g., via farmer cooperatives or EU innovation hubs), data flows (from sensors to policy dashboards), and behavioral shifts (as consumers demand sustainable food). Circular agriculture, in this framing, is not a single technology or practice but a co-evolving system enabled by interactions across sectors and scales.

4. DISCUSSION

The analysis conducted in this paper shows that circular agriculture is more than a technical innovation, it is a civilizational change which disrupts the accepted agricultural economics and policy frameworks. The CA principles are based fundamentally on the blending of ecology with economics rationality, and serves as a regeneration of the linear “take-make-dispose” model.

The model elaborated on in this research highlights the circular flow of resources (biomass, nutrients, energy, data) is optimally realized when a certain level production, innovations within the value added chain, and policy level structures complement each other. This aligns with Kirchherr et al (2017) and Geissdoerfer et al (2017) as they focus on the need for integration of systems approach for the transitioning towards circular economy. Nevertheless, our model applies this reasoning to consider the agri-food system, which is particular due to the biological cycles and spatial diversity.

As the EU has created several enabling frameworks like the Green Deal and the Farm to Fork Strategy, some frameworks remain incomplete due to persistence of institutional and behavioral barriers. There is a paradox noted in our findings where there is greater political and financial support for CA, farmers are still held back by outdated subsidy systems, fragmented governance, sparse circular technology access, and regulation. This is in line with De Jesus and Mendonça’s (2018) criticism which states that the transitions to Circular Economy are largely confined to the divergence of the policies adopted and practices implemented.

The most distinguishing factor of CA is its economic framing which sets it apart from agroecology, regenerative agriculture and bioeconomy. They try to implement social or ecological objectives without market incentives, while CA aims to achieve sustainability through value recovery and closed-loop efficiency. This difference has tangible consequences for how indicators and subsidy strategies and research agendas are crafted. On the other hand, there is an unresolved issue: the agricultural focus lacks standardized circularity metrics, which hampers the scaling and benchmarking of CA initiatives. Without robust evaluation tools, efforts to mainstream CA risk becoming norm-driven instead of action-driven.

Incorporating knowledge dissemination, digital traceability, and consumer demand as feedback loops to the model’s core leverage points is a case in point. These feedback loops exemplify a dynamic and co-evolving system in which behavioral changes and institutional learning are equally as important as the technologies utilized. However, this situation also adds another layer of complexity: patterns of adoption may vary from region to region and farm to farm, indicating further testing is needed to assess the model's generalizability.

One limitation faced during this conceptual synthesis is the lack of empirical works quantifying the economic tradeoff of circular practices. Policy documents appear to be abundant, but very few seem to focus on the rigorous economic impact assessment on the farm level. This lack of

documenting directly impacts the ability to rigorously validate the models provided or offer targeted prescriptive policies. More importantly, it showcases the need for research that integrates agricultural economics with environmental policy, as well as systems engineering.

To conclude, this research adds distinct value by providing a rigorously tested and theory-based-with policy implications model of circular agriculture which identifies enablers and barriers and situates circular agriculture in broader sustainabilty transitions frameworks. This is a call for shifting towards an economically rational and systemically-conscious restructuring of agri-food systems within the European Union.

CONCLUSION

This study has looked into circular agriculture as a transformative model for achieving ecological regeneration alongside economic resilience within the agri-food system. Integrating elements of the circular economy into the context of agricultural production, circular agriculture develops as a unique model defined by resource recycling, closed loops, and system-levelcoordination.

This paper outlines a conceptual model merging the synthesized practices at the production level, circular value chains, and the enabling policy instruments, underscoring the holistic character of circular agriculture. The analysis demonstrates that successful implementation relies on the complex interplay of economic drivers, technology, institutional frameworks, and action shifts. European Union frameworks such as the Green Deal and Farm to Fork Strategy offer critical enabling frameworks, however, EU financing and regulatory frameworks along with farmer engagement still remain barriers.

A key takeaway from this research is that circular agriculture should be perceived both as an environmental necessity and, equally, as an economic prospect. This reframing requires the development of standardised metrics, robust economic modelling, and more coherent policy instruments. Without these elements, circular practices risk remaining aspirational rather than operational.

This work also highlights significant gaps in empirical evidence, especially in relation to economics and put into practice the trade-offs of circular agriculture at the farm level. Closing these gaps will be important for expanding successful interventions and developing appropriate, evidence-based policies.

Future research should focus on:

1. Circular Agriculture Economic Modelling: research gaps exist in the theoretical and empirical frameworks estimating the economic consequences of circular practices as they pertain to cost-benefit analysis, labor participation, and overall efficiency of resources utilised.
2. Instrument Design and Policy Evaluation: there are knowledge gaps around the integration of CAP eco-scheme, carbon farming, and digital traceability in fostering circularity at farm and regional scales that need to be addressed.
3. Circular Behaviour and Institutional analysis: Understanding the perception of circularity among farmers, including adoption and engagement with policy frameworks, is crucial for effective program design to aid targeted, tailored support.
4. Development of Indicators and Metrics: there is a need to extend and standardise the indicators that define circularity in agriculture such as output vs inputs within EU frameworks.

5. Comparative And Cross-Sectoral Research: cross-national studies and integration with circular economy transitions in food processing, retail, and waste management sectors could provide deeper insights into systemic coordination challenges.

In summary, circular agriculture presents a compelling pathway for reimagining European agri-food systems. By grounding sustainability goals in economic logic and systemic design, it offers the potential for meaningful change-provided that research, policy, and practice move in coordinated and evidence-based directions.

ACKNOWLEDGMENT

This research was funded by a grant (No. S-MIP-24-30) from the Research Council of Lithuania.

REFERENCES

Batlles-delaFuente, A. et al. (2022) "An Evolutionary Approach on the Framework of Circular Economy Applied to Agriculture," Agronomy, Vol. 12, No. 3, p. 620. doi:10.3390/agronomy12030620.

Chiaraluce, G., Bentivoglio, D. and Finco, A. (2021) "Circular economy for a sustainable agri-food supply chain: A review for current trends and future pathways," Sustainability. Available at: https://doi.org/10.3390/su13169294.

Dagevos, H. and Lauwere, C. de (2021) "Circular Business Models and Circular Agriculture: Perceptions and Practices of Dutch Farmers," Sustainability, Vol. 13, No. 3, p. 1282. doi:10.3390/su13031282.

D'Amato, D. et al. (2017) "Green, circular, bio economy: A comparative analysis of sustainability avenues," Journal of Cleaner Production, Vol. 168, pp. 716. doi:10.1016/j.jclepro.2017.09.053.

Duquennoi, C. and Martínéz, J.A. (2022) "European Union's policymaking on sustainable waste management and circularity in agroecosystems: The potential for innovative interactions between science and decision-making," Frontiers in Sustainable Food Systems, 6. doi:10.3389/fsufs.2022.937802.

European Commission (2019) The European Green Deal, COM(2019) 640 final. Brussels: European Commission.

European Commission (2020) A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system, COM(2020) 381 final. Brussels: European Commission.

Fayet, C.M.J. et al. (2022) "The potential of European abandoned agricultural lands to contribute to the Green Deal objectives: Policy perspectives," Environmental Science & Policy, Vol. 133, pp. 44. doi:10.1016/j.envsci.2022.03.007.

Geissdoerfer, M. et al. (2016) "The Circular Economy – A new sustainability paradigm?," Journal of Cleaner Production, Vol. 143, pp. 757. doi:10.1016/j.jclepro.2016.12.048.

Hassan, H. and Faggian, R. (2023) "System thinking approaches for circular economy: enabling inclusive, synergistic, and eco-effective pathways for sustainable development," Frontiers in Sustainability, 4. doi:10.3389/frsus.2023.1267282.

Jayasinghe, S. et al. (2023) "Global Application of Regenerative Agriculture: A Review of Definitions and Assessment Approaches," Sustainability. Multidisciplinary Digital Publishing Institute, pp. 15941. doi:10.3390/su152215941.

Jesús, A. de and Mendonça, S. (2017) “Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy,” Ecological Economics, Vol. 145, pp. 75. doi:10.1016/j.ecolecon.2017.08.001.

Kirchherr, J., Reike, D. and Hekkert, M.P. (2017) “Conceptualizing the circular economy: An analysis of 114 definitions,” SSRN Electronic Journal. Available at: https://doi.org/10.2139/ssrn.3037579.

Lange, L. et al. (2021) “Developing a Sustainable and Circular Bio-Based Economy in EU: By Partnering Across Sectors, Upscaling and Using New Knowledge Faster, and For the Benefit of Climate, Environment & Biodiversity, and People & Business,” Frontiers in Bioengineering and Biotechnology. Frontiers Media. doi:10.3389/fbioe.2020.619066.

Pannell, D.J., Llewellyn, R. and Corbeels, M. (2013) “The farm-level economics of conservation agriculture for resource-poor farmers,” Agriculture Ecosystems & Environment, Vol. 187, pp. 52. doi:10.1016/j.agee.2013.10.014.

Rodino, S. et al. (2023a) “Developing an evaluation framework for circular agriculture: A pathway to sustainable farming,” Agriculture, p. 2047. Available at: https://doi.org/10.3390/agriculture13112047.

Rodino, S. et al. (2023b) “Developing an Evaluation Framework for Circular Agriculture: A Pathway to Sustainable Farming,” Agriculture, Vol. 13, No. 11, pp. 2047. doi:10.3390/agriculture13112047.

Sellami, M. and Lavini, A. (2023) “Advancements in Soil and Sustainable Agriculture,” Soil Systems, 7(4), p. 98. doi:10.3390/soilsystems7040098.

Streimikis, J. (2025) ”Comparative assessment of circular economy performance in the Baltic States using MCDM methods, “ Transformations and Sustainability, Vol. 1, No. 1, pp. 30-42. https://doi.org/10.63775/pcxj8p61.

Tan, E.C.D. and Lamers, P. (2021) “Circular Bioeconomy Concepts—A Perspective,” Frontiers in Sustainability, 2. doi:10.3389/frsus.2021.701509.

Velasco-Muñoz, J.F. et al. (2021) “Circular economy implementation in the agricultural sector: Definition, strategies and indicators,” Resources Conservation and Recycling, Vol. 170, pp. 105618. doi:10.1016/j.resconrec.2021.105618.

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Nga, P.T.H., Tran, T.P.T, Nga, P.T.Q., Tien, P.M. (2026), "Impacting ESG on the Performance of Commercial Banks: A Case Study in Vietnam", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 249-260.

Impacting ESG on the Performance of Commercial Banks: A Case Study in Vietnam

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ARTICLE INFO

Received March 28, 2025
Revised from April 29, 2025
Accepted May 10, 2025
Available online April 15, 2026

JEL classification: C10, G00, Q01

DOI: 10.14254/1800-5845/2026.22-2.19

Keywords:

Commercial banks,
Performance,
Environment,
Social,
Governance

ABSTRACT

Background: In the business activities of enterprises, banks actively contribute to the formation, development, and promotion of sustainable strategies related to environmental and social issues within the enterprise and are a significant factor for enterprises when deciding to transform their business models towards sustainable development. Objective: This study aims to assess the impact of environmental, social, and governance (ESG) factors on the performance of commercial banks in Vietnam. The performance indicators are return on assets (ROA), return on equity (ROE), and net interest margin (NIM). Methodology: The study employs the panel data quantification method, including the pooled regression models based on the generalized least squares method. Total ESG data based on the primary and secondary data systems collected from 27 banks in the period from 2015 to 2023. Result: Statistical evidence indicates that the dependent variables are significantly influenced by the criteria of Environment, Society, and Governance, as well as affected by factors such as loan-to-deposit ratio, bad debt ratio, liquidity ratio, price-to-book ratio, and economic growth. Conclusion: The study also considered internal bank factors, as well as the macroeconomic environment, to provide a more detailed evaluation. The loan-to-deposit ratio has a positive significance on ROA, ROE, and NIM, indicating that the ability to utilize capital and economic growth can help increase bank efficiency. Unique Contribution: This study considers control variables related to internal factors and the economic environment, and the independent variables are

environment, social, and governance. Key Recommendation: The authors have made policy recommendations for the banking system that priority should be given to integrating green strategies, improving credit quality, high security, and transparency; at the same time, there should be reasonable policies to ensure capital safety for development in a market that is increasingly concerned about climate change and sustainable development.

INTRODUCTION

Sustainable development is becoming increasingly important in the strategies of economic organizations, particularly in the financial sector, in the context of globalization and modernization, which are confronting numerous environmental, social, and governance challenges. Bloomberg estimates that by 2025, ESG-related assets will total $53 trillion, or more than one-third of all assets managed globally. This indicates the significance of ESG in contemporary financial development strategies. In Vietnam, awareness and actions regarding ESG have gradually received attention in recent years, especially after the Prime Minister issued a decision 167/QD-TTg in 2022 approving the "Support program for private sector enterprises on sustainable business for the period 2022-2025". This reflects a clear shift of the Government of Vietnam in promoting the financial sector to play a central role in sustainable development. However, in reality, the integration of ESG in banking activities in Vietnam is still in its early stages, and its theoretical and empirical research has not been fully explored. Therefore, it is necessary to study the impact of ESG on banks' operational efficiency to improve financial efficiency and enhance their ability to adapt to macro challenges. This study examines the effects of using the entire ESG and ROA, ROE, and NIM indexes to describe financial success rather than just one. The study examines the impact of using ESG and financial performance indexes, including return on assets, return on equity, and net interest margin, to measure financial performance. It also recommends policies to enhance the competitiveness and sustainability of Vietnam's banking system amid integration and global economic fluctuations.

1. LITERATURE REVIEW

Banks must consider the interests of all stakeholders, including employees, customers, communities, and governments (Freeman, 2015). By incorporating ESG criteria into this theoretical model, commercial banks will be able to develop sustainable development plans. ESG norms enhance institutional prestige, attract investment capital, foster customer trust, and mitigate legal risk. Despite cost increases and conflicts of interest, banks can improve operational efficiency by striking a balance between shareholder and environmental, social, and governance goals. Sustainable development is guided by stakeholder theory, which posits that long-term success is contingent upon social responsibility, environmental conservation, and financial benefits.

Banks should adhere to social standards to achieve acceptability and grow sustainably. ESG has evolved into a strategic tool for financial institutions to enhance transparency, comply with regulations, and foster investor trust, according to legitimacy theory. ESG standards contribute to a favorable image while also laying the groundwork for long-term financial stability in volatile markets. High compliance expenses and the need to change social expectations pose substantial difficulties to banks. According to legitimacy theory, ESG helps banks improve their reputation, increase transparency, and encourage sustainable development.

The legal rules, societal standards, and industry trust all have a significant impact on the operations of commercial banks. In today's world, ESG serves as more than just a compliance tool; it also helps banks improve their brand, attract investment money, and build consumer trust. Transparency in ESG reporting can assist reduce legal risks and offer competitive advantages. Although challenges such as high investment costs, difficulty in measuring effectiveness, and limitations in green project sources still exist, ESG remains an important strategy that helps banks adapt to institutional pressures, thereby expanding market share and maintaining long-term stability.

There is more research on ESG in the economy; however, many aspects remain unclear and require further study. Several studies use ROA and ROE to quantify efficacy (Nathania & Ekawati, 2024). Other measures, such as NIM, which indicate lending profitability, are rarely examined. Most ESG studies on bank performance focus on developed economies, such as those in Europe and the US, where ESG has become a key corporate governance criterion. In contrast, studies on emerging economies, particularly in Asia, including developing countries such as Vietnam, remain scarce. The study noted that these three institutional constraints shape organizational behavior. This notion is underutilized, particularly in banks in developing countries (Aras & Hacioglu, 2022).

2. THEORETICAL FRAMEWORK

In recent years, ESG has emerged as a crucial pillar in the sustainable development strategy of the global banking industry. Numerous empirical studies have been conducted in various countries to assess the impact of ESG on the operational efficiency of banks, thereby providing a multidimensional understanding of the role of these factors in the banking sector. Specifically, experimental studies have utilized multinational data to examine the relationship between ESG and bank financial indicators across various contexts. In 35 countries, Galletta et al. (2023) analyze how ESG affects operational risk in banks. With data from 837 banks, 20% are US banks, 8% are Japanese, and the remaining banks are from other countries. According to the study, banks' operational risk is negatively correlated with their ESG score.

Bogdanova et al. (2018) investigate the impact of sustainability reporting on the operational, economic, and market performance of banks across seven regions. Over the past decade, 60 nations have contributed 4,458 observations. The study demonstrated a negative correlation between ESG and ROA, ROE, and total quality, three key operational, financial, and market success metrics. In conclusion, global research indicates that ESG impacts banks' operations and financial performance differently across various areas.

Looking at specific nations will yield different results. This study aims to investigate the impact of banks' sustainable development initiatives on their accounting and market performance, as assessed by ESG scores, as reported by Çetenak et al. (2022). The flexible generalized least squares technique, using data from six Turkish banks, showed that the total ESG score has a favorable impact on ROA performance indicators. Thus, sustainable Turkish banks are likely to implement an acceptable ESG development plan, which will benefit the country's progress. However, Menicucci and Paolucci (2023) found that ESG harms the operational performance of 105 Italian banks over five years. Three econometric models demonstrated that environmental, social, and governance (ESG) characteristics harm bank efficiency (Cao et al., 2024).

According to a research assessment, ESG is becoming more significant in the banking industry's sustainable development plan. ESG impacts financial risks and operational performance

depending on the implementation scenario. Thus, financial institutions must tailor ESG strategies to their specific needs. To maximize benefits, ESG must be tailored to the domestic reality of Vietnamese banks, where ESG has received little attention. ESG is a trend and a tool for modern banks to gain a competitive edge and promote sustainable development.

In the context of limited current ESG research, this study will clarify the impact of ESG activities on the profits and financial performance of commercial banks (Çetenak et al., 2022). Based on the above fundamental theory and previous empirical results, this article proposes the following research hypothesis: ESG has a positive impact on bank performance. Previous studies have shown that ESG can lead to positive performance for banks. ESG investment has positive benefits for the financial stability of commercial banks (Cao et al., 2024; Lupu et al., 2022). The studies showed that high ESG performance helps commercial banks in emerging market economies reduce risk while improving their financial performance, as measured by return on equity (ROE) and return on assets (ROA). The loan-to-deposit ratio has a bidirectional impact on operating efficiency. The loan-to-deposit ratio has a two-way effect on performance. According to some studies, LDR has a positive impact on return on assets. When deposits and loans are well-managed, it can lead to increased profits (Chiaramonte et al., 2021). The effect of the non-performing loan ratio on operating efficiency is inverse.

The bad debt ratio lowers operational efficiency. According to the study, the bad debt ratio impacts the bank's profitability through provisioning expenses, which in turn harms asset quality and operating efficiency (Friede et al., 2015). A high liquidity ratio helps to achieve optimal operational efficiency. Commercial banks operate more efficiently when their liquidity ratio is high. The liquidity ratio is one method for assessing a company's ability to satisfy its short-term financial obligations. This ratio is computed using the following formula: Divide current liabilities by liquid assets to calculate the liquidity ratio. According to Galletta et al. (2023), a decrease in liquidity does not guarantee that the commercial banking system will stay stable. The relationship between operational efficiency and the market-to-book value ratio is two-sided. The market-to-book ratio has a beneficial effect on bank performance. The P/B ratio, which compares market value to the book value of equity, can be used to evaluate asset valuation and financial stability (Kelmendi, 2024).

Furthermore, GDP growth improves operational efficiency. Several studies have found varied results regarding the impact of GDP growth on bank performance. According to Ferreira (2012), while GDP growth can enhance bank performance, an overly concentrated banking sector can harm overall economic performance (Kolsi et al., 2023). The impact of the inflation rate on performance can be either positive or negative (Kelmendi, 2024; Torre et al., 2021).

3. RESEARCH METHODS

3.1 Research Data

The authors of this study employed a manual approach to creating ESG indices, as it is suitable for the Vietnamese context, given that most commercial banks in the country have not been officially evaluated for ESG. In reality, Vietnam is only in the early stages of ESG action. It requires support from international organizations and communities to continuously improve implementation capacity, gain experience, and gradually progress in the process of committing to

and implementing ESG actions. The purpose of this paper is to assist financial institutions in incorporating environmental, social, and governance (ESG) principles into their oversight and governance procedures (Lee et al., 2023; Lupu et al., 2022). However, to suit the actual conditions and information disclosure characteristics of commercial banks in Vietnam, the authors have reviewed and selected standards, thereby eliminating some inappropriate ones while retaining those that can be clearly and fully quantified from the annual reports and sustainable development reports of banks. The final set of ESG standards comprises 24 criteria, divided into three groups: Environment (E, 8 criteria), Society (S, 9 criteria), and Governance (G, 7 criteria). Each criterion is evaluated on a binary scale, where the bank will receive 1 point if it implements or publishes a policy related to the mentioned standard and 0 points if no information is provided (Menicucci & Paolucci, 2023). After scoring each criterion, to ensure balance between the three pillars, regardless of the difference in the number of criteria in each group, the authors calculated the average score for each criterion E, S, and G separately based on the formula:

$$E_{it} = \frac{1}{n_E}\sum_{j=1}^{n_E} E_{ijt}\,, \quad S_{it} = \frac{1}{n_S}\sum_{j=1}^{n_S} S_{ijt}\,, \qquad G_{it} = \frac{1}{n_G}\sum_{j=1}^{n_G} G_{ijt}$$

Where it is bank i in year t, j is the criterion in group E, S or G, nE = 8, nS = 9, nG = 7 is the number of criteria in each group, Eijt, Sijt, Gijt are the binary scores according to criterion j of bank i in year t. Finally, the aggregate ESG index of bank i in year t is calculated as follows:

$$ESG_{it} = \frac{E_{it} + S_{it} + G_{it}}{n} \times 100$$

This ensures that each pillar contributes equally to each bank's overall ESG score over time, creating a favorable basis for utilizing the models proposed by the authors.

3.2 Proposed Research Model

The research team inherited the research model of authors Aras and Haciioglu (2022) with ROA, ROE specifically as follows:

$$Y_{i,t} = \beta_0 + \beta_1 ESGscore_{i,t} + \sum_{k=2}^{K} \beta_k Bank_{k,i,t} + \sum_{m=K+1}^{M} \beta_m Macro_{m,i,t} + \varepsilon_{i,t}$$

$Y_{i,t}$: The dependent variables representing operating efficiency include ROA, ROE, NIM

$ESGscore_{i,t}$ - Variable representing the overall ESG score

$Bank_{k,i,t}$ — The variables representing the bank include LDR, NPL, LR, and P/B.

$Macro_{k,i,t}$ - Macro variables include GDPgr, INF

$\varepsilon_{i,t}$ — Random disturbance term – includes other factors influencing the dependent variable but are not observed in the model.

3.3 Description of Research Variables

Table 1. Dependent variable

Variable	Name Variable	How to determine	Empirical research
ROA	Return on assets	Profit/Total Assets	Njoki & Nyamute (2023)
ROE	Return on equity	Profit/Equity	Folger-Laronde et al. (2022)
NIM	Net Interest Margin	Net Interest Income/Average Interest Earning Assets	Zahid et al. (2023)

Source: own

Table 1 illustrates that ROA, ROE, and NIM are key performance indicators for banks. Specifically, ROA assesses asset efficiency, ROE gauges shareholder return and the impact of leverage, and NIM captures interest spread management.

Table 2. Independent variables

Variable	Name Variable	How to determine	Expected	Empirical research	Hypothesis
ESG score	ESG Composite Score	$ESG_{it}=\frac{E_{it}+S_{it}+G_{it}}{n}$ x 100	+	Lee et al. (2023), Torre et al. (2021)	H1
Variable representing bank					
LDR	Loan-to-deposit ratio	Total outstanding loans / Total customer deposits	+/-	Zheng & Bu (2024)	H2
NPL	Non-Performing Loan	Bad debt/ Total outstanding debt	-	Alareeni & Hamdan (2020)	H3
LR	Liquidity risk	Total assets / Equity	+	Tan et al. (2024)	H4
P/B	Stock price to book value	Stock price/book value	+/-	Bogdanova et al. (2018)	H5
Macro variables					
GDPgr	Economic growth	GDP growth	+	Zheng & Bu (2024)	H6
INF	Inflation	Inflation index over the years	+/-	Kelmendi (2024), Zahid et al. (2023)	H7

Source: own

Table 2 shows that the ESG score, loan-to-deposit ratio, non-performing loans, leverage ratio, price-to-book ratio, GDP growth, and inflation capture banks' sustainability practices, credit risk, risk-taking, market sentiment, and macroeconomic conditions. Their expected impacts on profitability vary: ESG and GDP growth positive, NPL negative, while LDR, LR, P/B, and inflation may be neutral or context-dependent.

4. STUDY RESULTS

4.1 Statistical Results

Table 3 presents 243 observations and the performance variables, including return on assets, return on equity, and net interest margin. The ROA, averaging 1.432%, indicates relatively stable

profitability; however, there is a significant with 18.050%. ROE has an average of 11.690%, ranging from -12.330% to 30.330%, indicating substantial differences in financial efficiency among banks. Additionally, the commercial banks in the sample exhibit relatively strong profitability, with an average net interest margin of 3.283%. Due to the standard deviation of 1.598%, there is considerable variation in profitability as well. These apparent differences in financial indicators reflect the uneven performance levels among banks, providing a crucial basis for analyzing the impact of ESG factors in the subsequent sections.

Table 3. Testing *descriptive statistics based on data from 2015 to 2023*

Variable	Unit	Mean	Standard deviation	Minimum	Maximum
ROA	%	1.432	2.230	-0.720	18.050
ROE	%	11.690	8.448	-12.330	30.330
NIM	%	3.283	1.598	0.000	9.330
ESGscore	Score	61.311	18.504	27.513	100.000
PB	-	1.239	1.150	0.000	11.800
LDR	%	91.532	14.927	43.900	142.820
NPL	%	2.079	2.326	0.470	29.760
LR	%	91.530	3.058	80.895	96.238
GDPgr	%	6.003	1.932	2.554	8.124
INF	%	2.746	0.886	0.631	3.540

Source: own

Table 3 displays ROA as 1.43%, with a range of -0.72% to 18.05%. The ROE is 11.69%, with a range of -12.33% to 30.33%. The NIM is 3.28%, with a range of 0% to 9.33%. ESG received a critical score of 61.31, while PB received a score of 1.24. 9.15% LDR, 2.08% NPL, and 9.53 % LR. A rise of 6.00% in GDP and 2.75% in inflation. The wide range of bank performances, risk profiles, and macroeconomic situations are reflected in these spreads and means.

Table 4. Correlation Matrix and Multicollinearity Test

Variable	ROA	ROE	NIM	VIF1
ESGscore	0.2574*	0.4148*	0.1881*	1.14
PB	0.1031	0.3114*	0.0945	1.07
LDR	0.3272*	0.4502*	0.4700*	1.16
NPL	-0.1019	-0.2784*	-0.1021	1.01
LR	-0.1048	0.0083	-0.3244*	1.06
GDPgr	-0.0507	-0.0975	0.005	1.04
INF	0.0362	0.1778*	0.0305	1.07

Note: *The symbol * represents the 5% statistical significance level.*
Source: own

Table 4 presents a model that builds on the correlation coefficients between variables, using the results to make a preliminary assessment of the relationships between the independent variables and the dependent variables in the model.

Table 5. Summary table of model fit and defect testing

Variable	Hausman Test	Appropriate model	chibar2 (01)	ALM(lambda=0)
ROA	1.28	REM	307.33***	27.50***
ROE	-12.90	REM	259.59***	35.27***

NIM	-3.13	REM	601.19***	19.03***

Notes: *The symbols *, **, and *** is 10%, 5%, and 1%, respectively.*
Source: own

Table 5 shows that the testing results indicate that REM is the more appropriate model. However, further diagnostic tests reveal that the REM model suffers from both heteroscedasticity and autocorrelation. The values of *chibar(01)* and ALM (*lambda = 0*), both significant at the 1% level, indicate that the REM model exhibits heteroscedasticity and autocorrelation. Therefore, the authors consider the flexible generalized least squares (FGLS) method as a suitable choice, ensuring that the results are not biased due to the defects inherent in the REM model. The summary of the regression results examining the relationship between the independent variable, ESG score, and the dependent variable, estimated using the flexible generalized least squares (FGLS) method, is presented in Table 6 below.

Table 6. Summary of FGLS regression results with the model

Variable	**ROA**	**ROE**	**NIM**
ESGscore	0.00878***	0.0896***	0.00549**
	-3.89	-4.63	-2.46
PB	0.0626**	0.118	0.0481*
	-2.34	-0.8	-1.68
LDR	0.0179***	0.156***	0.0125***
	-5.86	-5.46	-3.48
NPL	-0.0346***	-0.684***	-0.0555***
	(-3.98)	(-4.82)	(-5.10)
LR	-0.0783***	0.385***	-0.107***
	(-4.10)	-2.67	(-5.54)
GDPgr	0.0205*	0.185*	0.0482***
	-1.72	-1.9	-3.83
INF	-0.00653	0.117	-0.0402
	(-0.22)	-0.5	(-1.30)
Constant	5.956***	-44.96***	11.20***
	-3.28	(-3.34)	-6.06

Note: *The symbols *, **, *** is 10%, 5%, 1%, level respectively.*
Source: own

Table 6 shows that the ESG score has a positive impact on all dependent variables related to operational efficiency, as proposed by the authors. This suggests that banks that prioritize and implement ESG-based sustainable development are more profitable. ESG norms enhance transparency and risk management, thereby boosting investor and stakeholder trust. Long-term investors tend to prefer ESG-practicing banks (Friede et al., 2015; Nathania & Ekawati, 2024).

4.2 Discussion of Findings

These findings confirm the authors' claim that ESG has a favorable impact on bank performance. Njoki and Nyamute (2023) reached similar conclusions as the research group on the effect of ESG on bank performance. ESG stabilizes and preserves the financial system by mitigating non-financial risks. Tan et al. (2024) and Aras and Hacioglu (2022) investigated the impact of ESG on the financial stability of European banks, specifically examining how ESG influences bank performance before and after the COVID-19 pandemic. Other bank performance independent

variables: According to earlier research, such as Zahid et al. (2023), the loan-to-deposit ratio enhances bank performance by improving capital utilization efficiency, market trust, and organizational reputation. According to Zheng and Bu (2024), non-performing loans harm bank performance.

The Government needs to establish strict regulations while also enhancing mandatory requirements in the policy system and management process to protect every business and financial organization. Not only should they pay attention to the environmental aspect, but they should also comprehensively consider ESG factors to develop sustainability and social responsibility (Kelmendi, 2024; Zahid et al., 2023).

This suggests that minimizing non-performing loans is crucial for reducing credit risk and enhancing profitability. According to Alareeni and Hamdan (2020), the liquidity ratio has a two-way effect, underscoring the need for sufficient cash reserves to maximize financing, investor confidence, and system stability. According to Folger-Laronde et al. (2022), a high market price-to-book value ratio implies strong financial performance, facilitates capital raising, and attracts investors, all of which enhance operational efficiency. Finally, GDPgr improves bank efficiency across ROA, ROE, and NIM. Chiaramonte et al. (2021) and Galletta et al. (2023) discovered that GDP growth influences banking efficiency in two ways. The findings indicate that efficiency factors and economic cycle phases have a significant impact on economic growth.

CONCLUSION

The paper presents and discusses the impact of implementing ESG factors on the banking system, with a particular focus on Vietnamese banks. The paper also compares with the global situation to assess the importance of ESG in shaping the banking system and risk management. Additionally, this research examines the impact of ESG on Vietnamese commercial banks from 2015 to 2023. The authors measured bank performance using ROA, ROE, and NIM. The data indicate that ESG improves most key performance indicators, except for the net interest margin. This means that if ESG strategies are enhanced, banks will increase their market value and profitability. Moreover, the study considered both internal bank factors and the macroeconomic environment to provide a more comprehensive evaluation. The loan-to-deposit ratio and economic growth have a positive significance on return on assets, return on equity, and net interest margin, indicating that the ability to utilize capital and economic development can help increase bank efficiency. On the contrary, the bad debt or liquidity ratio harms ROA, ROE, and NIM, reflecting that high credit risk and excess payments will reduce financial efficiency. Finally, the P/B ratio has a positive impact on ROA and NIM, indicating that banks with a higher valuation than their book value tend to exhibit better market efficiency now or in the future.

To promote and encourage businesses, in general, and the banking system, in particular, to disclose ESG information in an increasingly better, more transparent, and more reliable manner, agencies, departments, sectors, and the Government need to take clear actions. The above results provide a basis for some policy implications:

(1) The banks need to develop clear and systematic internal ESG regulations and standards. A specialized department should be established to ensure progress and optimize ESG activities. On the management side, it is necessary to issue mandatory regulations on ESG standards to ensure consistency and improve the overall efficiency of the economy. Additionally, management agencies such as the State Bank can consider implementing policies to establish a set of ESG indicators in their bank credit ratings. This mechanism should include grading and publishing the annual rankings of sustainable development reports from public enterprises. From there, a reference basis will be established to encourage high-ranking enterprises to benefit from

preferential tax policies, as well as when investing and participating in bidding, thereby enabling enterprises to reap specific benefits. This will focus on improving the quality of sustainable development reports by specifically publishing ESG indicators.

(2) The banks also need to improve the quality of credit appraisal, tighten post-lending control, and be transparent in debt classification by applying technology such as artificial intelligence and big data. Additionally, they need to establish a reasonable insufficient debt reserve fund and proactively restructure debt when necessary to ensure operational stability. In today's context, the role of ESG is becoming increasingly important in building a sustainable and responsible financial system. In the Vietnamese banking system, promoting and enhancing the role of ESG is not only an urgent task but also a firm commitment to sustainable development.

(3) Banks need to manage mobilized capital effectively and allocate it to profitable loans. In addition, depending on the scale of operations and the level of risk, banks should establish a safe loan-to-deposit ratio to enhance capital efficiency and foster conditions for healthy credit growth. It is possible to diversify credit products and strive to maintain a reasonable level of loan-to-deposit ratio, thereby creating conditions for healthy credit growth. ESG risk management must also be carried out rigorously. ESG risk analysis and assessment will provide insight into the impact of environmental and social factors on the bank's strategy, operations, and long-term prospects. This not only helps businesses develop a rigorous risk mitigation plan but also enables banks to adapt flexibly to the challenges and opportunities posed by ESG.

(4) Banks need to develop a flexible liquidity management mechanism. Banks need to establish a reasonable liquidity threshold to strike a balance between safety and profitability. Banks need to strike a balance between maintaining a high liquidity level that does not waste assets and ensuring solvency to prevent systemic risks. Applying risk management technology in liquidity to minimize the opportunity cost of idle capital. In addition, issuing liquidity management policies needs to be flexible, especially in the context of economic and interest rate fluctuations.

(5) The banks should monitor the macroeconomic situation to make adjustments to credit plans and business operations as needed for each stage of market change. In addition, the Government and the State Bank need to operate monetary and fiscal policies flexibly, stabilize the macroeconomic environment, and support the banking system to overcome difficult periods, thereby promoting a sustainable link between economic growth and operational efficiency.

(6) The SBV needs to demonstrate its leadership in developing and implementing specific policies and regulations on green credit, ensuring that commercial banks and financial institutions seriously and effectively implement green principles and standards while maintaining consistency in their participation and implementation of ESG across the sector. The cooperation and contributions of all relevant ministries, departments, and agencies are also essential factors in ensuring that ESG implementation is comprehensive and the Government's commitments related to net emission reduction are fulfilled. Through solidarity and joint actions of all stakeholders, we can ensure the sustainability of the financial system and the natural environment in the future.

Limitations and future research: This study's limitation is that it is restricted to publicly traded commercial banks, specifically those listed on the HOSE, HNX, and UPCOM exchanges in Vietnam. Unlisted banks will not be included in the study. However, the study has yet to analyze the influence of ESG on each bank's individual performance. Finally, the authors employed non-dynamic regression models in the survey, so the results only reflect current performance and may not be indicative of long-term outcomes. Therefore, further research is needed to evaluate the long-term impact of ESG on the individual performance of each bank in Vietnam.

ACKNOWLEDGMENT

The authors acknowledge being supported by the University of Finance – Marketing, Vietnam.

REFERENCES

Alareeni, B. A., Hamdan, A. (2020), „ESG impact on performance of US S&P 500-listed firms“, Corporate Governance, Vol. 20, No.7, pp. 1409-1428. https://doi.org/10.1108/CG-06-2020-0258

Aras, G., Hacioglu, K. E. (2022), „Enhancing firm value through the lens of ESG materiality: Evidence from the banking sector in OECD countries“, Sustainability, Vol. 14, No.22, pp. 1-29. https://doi.org/10.3390/su142215302

Bogdanova, B., Fender, I., Takáts, E. (2018), "The ABCs of bank PBRs", Research in International Business and Finance, Vol. 21, No. 2, pp. 222-237. https://ideas.repec.org/a/bis/bisqtr/1803h.html.

Cao, Q., Zhu, T., Yu, W. (2024), "ESG investment and bank efficiency: Evidence from China", Energy Economics, Vol. 133, 2024, pp. 1-20. https://doi.org/10.1016/j.eneco.2024.107516.

Çetenak, E. H., Ersoy, E., Işık, Ö. (2022), "ESG (Çevresel, Sosyal ve Kurumsal Yönetim) skorunun firma performansına etkisi: Türk bankacılık sektörü örneği", Erciyes Üniversitesi İİBF Dergisi, Vol. 63, pp. 75-82. https://doi.org/10.18070/erciyesiibd.1212587.

Chiaramonte, L., Dreassi, A., Girardone, C., Piserà, S. (2021), "Do ESG strategies enhance bank stability during financial turmoil? Evidence from Europe", The European Journal of Finance, Vol. 28, No. 12, pp. 1173-1211. https://doi.org/10.1080/1351847X.2021.1964556.

Folger-Laronde, Z., Pashang, S., Feor, L., Elalfy, A. (2022), "ESG ratings and financial performance of exchange-traded funds during the COVID-19 pandemic", Journal of Sustainable Finance and Investment, Vol. 12, No. 2, pp. 490-496. https://doi.org/10.1080/20430795.2020.1782814.

Friede, G., Busch, T., Bassen, A. (2015), "ESG and financial performance: Aggregated evidence from more than 2000 empirical studies", Journal of Sustainable Finance & Investment, Vol. 5, No. 4, pp. 210–233. https://doi.org/10.1080/20430795.2015.1118917.

Galletta, S., Goodell, J. W., Mazzù, S., Paltrinieri, A. (2023), "Bank reputation and operational risk: The impact of ESG", Finance Research Letters, Vol. 51, 2023, pp. 1-24. https://doi.org/10.1016/j.frl.2022.103494.

Kelmendi, V. (2024), "Impact of macroeconomic factors on bank financial performance: A Turkey and Kosovo comparative study", International Journal of Sustainable Development & Planning, Vol. 19, No. 1, pp. 229-235. https://doi.org/10.18280/ijsdp.190121.

Kolsi, M. C., Al-Hiyari, A., Hussainey, K. (2023), "Does environmental, social, and governance performance mitigate earnings management practices? Evidence from US commercial banks", Environmental Science and Pollution Research, Vol. 30, pp. 20386-20401. https://doi.org/10.1007/s11356-022-23616-2.

Lee, M. T., Raschke, R. L., Krishen, A. S. (2023), "Understanding ESG scores and firm performance: Are high-performing firms E, S, and G-balanced?", Technological Forecasting and Social Change, Vol. 195, 2023, pp. 1-19. https://doi.org/10.1016/j.techfore.2023.122779.

Lupu, I., Hurduzeu, G., Lupu, R. (2022), "How is the ESG reflected in European financial stability?", Sustainability, Vol. 14, No. 16, pp. 1-14. https://doi.org/10.3390/su141610287.

Menicucci, E., Paolucci, G. (2023), "ESG dimensions and bank performance: An empirical investigation in Italy", Corporate Governance: The International Journal of Business in Society, Vol. 23, No. 3, pp. 563-586. https://doi.org/10.1108/CG-03-2022-0094.

Nathania, R., Ekawati, E. (2024), "Banking on ESG: How ownership influences financial outcomes in 5-ASEAN countries", Banks and Bank Systems, Vol. 19, No. 3, pp. 121-132. https://doi.org/10.21511/bbs.19(3).2024.11.

Njoki, N. M., Nyamute, W. (2023), “Factors affecting financial performance of commercial banks in Kenya”, Journal of Finance and Accounting, Vol. 7, No. 1, pp. 100–115. https://doi.org/10.53819/81018102t2122.

Tan, S., Liu, T., Wang, C. (2024), “The double-edged effect of bank liquidity creation efficiency on systemic risk: Evidence from China”, PLOS ONE, Vol. 19, No. 11, pp. 1-26. https://doi.org/10.1371/journal.pone.0313208.

Torre, L. M., Leo, S., Panetta, I. C. (2021), “Banks and environmental, social, and governance drivers: Follow the market or the authorities?”, Corporate Social Responsibility and Environmental Management, Vol. 28, No. 6, pp. 1620-1634. https://doi.org/10.1002/csr.2132.

Zahid, M., Naqvi, S. U. U. B., Jan, A., Rahman, H. U., Wali, S. (2023), “The nexus of environmental, social, and governance practices with the financial performance of banks: A comparative analysis for the pre and COVID-19 periods”, Cogent Economics & Finance, Vol. 11, No. 1, pp. 1-18. https://doi.org/10.1080/23322039.2023.2183654.

Zheng, X., Bu, Q. (2024), “Enterprise ESG performance, digital transformation, and firm performance: Evidence from China”, SAGE Open, Vol. 14, No. 4, pp. 1-18. https://doi.org/10.1177/21582440241291680.

ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

Streimikiene, D., Kyriakopoulos, G.L. (2026), "Measuring Sustainable Development of Baltic States Based on Ecological Footprint", *Montenegrin Journal of Economics*, Vol. 22, No. 2, pp. 261-278.

Measuring Sustainable Development of Baltic States Based on Ecological Footprint

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ARTICLE INFO

Received January 23, 2025
Revised from February 22, 2025
Accepted March 21, 2025
Available online April 15, 2026

JEL classification: Q28, Q48; J14; Q33, H55

DOI: 10.14254/1800-5845/2026.22-2.20

Keywords:
Low carbon transition,
Ageing society,
Barriers,
Drivers,
Policies and measures

ABSTRACT

This study assesses the sustainability of the Baltic States—Estonia, Latvia, and Lithuania—by analyzing trends in ecological footprint and biocapacity from 1992 to 2022 using data from the Global Footprint Network. The ecological footprint measures the demand placed on ecosystems by human consumption, while biocapacity reflects the ability of ecosystems to regenerate resources and absorb waste. The findings reveal significant disparities among the three countries. Estonia maintains the highest biocapacity per capita but also the highest ecological footprint, largely due to its reliance on carbon-intensive oil shale energy. Latvia demonstrates the most balanced sustainability profile, with moderate biocapacity and the lowest ecological footprint, consistently staying within ecological limits. Lithuania, in contrast, faces the greatest sustainability challenges, with the lowest biocapacity and a steadily increasing footprint resulting in a persistent ecological deficit. The paper discusses the underlying drivers of these differences, including land use, energy structures, economic development, and policy approaches. The study concludes that differentiated strategies are required to enhance sustainability in each country, and that ecological footprint and biocapacity are effective indicators for guiding policy and evaluating progress toward sustainable development.

INTRODUCTION

Theoretical background

Ecological footprint can be considered a methodology of evaluating the ecological environment and the sustainable development of a region/state. Such an evaluation showed that the biocapacity of built-up area and cropland is worsening after debris flow disaster, followed by forest land, grazing ground, fishing ground and barren ground. All these are protagonist factors of serious impediment in economic development. Other affected factors after disastrous phenomena are that of ecological deficit, nurturing of an unsustainable development and indirectly degrading the quality of life in densely populated urban

contexts, in which the geological disasters are certainly playing a significant impeding factor on the socio-economic development (Yue et al., 2012).

From a macro-economics viewpoint it was also reported in the relevant literature that while GDP and FDI often exacerbate environmental degradation, urbanization and value-added agriculture, forestry, and fishing (FAFGDP) improve sustainability in some provinces of China. It is also concluded that China's legal and regulatory frameworks may inadequately mitigate FDI's adverse environmental effects, making a necessity the revision of FDI policies in order to incentivize environmentally friendly practices (Güler et al., 2025).

Another set of valuing ecological footprint within the context of sustainable development is related to the environmental degradation, which is predominately observed when achieving economic growth. This environmental degradation is conceived despite concurring potential mitigating effects of technological advancements and cleaner energy sources (Boukhelkhal, 2022; Hong et al., 2024). In this context it has been literature challenging to investigate the critical impact of cleaner energy sources, advanced technology firms, and economic expansion, especially in the period 2010 - 2022. It was noteworthy that the joint comparison between E7 (emerging seven) and G7 (Group of Seven) economies, support researchers to delineate how these factors collectively influence environmental sustainability in developing and developed countries/emerging economies (Iian, 2024). A common target of all developed and developing countries is to enact environmental regulations in order to achieve sustainable development and ecological sustainability. However, no environmental sustainability guarantee is assured if environmental regulations are ineffectively implemented (Ahmed et al., 2022). Another critical determinant is the political institutions that play a key role in the formulation, issuing and monitoring the implementation of environmental regulations. Therefore, it is challenging research to focus on the interrelations developed among democracy, environmental regulations, economic growth and ecological footprint (EF) in long-run study containing the panel of G7 nations in the period 1985 - 2017 (Ahmed et al., 2022).

Among the developing countries it can be denoted the study of Olowu et al. (2018) who empirically investigated the bridging of financial development, sustainable economic opportunity and ecological footprint in Southern African Development Community (SADC) countries (Olowu et al., 2018). Similarly, G-11 countries are experiencing a rapid economic growth with unsustainable ecosystem, subsequently, these countries remain unable to cope with the devastating environmental degradation, making an imperative need of better understanding the effects of eco-innovations (ECO), sub-indices of globalization, economic growth (GDP), and urbanization (URB) on ecological footprints (EF) (Mehmood, 2024).

In the African continent it can be also referred the case of Nigeria, where the national economy is primary relying on the following two major sectors which are considered as emission-induced sectors: petroleum and agricultural sector. Both sectors can be characterized by the over-exploitation of non-renewable sources of energy in energy-fed operations (Udemba, 2020). Therefore, the mitigation of Nigerian economic performance and ecological footprint with other selected variables support country to contribute to the global principle of reducing global warming amidst competitive economic operations (Udemba, 2020). The author of this study further proved that from the ARDL regression findings, a positive relation among income (GDP per capita) and the selected independent variables (mainly that of ecological footprint, agriculture, FDI, energy use). It was also noticeable at the negative relationship amid income and population of the country. Of particular interest was the finding of a one-way (Uni-directional) transmission towards ecological footprint that was passed from economic growth (GDP per capita), from energy use, from population, from economic growth to energy use and from population to economic growth (Udemba, 2020).

From a regulatory and normative viewpoint there are already and globally introduced green initiatives to deal with such environmental issues, such as that of the Kyoto Protocol, the Paris Agreement, and the Sustainable Development Goals (SDGs), but it still remains a contentious multiparametric problem (Udemba et al., 2024). Practically emerging economies are unavoidably excluded from such initiative and only few literature studies have been recently devoted to better understand the response of emerging

economies toward a sustainable environment, such as that of BRICS economies (Brazil, Russia, India, China and South Africa) (Udemba et al., 2024). In this empirical study authors employed representative innovative environmental determinants including real income, urbanization, entrepreneurial activities, per capita renewable energy, financial innovation and environmental policy for selected regions in the referencing period 2000 - 2021. It was shown significant contribution of per capita green energy consumption, environmental policy and entrepreneurial activities toward environmental sustainability. Contrarily, income, financial inclusion and urbanization had been contributed to environmental damage (Udemba et al., 2024).

When considering the densely population regions with the emerging economies, it was argued an intensification of the ecological stress in both the short and long run. In the case of Somalia, and unlikely of other countries, it was not exhibited consistency with the Environmental Kuznets Curve hypothesis, implying the urgent need for targeted policy interventions (Abdi et al., 2025). In such a case the role of energy production and the specific socio-economic conditions can be considered. Indeed, by adopting renewable energy, integrating environmental education and implementing sustainable urban and economic strategies can distress ecological pressures and to simultaneously ensure long-term environmental sustainability. Such finding can also underscore those critical factors that policymakers among emerging economies should take into consideration, especially among those developing economies that are facing similar environmental challenges (Abdi et al., 2025).

This study provides a comparative case study on assessment of ecological footprint and biocapacity for Baltic States sharing the similar geographic and social-economic development conditions with the aim to reveal those distinct characteristics and to highlight the reasons of these observed differentiates.

Methodologies and Analytical Techniques

The theoretical production of linking ecological footprint and biocapacity towards sustainable development enabled the collection and presentation of the main methodologies and analytical techniques that have been employed. In this context these methodologies and techniques have been collected and presented in reverse chronological order, from the newest to the earliest, in the following Table 1.

Table 1. Methodologies and Analytical Tools. Source: Authors own study.

Reference	*Methodologies- Analytical tools*
Güler Et al., 2025	Remote sensing and GIS spatial analysis techniques were employed to investigate the impact of economic growth and foreign direct investment (FDI) on China's sustainable development goals (SDGs). Research focus on Zero Hunger (SDG 2), Life Below Water (SDG 14), and Life on Land (SDG 15). Ecological footprints and load capacity factors (LCFs) in cropland, fishing, forest, and grazing land were examined using Fourier bootstrap autoregressive distributed lag (ARDL) cointegration analysis and fully modified ordinary least squares (FMOLS) estimators.
Hong et al., 2024	Advanced econometric estimation methods have been employed.
lian, 2024	A robust panel estimation technique was employed, enabled authors to systematically explore the key-parameters of this study.
Mehmood, 2024	Annual data of 1990–2020 have been utilized to apply the cross-sectional autoregressive distributed lag approach and validates the Environmental Kuznets Curve in the G-11 eleven nations group.
Galli et al., 2023	Resource dependence and carbon emissions of the EU-27's food systems at the period 2004 - 2014 via an ecological footprint-extended multi-regional input–output approach The method counts for demand and supply (including trade), and consideried multiple externalities.
Kongbuamai et al., 2023	The Environmental Kuznets Curve framework was employed to explore the impacts of economic growth, energy consumption, information, and communication

	technology (ICT), and urbanization on the ecological footprint for the Next-11 (N-11) countries. The Driscoll––Kraay standard error and Feasible General Least Squares (FGLS) methods were applied to investigate the long-run relationship between the highlighted variables. In addition, the Dumitrescu and Hurlin panel causality test was employed for exploring the causality path of the variables under consideration.
Onifade, 2023	The Augmented Mean Group (AMG) estimator produced important information offering the additional advantage of exploring country-specific outcomes in the empirical analyses that were subsequently corroborated by the Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square (FMOLS) approaches.
Sampene et al., 2023	The impact of economic growth, biocapacity, renewable energy use, natural resource rent, agricultural value-added, green finance and information and communication technology on the ecological footprint. The environmental Kuznets curve framework was employed with a dataset at the period 1990 - 2017. The cross-sectional-augmented autoregressive distributed lag (CS-ARDL) approach was applied to estimate the variable's short and long-term interaction.
Shen and Yue, 2023	The nonlinear impact of the ecological footprint on biocapacity from the perspective of the self-regulation capacity of the ecosystem provided a new perspective to value the sustainability satisfaction/experience of a country. Using panel data of the G20 countries, a panel smooth transition model with a continuous transition process was established. This model abandons the constraints of linear models and agrees with the gradual characteristics of ecosystem evolution.
Ahmed et al., 2022	Second generation econometric techniques were used of data analysis.
Boukhelkhal, 2022	The determinants of ecological footprint were identified as a proxy for environmental quality in Algeria in the period 1980 - 2017 using several economic indicators. The autoregressive distributed lags (ARDL) approach has been utilized in order to estimate the constructed environmental degradation models.
Qaiser Gillani et al., 2021	Fixed effects panel data estimations and the utility of the Hausman specification test have been counted for the fixed effects model as the suitable identification estimator.
Ullah et al., 2021	Panel time-series data in the period 1996 - 2018 has been focused on. Panel Smooth Transition Model has been utilized in order to explore the nonlinear relationship and transition between the low and the high regimes due to nonlinear behavior.
Majeed and Mazhar, 2020	Reinvestigation of the Environmental Kuznets Curve was materialized by exploiting the lager panel data set, covering a longer time horizon more than half century (1961-2018) and using ecological footprint as a comprehensive environmental indicator, while the employment of first-generation and second-generation panel time's series methods were undertaken.
Świąder et al., 2020	Considering annual data from 1990–2020 robust methodologies were employed to present the findings. The CS-ARDL method showed that jointly the renewable energy, ICT, and government stability played a pivotal role to moderate environmental pollution in G11 countries. Environmental Carrying Capacity (ECC) is a concept and a tool for the sustainable development of human settlements.In this study the utilization of the environmental indicators such as ecological footprint and biocapacity were employed for ECC quantification.
Udemba, 2020	Autoregressive Distributed Lag (ARDL) and Granger Causality (GC) methods.

Shujah-ur-Rahman et al., 2019	Having the research focus on the Central and Eastern European Countries (CEECs), in this study there is a cooperation among biocapacity and human capital in the growth–energy–environment nexus. Annual data of 16 CEE countries in perspective of the One Belt One Road (OBOR) initiative in the reference period of 1991–2014. This study has been focused on second-generation econometric approaches to check stationarity, cross-sectional dependency, and co-integration among the model parameters. The long-run estimations of the "Dynamic Seemingly Unrelated-co-integration Regression" (DSUR) disclosed an instability of economic growth on ecological footprint and validated the environmental quality through a N-shaped relationship for cubic functional form between per capita income and ecological footprint.
Olowu et al., 2018	Use of time series data on financial access (bank branches per 100,000 adults), financial depth (private credit by deposit money banks to GDP), financial efficiency (bank return on equity percentage, after tax), financial stability (bank Z-score), composite index for financial development, ecological footprint indicator and sustainable economic opportunity.
Niccolucci et.al., 2012	Footprint and biocapacity dynamics have been determined by many different factors, making each profile unique and complex to explain. Identification of four main dynamic typologies: parallel, scissor, wedge and descent. The evaluation criteria were that of population trends jointly with other indicators, including: environmental performance index, EPI, environmental sustainability index, ESI and human development index, HDI.
Yue et al., 2012	Remote sensing and GIS spatial analysis techniques.
Carlei et al., 2011	The Absolute Ecological Footprint instead the Pro-Capita was considered as a suitable proxy to effectively investigate socio-economic patterns of sustainable development. Setting out a methodology of non-linear analysis, based on Neural Networks Self Organizing Map in order to explore the relationship between different kinds of socio-economic patterns. Research focus on demonstrating the relevance of selected social-economic features as a complex factor for sustainable development.

Source: own

Concerns and considerations of linking ecological footprint and biocapacity towards sustainable development

Based on the theoretical background of the aforementioned published studies in linking ecological footprint and sustainable development, it can be inferred that the principles of sustainable development consist of economic, societal, and environmental considerations. All economic systems and social structures are more or less shaping social impacts on health, which are engaged with the broader environment and they are affecting the distribution of energy resources worldwide (Jie et al., 2023).

Among the socio-economic features of linking ecological footprint, economic growth and natural resources towards the accomplishment of sustainable development is the assessment of how education and life expectancy as social indicators can influence the environmental quality (Boukhelkhal, 2022). Considering the symbiosis of natural resources, population growth, and industrial development, contemporary studies are mainly concentrating on the impact of sustainable energy policy and socio-economic development on the ecological footprint, as in the case of China in the long-run period 1990-2019 (Jie et al., 2023). It was shown that the main contributors of natural net financial accounts, natural resources, and economic growth are all positively linked with the ecological footprint. In this context environmental sustainability is valued as a long-term result of socio-economic development (Jie et al., 2023). In approaching the determining factors of the theoretical coverage, a map of the CE-operational grid has been adopted and presented below, Figure 1.

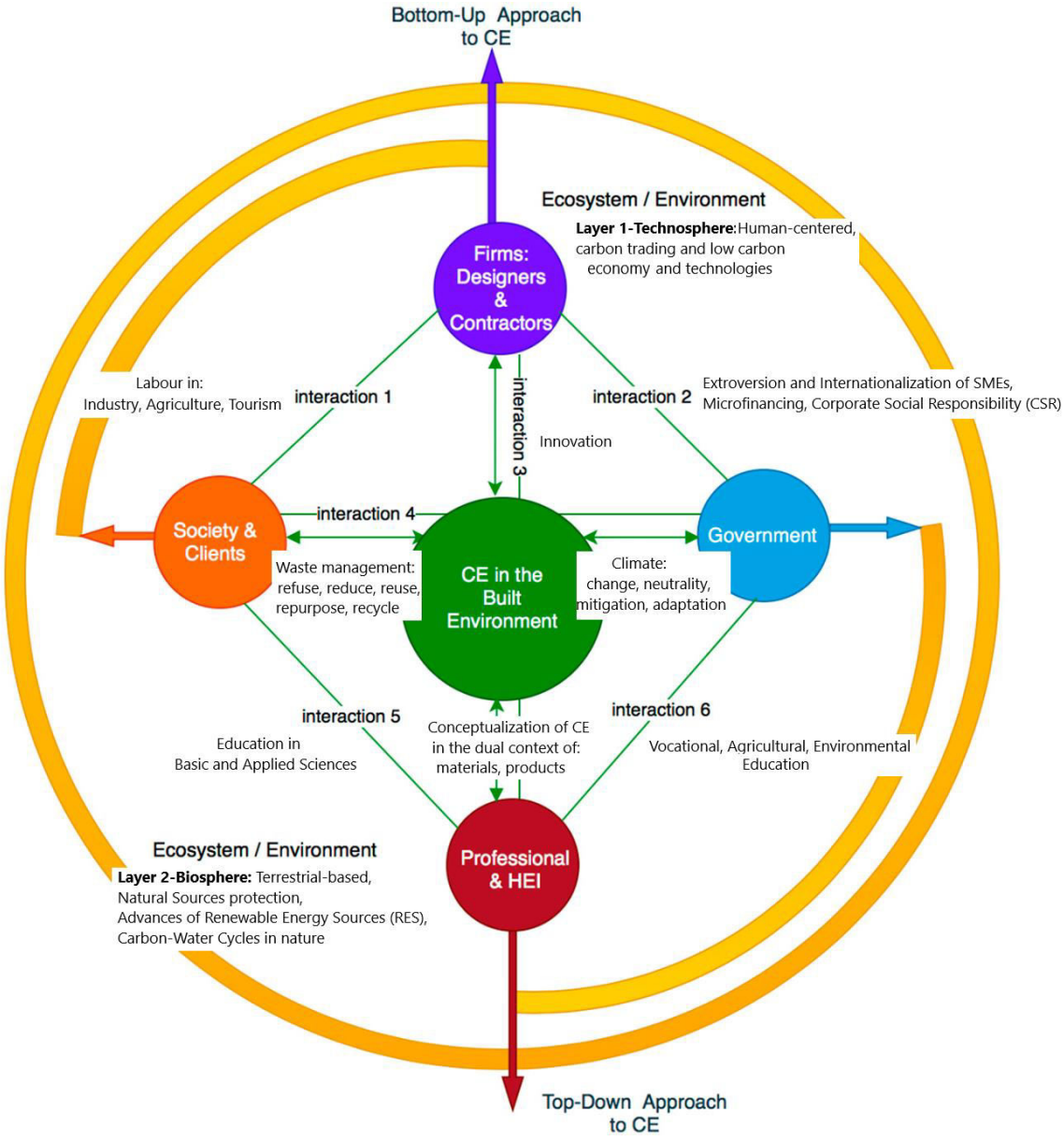

Figure 1. A map of the CE-operational grid. Source: Modified and enhanced from: Michael Atafo Adabre et al., (2024), Figure 2, p.4.

Based on the aforementioned CE-oriented map, it is noteworthy that there is currently nurtured a green energy supportive behavior that can make an additional step to investigate in a holistic approach the mediating effect on financial inclusion, environmental policy and entrepreneurship. However, such a mediating effect can only support environmental policy and entrepreneurship activities to reduce environmental pressure, whereas from the policy perspective, there is need of specified economies to allocate their financial resources to clean and green projects in order a credible and realistic level of sustainability to be developed (Udemba et al., 2024).

Some developing countries have shown poor health outcomes thus they are facing challenges to cope with sustainable economic development and governmental/national health expenditure based on ecological footprint consumption, in order more positive and prosperous outcomes for such goals to be attained (Qaiser Gillani et al., 2021). Therefore, public health expenditures and health outcomes among fast emerging economies should be identified in a long run period (Qaiser Gillani et al., 2021).

Regarding the biocapacity perspective it is critical to ensure that nations or countries can sustain its inhabitability and self-sufficiency in terms of natural resources, under the precondition that the total amount of biocapacity areas are equal to or higher than the ecological footprint. In the relevant literature an analytical study has been carried out to remedy the biocapacity deficit by utilizing this information for national data which can be optimized with heuristic optimization techniques (Pençe et al., 2024). Such a developed model can be used in other than environmental context, such as in the industrial sector or within the frame of national and governmental development policies to balance under control between ecological footprint and biocapacity (Pençe et al., 2024). Closing the theoretical background of this study it is noteworthy mentioning the following important aspects of it:

- Normally biocapacity decreases and ecological footprint increased whenever urbanization take place. Therefore, there is a causality between human capital, ecological footprint, urbanization and economic growth especially among emerging economies (Nathaniel, 2021). It is also noticeable a fundamental environmental challenge that especially developed and highly internationalized countries have to contend with, despite the fact they experience a high, or even tremendous, growth for decades (Nathaniel, 2021). Therefore, the critical point here is the identification and the functionality of influential tof biocapacity factors, like that of human capital and urbanization on the ecological footprint with advanced techniques that cope with core panel data issues having also the ability to derive country-specific results and to guide relevant policy recommendations and future research directions (Nathaniel, 2021).

- Among the far-reaching implications for ecosystems, economies, and societies worldwide is the challenge to confront climate change. In response to address this challenging issue the Human Capital (HUC) and the Economic Complexity (ECC) can be perceived as structural transformations toward more sophisticated and knowledge-based production, having also the pivotal ability in curtailing ecological degradation (Boukhelkhal, 2022; Hong et al., 2024). In this context, future research works can focus on deepening more systematic to intricate relationship between HUC, financial development, financial globalization, gross domestic product, ECC, and ecological footprints (Hong et al., 2024).

1. LITERATURE REVIEW

Research shows that economic growth can have varying effects on both Ecological Footprint (EF) and biocapacity across different countries. For example, while developing nations often experience a decline in biocapacity due to increasing ecological footprints, developed countries may enhance their biocapacity even in the presence of rising ecological footprints. This illustrates a complex relationship influenced by technological advancements and resource management practices The concepts of ecological footprint and biocapacity are critical for understanding sustainability and human impact on the environment. The ecological footprint measures the demand a population places on Earth's ecosystems in terms of the land and water required to produce the consumed resources and to assimilate the waste generated. In contrast, biocapacity refers to the capacity of an ecosystem to regenerate resources and provide services. The relationship between these two metrics defines ecological overshoot, which occurs when a population's ecological footprint exceeds its biocapacity, indicating unsustainable practices (AEFR (2012; Pençe et al., 2024).

The significance of ecological footprint analysis (EFA) lies in its ability to quantify environmental sustainability by assessing the pressure exerted on natural resources by human activities (Jiang and Li, 2010). For instance, Santoso et al. highlight how the ecological footprint can inform regional planning by identifying human activity-generated consumption patterns and contrasting them with available natural resources (Santoso et al., 2019). This method elucidates the balance—or imbalance—between ecological consumption and resource availability, offering strategic insights for sustainable development efforts (Mishra et al., 2025).

The ecological footprint serves as a tangible metric to quantify the environmental impact associated with human consumption patterns, while biocapacity defines the ecosystem's ability to regenerate resources and assimilate wastes. This relationship is pivotal in recognizing ecological overshoot, where

human demands exceed what the planet can sustainably provide. Therefore, the Sustainable development can be assessed with two overarching indicators. The first indicator is the United Nations' Human Development Index (HDI), which measures how well a country's residents live by tracking the country's achievements in longevity, access to education, and income. An HDI higher than 0.7 is "high human development". The second indicator is the ecological footprint, which measures whether humanity lives within the means of nature. An ecological footprint of less than 1.5 global hectares per person makes the resource to be consumed at a slower rate than that of replenishing it. Actually, it should be significantly less than 1.5 gha/person if we want to maintain biodiversity and leave space for wild species (AEFR, 2012). However, given growing populations and recognizing wild species' needs for biocapacity, the average ecological footprint per person worldwide needs to fall significantly below this threshold. he Ecological Footprint can be measured in either global hectares per person or in "Number of Earths", which represents how many Earths would be required to support humanity of everyone had that ecological footprint (Rao, 2024).

The intricate interplay between ecological footprint and biocapacity underscores critical implications for policymaking. Effective environmental policies must be grounded in the evaluation and management of both metrics to prioritize sustainable resource practices. For instance, the establishment of carbon pricing mechanisms has demonstrably contributed to reducing footprints while promoting sustainable economic growth (Skare et al., 2024). Furthermore, regional planning that emphasizes biocapacity optimization can guide land-use decisions to ensure that communities operate within their ecological limits (Guo et al., 2017).

Technological innovations play a crucial role in managing ecological footprint and enhancing biocapacity. Advances in precision agriculture, renewable energy, and waste management significantly contribute to mitigating resource consumption. The integration of ICT facilitates efficient monitoring of resource use and promotes environmentally friendly practices across sectors. The role of e-commerce suggests that digital platforms can enhance the sustainability of business operations and contribute positively to achieving the SDGs (Kongbuamai et al., 2023).

Despite the promise that ecological footprint and biocapacity measurements hold for informing sustainability, challenges persist. The primary limitations lie in data accuracy, especially in regions with incomplete statistics and environmental assessments. Differences in local ecosystem productivity complicate the efficacy of generalized assessments, particularly when applied across diverse geographical contexts (Carlei et al., 2011). Furthermore, the emergence of environmental carrying capacity assessment presents an evolving framework necessitating interdisciplinary approaches that consider social, economic, and ecological systems (Yue et al., 2012). The development of region-specific models offers the potential for tailored solutions addressing unique environmental challenges, such as those found in industrial growth regions and urban centers (Jie et al., 2023; Udemba et al., 2024)

As the need for sustainable practices becomes increasingly urgent, it is important to develop comparative case studies on ecological footprint and biocapacity assessments to emphasize the potential for integration of otherwise diversified policies in order to harmonize the principles of sustainability across diverse sectors (Onifade, 2023).

The ecological footprint and biocapacity metrics provide essential frameworks for evaluating sustainability. Understanding their interdependencies is critical for formulating policies that aim to balance human development and environmental conservation. Future research should focus on refining measurement techniques and improving the integration of these metrics into policy frameworks to support sustainable practices globally.

2. METHODS AND DATA

2.1 Ecological Footprint and Biocapacity

The ecological footprint is quantified as the amount of biologically productive land and water area required to support a population's consumption and waste generation (Venetoulis & Talberth, 2007). This measure has evolved to encompass various consumption categories, including food, energy, and goods. The methodology for calculating ecological footprints can be broadly categorized into top-down approaches, relying on national or regional statistics, and bottom-up assessments, which involve individual-level data collection (Jiang and Li, 2010). Recent research efforts have illustrated the use of diverse methodologies, including input-output analysis and life cycle assessment (LCA), which allow for a more comprehensive understanding of ecological impacts (Santoso et al., 2019).

Biocapacity refers to the capacity of ecosystems to regenerate resources and provides a measure of the ecological services they can sustainably yield. Recent studies have utilized sophisticated theoretical models to evaluate environmental carrying capacity, addressing deficits and surpluses in resource availability in specific regions (Li et al., 2019). Emerging methodologies increasingly incorporate data-driven approaches that combine geographical and ecological factors for more precise assessments of biocapacity (Lin et al., 2023). The integration of emergy analysis, as demonstrated by Jung et al., enhances insights into vulnerabilities that could impede sustainable development and offers a novel perspective on measuring carrying capacity (Jung et al., 2018).

The relationship between ecological footprint and biocapacity is fundamental to understanding sustainability. When a community's ecological footprint exceeds its biocapacity, it enters a state of ecological overshoot, which can have damaging long-term consequences for the environment. Research indicates a global trend of increased ecological overshoot over recent decades, highlighting the urgent need for sustainable practices (Fanning et al., 2022). In specific case studies, such as those investigating industrial centers in the Yangtze River Economic Belt, correlations between resource utilization and environmental stress are observed, emphasizing the importance of effective governance in addressing these challenges (Bao et al., 2020; Wang et al., 2019).

Globally, variations in ecological footprints and biocapacity reflect disparate levels of consumption, technological advancement, and resource management practices. Countries like China present a stark example of these dynamics; as the economy has rapidly expanded, ecological footprints in urban areas have frequently surpassed local biocapacity, resulting in severe environmental degradation (Boukhelkhal, 2022; Hong et al., 2024). Studies cite the importance of regional assessments, such as those conducted in Xinbei District, Changzhou, which provide localized data on carrying capacity and illuminate the distinct pressures faced by urbanizing areas Li et al., 2019). In contrast, less developed regions may face a declining biocapacity due to insufficient infrastructure for resource conservation (AEFR, 2012).

The methodology of Ecological Footprint and Biocapacity is a quantitative approach used to assess the sustainability of human activities by comparing the demand placed on nature with the Earth's capacity to regenerate resources and absorb waste. The Ecological Footprint measures the biologically productive land and water area required to produce the resources a population consumes and to absorb the associated waste, particularly carbon emissions. This includes areas needed for food production (cropland and grazing land), fishing, forest products, built-up infrastructure, and carbon sequestration (AEFR, 2012). In contrast, Biocapacity represents the Earth's biological ability to provide renewable resources and absorb wastes, considering the productivity of different land types. Biocapacity is the capacity of ecosystems to regenerate what people demand from those surfaces (e.g., produce food, absorb CO_2). It is measured in the same units (gha), biocapacity depends on: Land area available, Yield factors (productivity of a region compared to global average). Equivalence factors (convert land types to a common unit, i.e., gha). Both metrics are measured in a common unit called global hectares (gha), which standardizes the productivity of various ecosystems. The Earth assessment involves comparing the global or national Ecological Footprint with the corresponding Biocapacity. If a population's Footprint exceeds its Biocapacity, it results in an ecological deficit, indicating that it is depleting natural capital or depending on imports or global commons (like the atmosphere). If the Footprint is lower than the biocapacity, there is an ecological reserve

(Pençe et al., 2024). An ecological deficit occurs when the Ecological Footprint of a population exceeds the biocapacity of the area available to that population. A national ecological deficit means that the country is net-importing biocapacity through trade, liquidating national ecological assets or emitting more carbon dioxide waste into the atmosphere than its own ecosystems absorb. In contrast, an ecological reserve exists when the biocapacity of a region exceeds its population's ecological footprint (Pençe et al., 2024).

3. CASE STUDY

The data for Baltic States on biocapacity and carbon footprint was derived from Global Footprint Network (2021; 2025)

In Figure 2 the development of biocapacity per capita in Baltic States during 1992-2022 year period provided.

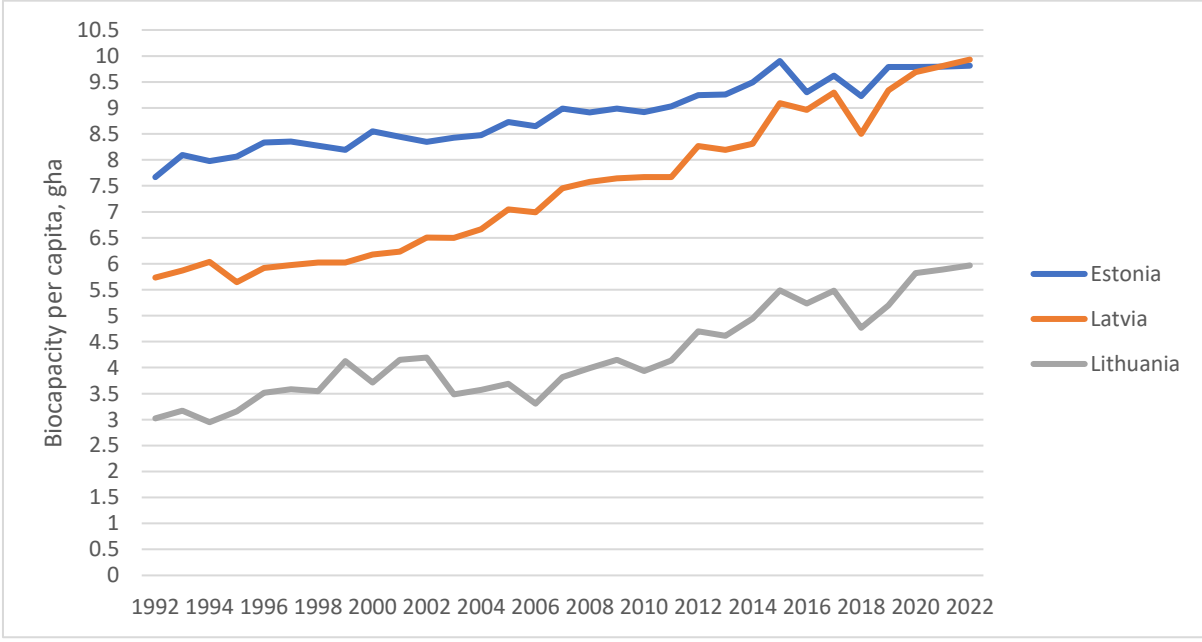

Figure 2. Development of biocapacity per capita in Baltic States

Figure 2 shows that vver the 30-year period, Estonia consistently was showing the highest biocapacity per capita among the Baltic States. This is likely due to its relatively low population density and large forested areas, which contribute positively to biocapacity. Latvia also maintains moderate biocapacity levels, while Lithuania exhibits the lowest biocapacity per capita. This gap may stem from differences in land use intensity, natural resource endowment, or environmental management practices. Trends over time show a gradual decline in biocapacity across all three countries, reflecting increasing pressure on land resources, land degradation, or urban expansion. The decline is most pronounced in Lithuania, indicating that it may be more vulnerable to ecological stress or less effective in conserving its natural resource base.

In Figure 3 the development of ecological footprint per capita in Baltic States during 1992-2020 period is provided.

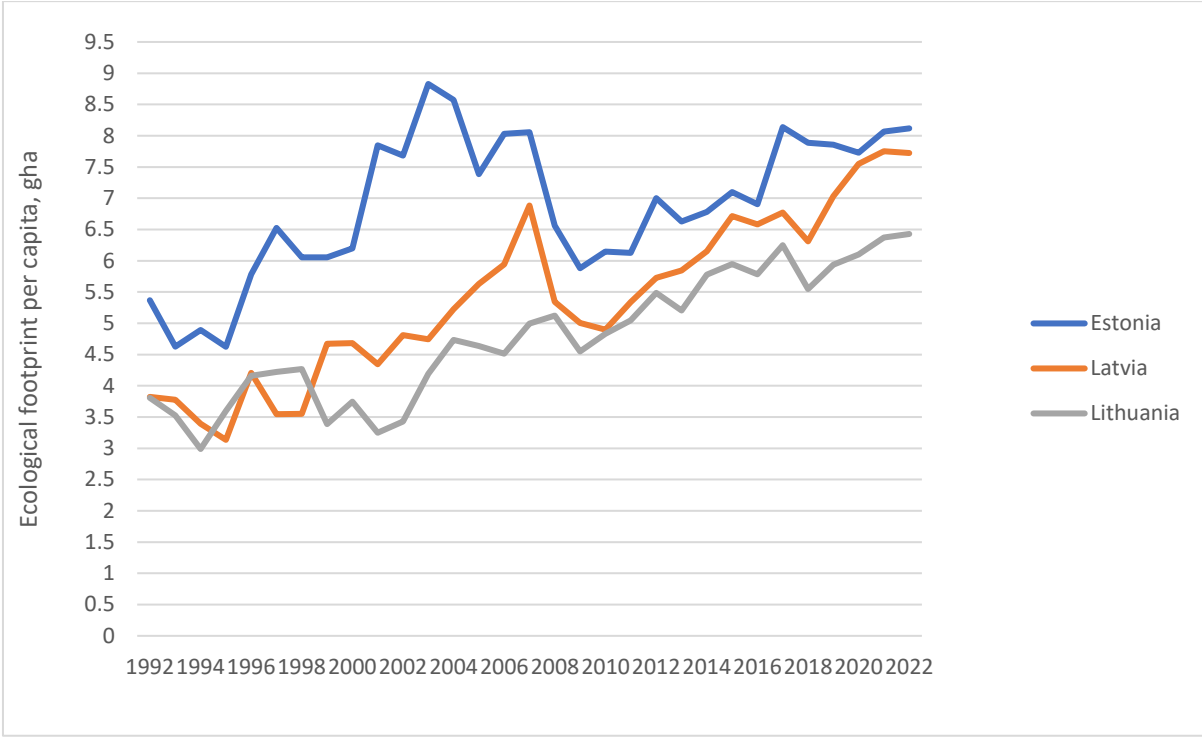

Figure 3. Development of ecological footprint per capita in Baltic States, gha

As one can notice from Figure 3 in contrast to biocapacity, the ecological footprint per capita has varied more dynamically over time, particularly reflecting economic changes in Baltic States. Estonia shows the highest and most volatile footprint, particularly in periods of rapid economic growth or high energy consumption. Its heavy reliance on oil shale energy could explain higher carbon emissions contributing to the footprint. Lithuania and Latvia have lower footprints, but Lithuania's footprint has shown a steady increase, particularly after the early 2000s, reflecting rising consumption and economic development. Latvia has the lowest footprint among the three, suggesting either lower per capita consumption or more energy-efficient practices. While, Estonia benefits from high biocapacity, it also exerts the greatest environmental pressure, potentially placing it at risk of overshooting its resources unless policy interventions are strengthened.

In Figure 4 the dynamics of biocapacity reserve or deficit of Baltic States during 1992-2023 period is provided.

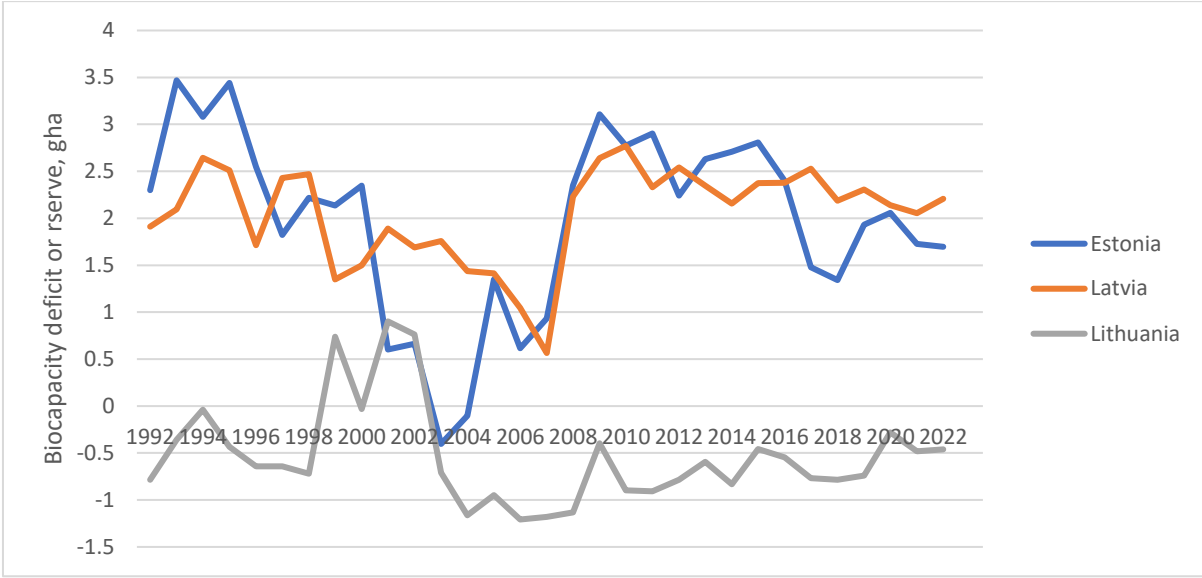

Figure 4. Development of biocapacity reserve of deficit in Baltic States

As one can notice from Figure 4, Estonia appears to fluctuate between ecological reserve and deficit, depending on how much its ecological footprint exceeds or remains within its biocapacity. Despite its high biocapacity, its high footprint brings it close to or into deficit in many years. Latvia tends to maintain a more stable ecological reserve, suggesting a better alignment between consumption and resource availability. This may reflect a more balanced development path or stronger environmental policies. Lithuania, on the other hand, consistently experiences an ecological deficit, as its growing footprint surpasses its comparatively low biocapacity. This highlights the greatest sustainability challenge among the three and indicates the need for stronger measures to curb resource use and improve ecosystem productivity.
In Figure 5 the dynamics of ecologocal footprint converted to Earths during 1992-2022 is provided for Baltic States.

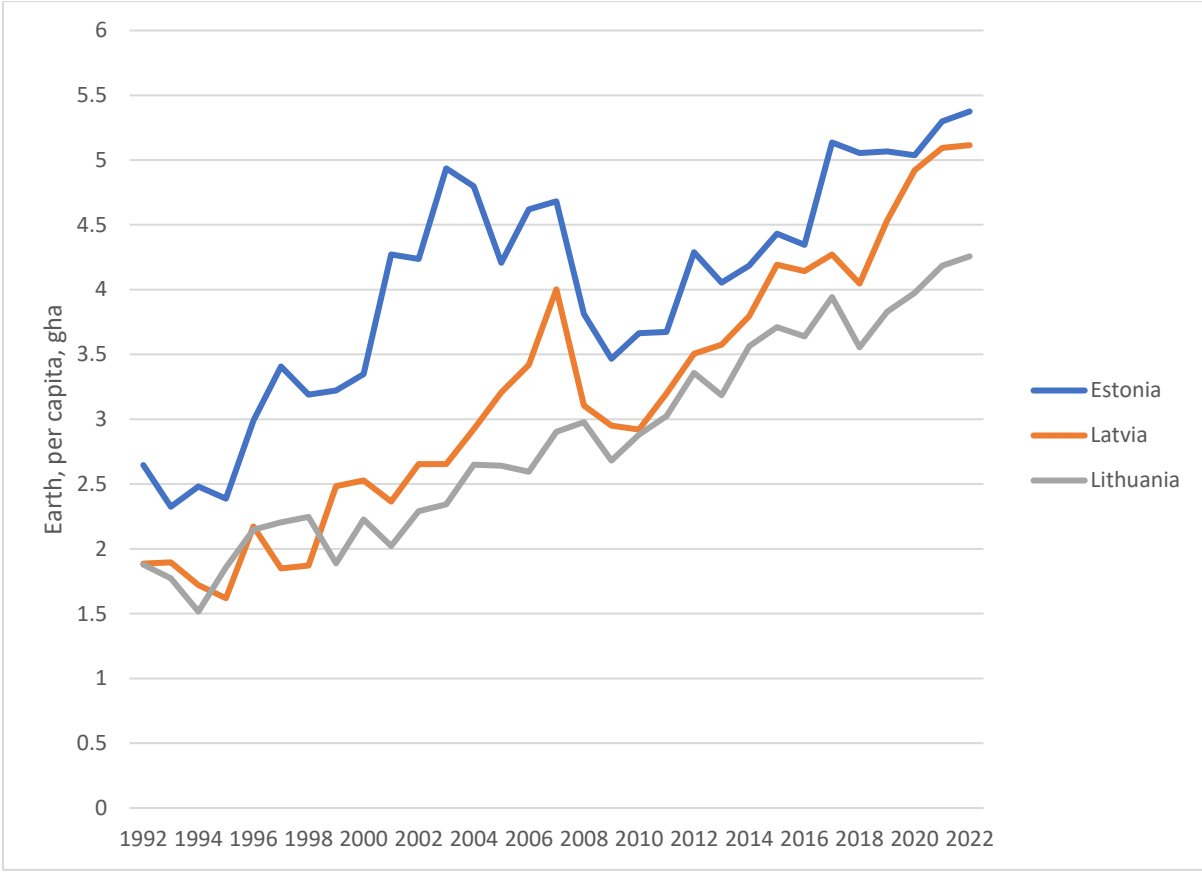

Figure 5. Development of earth in Baltic States

Figure 4 translates ecological footprint into a more relatable metric: how many Earths would be required if the global population consumed resources at the same rate. Estonia reaches values above 1 Earth, signaling unsustainable consumption levels, especially during periods of high economic activity. Lithuania also trends toward 1 or slightly above, consistent with its ecological deficit, while Latvia remains closer to 1 Earth or slightly below, indicating relatively more sustainable living standards. This metric underscores that none of the Baltic States consistently operate within globally sustainable limits, though Latvia comes closest, while Estonia and Lithuania exceed the Earth's regenerative capacity in many years.

The comparative analysis of ecological footprint and biocapacity across the Baltic States—Estonia, Latvia, and Lithuania—reveals distinct sustainability trajectories despite shared geographical and socio-economic conditions. Estonia stands out for its high biocapacity per capita, largely attributable to its vast forest resources and low population density. However, its advantage is offset by a consistently high ecological footprint, primarily driven by energy-intensive sectors such as oil shale-based electricity production. This duality places Estonia in a precarious position where it oscillates between ecological reserve and deficit.

Latvia, by contrast, presents a relatively balanced profile. It has moderate biocapacity levels and the lowest ecological footprint among the three countries. This equilibrium allows Latvia to maintain a stable ecological reserve over time, reflecting more sustainable consumption patterns, possibly aided by energy efficiency policies, moderate industrialization, and strong environmental governance. The trend suggests that Latvia may serve as a model of sustainable development for the region.

Lithuania, however, faces the most persistent ecological challenges. It has the lowest biocapacity per capita, likely due to higher population density and limited forest coverage. At the same time, its ecological footprint has increased steadily over the decades, reflecting economic growth accompanied by rising energy and material consumption. Consequently, Lithuania exhibits a long-term ecological deficit, which

signals the urgency for comprehensive environmental reforms, especially in the energy, transportation, and land-use sectors.

The use of the "number of Earths" metric (Figure 5) illustrates the global implications of national consumption patterns. Estonia and Lithuania frequently exceed the one Earth threshold, indicating that their lifestyles, if adopted globally, would require more than one planet to sustain. Latvia, while closer to the sustainability line, still occasionally breaches the limit, underscoring that even the best-performing Baltic State has room for improvement.

The differences in ecological footprint and biocapacity among the Baltic States—Estonia, Latvia, and Lithuania—can be attributed to a combination of natural resource endowments, energy structures, demographic characteristics, economic development patterns, and policy priorities. Although these countries share similar historical, geographical, and socio-economic backgrounds, several key factors explain their divergent sustainability profiles.

One of the most significant drivers of difference lies in biocapacity, which is largely influenced by the availability and productivity of biologically active land. Estonia has the highest biocapacity per capita due to its large forest cover and low population density. This extensive ecological resource base contributes significantly to its overall regenerative capacity. In contrast, Lithuania has the lowest biocapacity per capita, primarily due to more intensive land use, higher population density, and a smaller proportion of forested and undeveloped land. Latvia falls between the two, with a more balanced distribution of land resources and moderate population pressure, resulting in stable biocapacity levels over time.

In addition, energy consumption structure plays a crucial role in determining ecological footprint, especially the carbon footprint, which forms a major component. Estonia's high ecological footprint is largely driven by its continued reliance on oil shale, one of the most carbon-intensive energy sources. Despite its small size, this fossil fuel use significantly inflates Estonia's footprint per capita, especially during periods of economic growth. On the other hand, Latvia and Lithuania have more diversified and less carbon-intensive energy systems, with greater shares of hydropower (Latvia), biomass, and imported electricity. Latvia, in particular, has benefited from an energy mix that includes a relatively high proportion of renewable energy, helping it maintain a lower footprint.

The structure of the economy and patterns of consumption also impact ecological footprint. Estonia has a higher per capita income than the other two countries and a more industrialized economy, which correlates with greater consumption of energy and goods. This leads to a larger ecological footprint, despite high biocapacity. It can be stated that Lithuania's economy has grown rapidly, especially after EU accession, leading to increased material and energy consumption. This economic expansion, while beneficial in terms of income and development, has outpaced gains in ecological efficiency, resulting in a rising ecological deficit.

Latvia, meanwhile, has had slower and more measured economic growth, which has likely helped it to stay within or near its biocapacity limits. Additionally, its relatively conservative consumption patterns and lower energy intensity have contributed to its better sustainability performance.

These findings underscore the critical importance of tailoring sustainability policies to national contexts. Estonia's energy system requires urgent decarbonization, Lithuania must prioritize land and resource conservation, while Latvia should aim to preserve and refine its relatively favorable position. Cross-country collaboration in knowledge sharing and environmental policy harmonization could further strengthen the region's overall sustainability.

CONCLUSION

The concepts of ecological footprint and biocapacity provide essential frameworks for evaluating environmental sustainability and guiding human development. Understanding their interdependencies is critical for formulating policies that seek to balance economic growth with environmental protection. As global environmental pressures continue to escalate, the integration of technological innovation, sound resource management, and equitable socio-economic practices will prove indispensable in achieving sustainable development goals.

This study highlights the value of ecological footprint and biocapacity metrics as essential tools for assessing and guiding sustainable development. By examining the Baltic States over a 30-year period, the paper demonstrates significant variations in environmental performance, despite similarities in regional characteristics.

Latvia emerges as the most balanced in terms of sustainability, maintaining a relatively low ecological footprint and a stable biocapacity, which allows it to remain within the Earth's ecological limits more consistently. Estonia, while rich in ecological assets, risks undermining its environmental advantages due to high carbon emissions and consumption levels. Lithuania, on the other hand, faces the greatest environmental pressure, with persistent ecological deficits driven by low biocapacity and growing demand.

The trends call for differentiated policy responses. Estonia should focus on energy diversification and carbon intensity reduction, Lithuania must enhance biocapacity through land and ecosystem restoration, and Latvia should reinforce its current path with continuous innovation in sustainable development practices.

The ecological footprint framework offers a valuable lens for policymakers to understand and address ecological limits. Its integration into national sustainability strategies can guide the Baltic States toward a future that aligns economic progress with environmental stewardship.

REFERENCES

Abdi, A.H., Mohamed, A.A., Mohamed, M.A. (2025), "Education for sustainable development in Somalia: do economic growth, energy consumption, and population density affect ecological footprints?", Discover Sustainability, Vol. 6, No. 1, pp. 292. DOI: 10.1007/s43621-025-01019-w

Adabre, M. A., Chan, A. P. C., Darko, A., Edwards, D. J., Yang, Y., Issahaque, S. (2024), "No Stakeholder Is an Island in the Drive to This Transition: Circular Economy in the Built Environment", Sustainability, Vol. 16, No. 15, pp. 6422. https://doi.org/10.3390/su16156422.

Adabre, M.A., Chan, A.P.C., Darko, A., Edwards, D.J., Yang, Y., Issahaque, S. (2024), "No Stakeholder Is an Island in the Drive to This Transition: Circular Economy in the Built Environment", Sustainability, Vol. 16, No. 15, pp. 6422. https://doi.org/10.3390/su16156422.

AEFR (2012), "Africa Ecological Footprint Report: Green Infrastructure for Africa's Ecological Security", pp. 72. ISBN 978-2-940443-39-0. Available at https://www.afdb.org/sites/default/files/documents/projects-and-operations/africa_ecological_footprint_report_-_green_infrastructure_for_africas_ecological_security.pdf (Accessed on 10 May 2025).

Ahmed, Z., Ahmad, M., Rjoub, H., Kalugina, O.A., Hussain, N. (2022), "Economic growth, renewable energy consumption, and ecological footprint: Exploring the role of environmental regulations and democracy in sustainable development", Sustainable Development, Vol. 30, No. 4, pp. 595-605. DOI: 10.1002/sd.2251.

Bao, H., Wang, C., Han, L., Wu, S., Lou, L., Xu, B., Liu, Y. (2020), "Resources and Environmental Pressure, Carrying Capacity, And Governance: A Case Study of Yangtze River Economic Belt", Sustainability, Vol. 12, No. 4, pp. 1576. https://doi.org/10.3390/su12041576.

Boukhelkhal, A. (2022), “Impact of economic growth, natural resources and trade on ecological footprint: do education and longevity promote sustainable development in Algeria?”, International Journal of Sustainable Development and World Ecology, Vol. 29, No. 8, pp. 875-887. DOI: 10.1080/13504509.2022.2112784.

Carlei, V., Colantonio, E., Furia, D., Mattoscio, N. (2011), “Economic patterns of sustainable development: An analysis of absolute ecological footprint through self-organizing map”, Quality and Quantity, Vol. 45, No. 1, pp. 157-171. DOI: 10.1007/s11135-010-9362-4.

Fanning, A.L., O’Neill, D.W., Hickel, J., Roux, N. (2022), „The social shortfall and ecological overshoot of nations“, Nature Sustainability, Vol. 5, pp. 26–36. https://doi.org/10.1038/s41893-021-00799-z.

Galli A., Antonelli M., Wambersie L., Bach-Faig A., Bartolini F., Caro D., Iha K., Lin D., Mancini M.S., Sonnino R., Vanham D., Wackernagel M. (2023), “EU-27 ecological footprint was primarily driven by food consumption and exceeded regional biocapacity from 2004 to 2014”, Nature Food, Vol. 4, No. 9, pp. 810-822. DOI: 10.1038/s43016-023-00843-5.

Global Footprint Network (2025), Available at https://data.footprintnetwork.org/?_ga=2.194075626.657601560.1747566889-1053040308.1747566056#/ (Accessed on 10 May 2025).

Global Footprint Network. (2021), “What is the Ecological Footprint?” Available at: https://www.footprintnetwork.org (Accessed on 10 May 2025).

Güler, İ., Naimoğlu, M., Şimşek, O., Adalı, Z., Özbek, S. (2025), “Analyzing the impact of economic growth and FDI on sustainable development goals in China: insights from ecological footprints and load capacity factors”, Frontiers in Environmental Science, Vol. 13, pp. 1513158. DOI: 10.3389/fenvs.2025.1513158. (Accessed on 10 May 2025).

Guo, J., Yue, D., Li, K., Hui, C. (2017), “Biocapacity optimization in regional planning”, Scientific Reports, Vol. 7, No. 41150. DOI: 10.1038/srep41150.

Hong, T., Yin, J., Latif, M.N., Ahmad, M. (2024), “Human capital, economic complexity, and ecological footprints: Crafting a sustainable development policy framework for E7 nations”, Natural Resources Forum, Vol. 48, No. 4, pp. 1494-1511. DOI: 10.1111/1477-8947.12520.

Jiang, S., Li, X. (2010),“Study on Harmonizing Land-use and Ecological Environment Based on Ecological Footprint: A Case Study of Gu'an County, Hebei in China”, The 2010 International Conference on Environment and BioScience (ICEBS 2010), pp. 203-207.

Jie, H., Khan, I., Alharthi, M., Zafar, M.W., Saeed, A. (2023), “Sustainable energy policy, socio-economic development, and ecological footprint: The economic significance of natural resources, population growth, and industrial development”, Utilities Policy, Vol. 81, No. 101490. DOI: 10.1016/j.jup.2023.101490.

Jung, C., Kim, C., Kim, S., Suh, K. (2018), “Analysis of Environmental Carrying Capacity with Emergy Perspective of Jeju Island” Sustainability, Vol. 10, No. 5, pp. 1681. https://doi.org/10.3390/su10051681.

Kongbuamai, N., Bui, Q., Adedoyin, F.F., Bekun, F.V. (2023), “Developing environmental policy framework for sustainable development in Next-11 countries: the impacts of information and communication technology and urbanization on the ecological footprint”, Environment, Development and Sustainability, Vol. 25, No. 10, pp. 11307-11335. DOI: 10.1007/s10668-022-02528-8.

Li, K., Jin, X., Ma, D., Jiang, P. (2019), “Evaluation of Resource and Environmental Carrying Capacity of China’s Rapid-Urbanization Areas—A Case Study of Xinbei District, Changzhou”, Land, Vol. 8, No. 4, pp. 69. https://doi.org/10.3390/land8040069.

Lian, M. (2024), “The impact of cleaner energy sources, advanced technology firms, and economic expansion on ecological footprints is critical in sustainable development”, Heliyon, Vol. 10, No. 11, pp. 31100. DOI: 10.1016/j.heliyon.2024.e31100.

Lin, A., Liu, Y., Zhou, S., Zhang, Y., Wang, C., Ding, H. (2023), “Data-Driven Analysis and Evaluation of Regional Resources and the Environmental Carrying Capacity”, Sustainability, Vol. 15, No. 10, pp. 8372. https://doi.org/10.3390/su15108372.

Majeed, M.T., Mazhar, M. (2020), “Reexamination of environmental Kuznets curve for ecological footprint: The role of biocapacity, human capital, and trade”, Pakistan Journal of Commerce and Social Sciences, Vol. 14, No. 1, pp. 202-254.

Mehmood, U. (2024), “Assessing the Impacts of Eco-innovations, Economic Growth, Urbanization on Ecological Footprints in G-11: Exploring the Sustainable Development Policy Options”, Journal of the Knowledge Economy. DOI: 10.1007/s13132-024-01759-6.

Mehmood, U., Agyekum, E.B., Kotb, H., Milyani, A.H., Azhari, A.A., Tariq, S., Haq, Z.U., Ullah, A., Raza, K., Velkin, V.I. (2022), “Exploring the Role of Communication Technologies, Governance, and Renewable Energy for Ecological Footprints in G11 Countries: Implications for Sustainable Development”, Sustainability, Vol. 14, No. 19, pp. 12555. DOI: 10.3390/su141912555.

Mishra, R.-K., Mishra, D., Agarwal, R. (2025), “Environmental sustainability and ecological balance”, In book: Implementation of Innovative Strategies in Integral Plant Protection,

Publisher: Bhumi Publishing, India, pp.81-103.

Nathaniel, S.P. (2021), “Biocapacity, human capital, and ecological footprint in G7 countries: the moderating role of urbanization and necessary lessons for emerging economies”, Energy, Ecology and Environment, Vol. 6, No. 5, pp. 435-450. DOI: 10.1007/s40974-020-00197-9.

Niccolucci, V., Tiezzi, E., Pulselli, F.M., Capineri, C. (2012), “Biocapacity vs Ecological Footprint of world regions: A geopolitical interpretation”, Ecological Indicators, Vol. 16, pp. 23-30. DOI: 10.1016/j.ecolind.2011.09.002.

Olowu G., Bein M., Olasehinde-Williams G. (2018), „Examining the relationship between financial development, sustainable economic opportunity and ecological footprint in SADC countries“, Applied Ecology and Environmental Research, Vol. 16, No.5, pp. 7171-7190. DOI: 10.15666/aeer/1605_71717190

Onifade, S.T. (2023), “Environmental impacts of energy indicators on ecological footprints of oil-exporting African countries: Perspectives on fossil resources abundance amidst sustainable development quests”, Resources Policy, Vol. 82, No. 103481. DOI: 10.1016/j.resourpol.2023.103481.

Pençe, İ., Çeşmeli, M.Ş., Kumaş, K., Akyüz, A., Tuncer, A.D., Güngör, A. (2024), “Study of biocapacity areas to reduce ecological footprint deficits: A case study of Turkey”, Science of the Total Environment, Vol. 932, No. 173018. DOI: 10.1016/j.scitotenv.2024.173018.

Qaiser Gillani, D., Gillani, S.A.S., Naeem, M.Z., Spulbar, C., Coker-farrell, E., Ejaz, A., Birau, R. (2021), “The nexus between sustainable economic development and government health expenditure in Asian countries based on ecological footprint consumption”, Sustainability, Vol. 13, No. 12, pp. 6824. DOI: 10.3390/su13126824.

Rao, P. (2024), “GreenThe Number of Earths Needed for Different Countries’ Lifestyles”, Availability at https://www.visualcapitalist.com/the-number-of-earths-needed-for-different-countries-lifestyles/ . (Accessed on 10 May 2025).

Sampene, A.K., Li, C., Khan, A., Agyeman, F.O., Brenya, R., Wiredu, J. (2023), “The dynamic nexus between biocapacity, renewable energy, green finance, and ecological footprint: evidence from South Asian economies”, International Journal of Environmental Science and Technology, Vol. 20, No. 8, pp. 8941-8962. DOI: 10.1007/s13762-022-04471-7.

Santoso, E.B., Aulia, B.U., Aninditya, D.N. (2019), “Estimation of Ecological Footprint for Sidoarjo Regency and its Implication towards Spatial Development”, IOP Conference Series Earth and Environmental Science, Vol. 313, No. 1, pp. 012047.

Shen, Y., Yue, S. (2023), “Does ecological footprint affect biocapacity? Evidence from the experiences of G20 countries”, Natural Resource Modeling, Vol. 36, No. 3, pp. 12369. DOI: 10.1111/nrm.12369.

Shujah-ur-Rahman, Chen S., Saud S., Saleem N., Bari M.W. (2019), “Nexus between financial development, energy consumption, income level, and ecological footprint in CEE countries: do human capital and biocapacity matter?”, Environmental Science and Pollution Research, Vol. 26, No. 31, pp. 31856-31872. DOI: 10.1007/s11356-019-06343-z.

Skare, M., Gavurova, B., Porada-Rochon, M. (2024), “Digitalization and carbon footprint: Building a path to a sustainable economic growth”, Technological Forecasting and Social Change, Vol. 199, pp. 123045. https://doi.org/10.1016/j.techfore.2023.123045.

Świąder M., Lin D., Szewrański S., Kazak J.K., Iha K., van Hoof J., Belčáková I., Altiok S. (2020), „The application of ecological footprint and biocapacity for environmental carrying capacity assessment: A new approach for European cities“, Environmental Science and Policy, Vol. 105, pp. 56-74. DOI: 10.1016/j.envsci.2019.12.010.

Udemba, E.N. (2020), A sustainable study of economic growth and development amidst ecological footprint: New insight from Nigerian Perspective. Science of the Total Environment, Vol. 732, No. 139270. DOI: 10.1016/j.scitotenv.2020.139270.

Udemba, E.N., Shah, S.A.R., Philip, L.D., Zhao G. (2024), „The mediating role of green energy and environmental policies in sustainable development for BRICS economies: A tripartite impact of entrepreneurial activities, urban development and economic growth on ecological footprint“, Sustainable Development, Vol. 32, No 5, pp. 4649-4670. DOI: 10.1002/sd.2916.

Ullah, A., Ahmed, M., Raz,a S.A., Ali, S. (2021), „A threshold approach to sustainable development: Nonlinear relationship between renewable energy consumption, natural resource rent, and ecological footprint“, Journal of Environmental Management, Vol. 295, No. 113073. DOI: 10.1016/j.jenvman.2021.113073.

Wang, Y., Peng, B., Wei, G., Elahi, E. (2019), "Comprehensive Evaluation and Spatial Difference Analysis of Regional Ecological Carrying Capacity: A Case Study of the Yangtze River Urban Agglomeration", International Journal of Environmental Research and Public Health, Vol. 16, No. 18, pp. 3499. https://doi.org/10.3390/ijerph16183499 .

Yue, D., Zhang, J., Guo, J., Du, J., Ma, J., Meng, X. (2012), „An analysis of sustainable development based on a comparison of the pre- and post- disaster biocapacity and ecological footprint in Zhouqu County, China“, Advanced Materials Research, 361-363, pp. 663-670. DOI: 10.4028/www.scientific.net/AMR.361-363.663.

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- **For journals** - Surname, Initials (year), “Title of article”, *Journal Name*, volume, number, pages.

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e.g. Draskovic, V. (2007), “Specificities and problems of Montenegrin transition”, working paper, No. ..., Leeds University Business School, TIGER, Warsaw, September.

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e.g. Miller, M. C. (1997), “The Crushing Power of Big Publishing”, *The Nation*, 17 March, p. 10.

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