ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

For citation:

El Ebiary, H., El Garf, M., Fayed, M.E. (2026), "The Impact of Exchange Rate Fluctuations on Export Performance in the Context of Global Supply Chain Participation: The Case of Automotive Exports in Egypt", *Montenegrin Journal of Economics*, Vol. 22, No. 1, pp. 135-157.

The Impact of Exchange Rate Fluctuations on Export Performance in the Context of Global Supply Chain Participation: The Case of Automotive Exports in Egypt

HEND EL EBIARY[1] (Corresponding author), MONA EL GARF[2] and MONA E. FAYED[3]

[1]Associate Lecturer and PhD. Candidate, Faculty of Management Sciences, October University for Modern Sciences & Arts (MSA), Giza, Egypt, email: hebiary@msa.edu.eg
[2]Professor of Economics, Faculty of Economics & Political Science, Cairo University, Giza. Egypt, email: elgarfmona@gmail.com
[3]Professor of Economics, Faculty of Economics & Political Science, Cairo University, Giza, Egypt, email: Monaesam@feps.edu.eg

ARTICLE INFO

Received July 04, 2024
Revised from August 10, 2024
Accepted September 11, 2024
Available online January 15, 2025

JEL classification: F10, F14, F30, F31

DOI: 10.14254/1800-5845/2026.22-1.12

Keywords:

Global Supply Chains,
Price Elasticity of Demand,
Exchange Rate,
Egyptian Pound Depreciation,
Egyptian Automotive Exports,
Pesaran-Shin-Smith (2001)
Cointegration Technique

ABSTRACT

Participation and upgrading in global supply chains are considered major challenges facing developing countries, requiring a revaluation of the effect of monetary policy measures. Accordingly, this article examines the impact of exchange rate fluctuations on Egyptian automotive exports in light of the rising significance of international production fragmentation. It employs the Pesaran-Shin-Smith (2001) cointegration technique to estimate demand for Egyptian automotive exports -both to the world and to Egypt's main trade partners- using quarterly data over the period 2000-2020. Results showed that participation in global supply chains has disrupted the relationship between exchange rate changes and export performance, contrary to predictions based on the conventional elasticities approach. This distortion is further emphasized by the high imported value-added throughout the supply chain in exported goods, particularly that Egypt's firms are found mostly in the downstream tiers of the chain. The demand for automotive exports is found to be highly elastic in the long-run, but with a ***positive*** *sign. Hence, the pound depreciation is expected to* ***negatively*** *affect automotive exports. One key policy implication is that the real depreciation is expected to have a desirable impact on Egyptian automotive exports* ***only if*** *the domestic value-added is raised while its foreign counterpart is reduced and when the automotive sector becomes engaged in its global supply chain through forward linkages rather than the mere current backward linkages.*

INTRODUCTION

As the international production fragmentation expands, it is crucial to ensure a favorable investment environment and sound economic policies. Among the factors that require revision is the exchange rate movements. The assumption that local currency depreciation enhances the competitiveness of exports is no longer a simple hypothesis, as proposed by the conventional elasticities approach. This highlights the importance of studying the impact of participation in global supply chains (GSC) on the elasticity of demand for exports to changes in the exchange rate (referred to as elasticity of exports). Recent academic debate

suggests that the changing structure of international trade distorts the relationship between exchange rates and foreign trade. However, empirical studies yield conflicting results regarding the magnitude and direction of export responsiveness to exchange rate changes, leaving the debate inconclusive.

The academic discussion is coinciding with another debate in Egypt concerning the influence of exchange rate floatation and the successive depreciations of the Egyptian pound. The pound depreciated by nearly 108% by the end of 2016 and lost 47.7% of its value during 2022. Lastly, it depreciated by another 25% in the first quarter of 2023 (Computed from the IMF, IFS Online Database). This argument particularly involves the impact on Egyptian manufacturing exports, given their heavy reliance on foreign parts and components. The manufacturing industries are characterized by high imported production inputs, accounting on average for 36% in 2016 (Calculated from the CAPMAS, Annual Industrial Production Statistics - Private Sector Online Database).

This article is thereby motivated to investigate the effect of Egyptian pound depreciation on the competitiveness of the automotive exports in case of participating in its GSC. It contributes to the literature on Egyptian exchange rate and trade, by combining GSC and exchange rate analyses. This topic, to the best of the authors' knowledge, has not been previously addressed empirically for Egypt. The incorporation of GSC into the demand model for exports takes the form of adding a variable representing the backward linkages of Egyptian automotive exports with its supply chain and adjusting the calculation of the real effective exchange rate (REER). This approach is particularly relevant to the Egyptian automotive sector, which primarily relies on assembly and adds simple local components, amounting to *only* 28% of total inputs (Calculated from the CAPMAS, Annual Industrial Production Statistics - Private Sector Online Database). Therefore, the currencies of countries supplying foreign intermediates have a significant impact.

The Egyptian automotive export sector is chosen for several reasons. First, the global automotive industry has seen a 43% surge in demand over the period 2010-2019 (Calculated from the UNCTAD Online Data Center), making it a significant driver of worldwide economic growth. Additionally, the high international fragmentation of automotive production provides growth opportunities for emerging economies like Egypt. Second, Egypt emerges as an attractive country for automotive production in the Middle East and North Africa, as per the Risk and Rewards Index released by Fitch Solutions during the third quarter of 2023, preceded only by Iran and Morocco (Information & Decision Support Center, 2023). It stands to gain from the advantages of lower wages and labor-intensive production in automotive feeding industries, producing components like glass and windshields, wire harnesses, as well as batteries. The domestic reoperation by original equipment manufacturers (OEMs), such as Mercedes-Benz, has contributed to the 19.5% growth in Egyptian automotive exports, reaching $84.9 million in 2020 (ITC, Trade Map Online Database). This opens opportunities for upsurged engagement in the GSC. Third, this sector lies among the Egyptian government's strategic goal of expanding the export base, especially with the involvement of numerous small and medium-sized enterprises in the automotive feeding industries (Egyptian Ministry of Trade & industry, 2016). Fourth, automotive and feeding industries facilitate localization and deepening of manufacturing, thereby promoting local supply chains and economic sophistication. In response, the government has recently instituted the Automotive Industrial Development Program (AIDP), which ultimately aims to position Egypt as a regional hub for automotive exports.

To estimate the elasticity of Egyptian automotive exports, this article employs the Pesaran-Shin-Smith (2001) (PSS (2001)) cointegration technique. The estimation is conducted using quarterly data for the period 2000-2020.

The rest of this article is divided into four sections. The first section discusses the theoretical framework and reviews empirical studies on how participation in the GSC alters the analysis of the effect of exchange rate movements on exports, within the elasticities approach framework. The second section formulates and estimates the demand model for Egyptian automotive exports. The third section discusses the elasticity of exports estimation. Finally, the conclusion summarizes the key findings and policy implications.

1. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The literature on exchange rate typically overlooks the impact of the GSC variable when analyzing the mechanism of restoring trade balance equilibrium. Recent academic arguments have addressed the distortion of the relationship between exchange rate and foreign trade. However, the nature of the relationship between exchange rate changes and export performance remains uncertain. This section discusses the variation in the elasticities approach and reviews empirical studies with conflicting results regarding the responsiveness of exports to changes in exchange rates.

1.1 Theoretical Framework

Until the late 2000s, the impact of GSC participation on the relationship between exchange rate changes and international trade received limited attention. With the growing role of cross-border production fragmentation, local currency depreciation is no longer a sufficient condition for boosting exports performance, as proposed by the elasticities approach. This distortion in the relationship can be attributed to several changes in the structure of international trade. Firstly, the transition from producing and assembling local components into final goods in a single country, to the intra-industry trade where multiple countries compete to add domestic value at different stages of production (Yamashita, 2011). Secondly, in the GSC context, trade primarily involves the exchange of goods with standardized qualities, facilitated by the lead firm's codification of information. This practice reduces final product prices through economies of scale, just-in-time delivery, and reduced transaction costs (Gereffi & Fernandez-Stark, 2011; Ponte & Gibbon, 2005). Thirdly, unlike conventional trade where products among countries are differentiated and competitive, exports and imports within a single country become complementary. Hence, exports of final goods contain a lower share of domestic value-added, while imported final goods may have significant local components, which were exported for processing abroad (Anukoonwattaka, 2016; Cheng et al., 2016). Lastly, the demand for trade shifts from being determined solely within the directly importing market to becoming a derived demand, influenced by both the markets for intermediates and final goods (Arndt, 2004).

Accordingly, trade within the GSC context is expected to respond differently to exchange rate movements compared to conventional trade. The impact of the local currency depreciation (the reverse scenario of appreciation can be envisioned) varies based on a country's position in the GSC, i.e., either at the downstream tiers exporting final goods (a country with backward linkages), or at the upstream tiers exporting intermediates (a country with forward linkages). This article explores the influence of GSC participation on the analysis of the elasticities approach.

Participating in international production with *backward linkages* results in currency depreciation, *ceteris paribus*, affecting export competitiveness both directly and indirectly through multiple exchange rate pass-through mechanisms. Depreciation directly lowers the foreign currency price of exports but indirectly raises the price of intermediates imported from upstream tiers. This increase in production costs subsequently raises the local currency price of exports, contradicting the elasticities approach's fixed price assumption. Hence, the higher the foreign value-added share in exports, the greater the decline in the competitive advantage gained due to the direct effect of the depreciation on only the local component in exports (Georgiadis et al., 2020; Arndt, 2004). On the quantity side, joining GSC at its downstream tiers restricts the responsiveness of export volume to exchange rate movements, indicating lower elasticity of exports compared to conventional trade. Given the integration between domestic and foreign value-added in final goods, depreciation increases exports of domestic components, consistent with the elasticities approach. Also, it boosts the imported intermediates, contrary to conventional theory (Cheng et al., 2016). The rise in foreign value-added at the expense of domestic value-added, cancels out the positive effect of depreciation on local components and could be outweighed by the negative impact on foreign components.

On the other hand, local currency depreciation in a country with *forward linkages* decreases, *ceteris paribus*, the foreign currency price of exported intermediate goods. Consequently, this lowers the production cost and price of final goods, boosting their competitiveness and eventually their demand. This causes a subsequent increase in the derived demand for intermediates. Also, it may offset the negative impact of downstream countries' currency depreciation on the prices of imported components, as illustrated above (Thorbecke, 2016). Clearly, the net impact of exchange rate changes on exports in the GSC context is

uncertain. Hence, the sign of the elasticity of exports becomes ambiguous. This uncertainty raises empirical questions, as several studies have examined the impact of exchange rate changes on exports to GSC.

1.2 Review of Empirical Literature

Empirical studies are categorized into five groups based on exchange rate measurement: conventional Real Exchange Rate and Real Effective Exchange Rate (REER), adjusted REER, aggregate REER, integrated REER, and corrected REER. The *first group* of studies employed the real exchange rate or the conventional REER. Despite REER's inherent inaccuracy in measuring the effect of exchange rate changes on exports, it remains widely used due to data limitations. This imprecision arises from using weights based on gross trade, which assumes that trade involves only final goods entirely produced in one country, ignoring the use of imported inputs (Patel et al., 2014). Due to international production fragmentation, the need to calculate a REER that accounts for increased intra-industry trade among countries has led to the adoption of new REER measurements in several studies.

Researchers in the *second group* used the adjusted REER, which accounts for a country's participation in GSC through backward linkages. It calculates the country's exchange rate relative to those of the countries supplying intermediate goods (Yamashita, 2011).

The *third group* of studies combined the previous two measures into an aggregate REER index. It measures exchange rate movements in terms of the exchange rates of both trade partners and suppliers of imported inputs (Ahmed, 2009).

Integrated REER in the *fourth group* accounts for currency fluctuations in both final goods and inputs exporting countries relative to the currencies of the main partners purchasing the final goods. This approach is particularly useful in regional production networks like East Asia, emphasizing the need for coordinated exchange rate policies among countries in the network (Thorbecke & Smith, 2010).

Recent studies in the *fifth group* have corrected for production process slicing by calculating the corrected REER (value-added REER), using industry value-added trade instead of gross trade to determine weights and prices. However, this REER application faces challenges in obtaining value-added trade data (Guedidi & Baghdadi, 2023).

Empirical studies, as shown in Table 1, have yielded conflicting results regarding the sign of the elasticity of exports. Some studies, like Ahmed (2009), and Tan et al. (2019), found an elastic demand with a negative sign. This means that local currency depreciation, *ceteris paribus*, enhances the export performance of Chinese ordinary and processed exports and ASEAN total goods and services exports, respectively. Other studies, including Saygili and Saygili (2011), Ahmed et al. (2017), and Bang and Park (2018), found an inelastic demand for Turkish non-traditional exports, sectoral-level manufacturing exports for 46 countries, and Chinese and Korean industry-level exports, respectively.

Contrarily, some studies estimate a positive elasticity of exports, particularly exports of final goods within GSC, influenced by the embodied high share of foreign value-added, due to the reliance on imported intermediates from upstream tiers. This is evident in various cases, such as Chinese final products export in Yamashita (2011), ASEAN exports of finished goods, high-tech products, and medium-tech parts and components in Hooy et al. (2016), Malaysian manufactured exports in Oktaviani and Shrestha (2021), and Chinese value-added processed exports following the global financial crisis of 2009 in Ke (2022).

This conclusion is confirmed by the negative elasticity of exports estimated in the last group of studies using more precise models focusing on domestic value-added exports. They show that participation in the GSC significantly reduces the favorable impact of local currency depreciation on exports. For instance, Ahmed et al. (2017) found that the elasticity of value-added exports, using the corrected REER, was only one-quarter of the elasticity of total and manufactured exports based on conventional REER. The former elasticity did not show the same decline over time as the latter, which may result from the use of gross versus value-added measures of REER and exports. Moreover, a high foreign value-added share in total exports reduces export sensitivity to exchange rate changes, varying from 18% in Korea to 93% in ASEAN economies (Bang & Park, 2018; Tan et al., 2019). However, Oktaviani and Shrestha (2021) found a 122% increase in elasticity of Thai manufactured exports when incorporating GSC into the model. This is due to

the modernization of this sector shifting towards medium-tech industries like automobiles and electronics and benefiting from the trade creation effect caused by GSC participation.

Finally, reviewing the literature on the impact of pound depreciation on Egyptian exports reveals a gap concerning the influence of participating in the GSC on this relationship, as the existing studies did not incorporate the GSC variable in their models. In most studies, the elasticity sign is consistent with the conventional theory. Nevertheless, the elasticity of non-petroleum commodity exports is insignificant in Al-Shawarby (2000), El Ebiary (2009), and Aly and Hosni (2018). But El Ebiary (2009) found significance and higher elasticity estimates for the EU and the USA markets. Bahmani-Oskooee and Gelan (2018) and Adams and Metwally (2021) reported an elastic demand for total exports, while Shokry et al. (2020) found an inelastic demand. For the automotive industry, Zaki et al. (2019) reported a weak response of its exports to pound depreciation.

Table 1. Empirical Studies on Elasticity of Exports in The GSC Context

Study	*Country*	*Estimation Period and Data Frequency*	*Methodology*	*Type of Exports*	*GSC Variable*	*Findings*
Group One: Conventional Real Exchange Rate and REER						
Ahmed (2009)	China	1996-2009 (quarterly)	Ordinary least square (OLS)	Ordinary exports and processed exports to GSC		Elasticity of exports was substantially greater than unity, with a negative sign.
Saygili & Saygili (2011)	Turkey	1987-2008 (quarterly)	Time series analysis, Engle-Granger cointegration technique, and panel fully modified ordinary least square (FMOLS)	Traditional exports and non-traditional exports related to international production fragmentation		Elasticity of non-traditional exports was less than unity and lower than that of traditional exports.
Hooy et al. (2016)	5 ASEAN countries (Thailand-Indonesia-Singapore-Philippine-Malysia)	1994-2008	Panel FMOLS	Bilateral aggregate and disaggregated (by usage and technology) exports to China. Also, Parts and components exports disaggregated by technology		Inelastic demand for exports except for intermediate goods and high-tech products. The elasticity sign was negative in the case of exports with high share of domestic value-added (like primary products & low-tech products). Conversely, in the case of high share of foreign value-added (like finished goods, medium & high-tech products, and medium-tech intermediates).
Ahmed et al. (2017)	46 different countries	1996-2012	Panel data regression	Manufacturing exports and industry-level exports	GSC forward linkages, GSC backward linkages, GSC participation index, and GSC position index	Joining GSC reduced the elasticity of manufacturing exports by an average of 22% and nearly 30% in countries with high participation. The backward linkages play a greater role in explaining this reduction than the forward linkages.

Oktaviani & Shrestha (2021)	4 ASEAN countries (Thailand-Indonesia-Philippine-Malysia)	2009-2015	Least square dummy variable method (LSDV)	Manufactured exports	GSC participation index, GSC position index, and share of foreign value added in total exports	When the GSC was incorporated into the model, the elasticity of Thai exports increased by 122%, and its sign changed to negative. Conversely, elasticity of exports in Indonesia and Malaysia, decreased by an average of 70%–89%. Exhibiting a weak response to exchange rate changes while maintaining a negative sign for the former and turning positive for the latter. Lastly, the Philippine elasticity of exports was insignificant.
Ke (2022)	China	1995-2021	Time series Analysis and Johansen cointegration method	Value-added manufactured exports to GSC		Before the 2009 global financial crisis, the exchange rate relationship with domestic value-added export was negative, contrary to the post-crisis period.
Group Two: Adjusted REER						
Ahmed (2009)	China	1996-2009 (quarterly)	OLS	Ordinary exports and processed exports to GSC		Elasticity of exports was positive but insignificant in the case of processed exports. On the contrary, the demand for ordinary exports was significantly elastic with a negative sign.
Yamashita (2011)	China	1992/1993-2008/2009	Panel data regression	Final products export to the USA and the EU excluding the imported parts and components		The demand for final product exports was inelastic in the case of total exports and labor-intensive goods like textiles. Conversely, it was elastic in the case of capital and technology-intensive goods such as machinery. In both cases, the elasticity sign was positive.
Group Three: Aggregate REER						
Ahmed (2009)	China	1996-2009 (quarterly)	OLS	Total exports, ordinary exports, and processed exports to GSC		Elasticity of exports was significantly greater than one with a negative sign.
Group Four: Integrated REER						
Thorbecke & Smith (2010)	China	1994-2005	Panel dynamic OLS	Processed exports		Unit elasticity of processed exports with a negative sign. Appreciation of both the Renminbi and the currencies of East Asian countries supplying China with inputs for exports production, is a necessary condition for a significant decline in China's exports.
Group Five: Corrected REER						
Ahmed et al. (2017)	46 countries	1996-2012	Panel data regression	Value-added exports		The elasticity of domestic value-added exports was significantly low with a negative sign and less than its counterpart using conventional REER.

Bang & Park (2018)	China and Korea	1995-2011	LSDV, and system generalized method of moments	Industry-level exports	GSC participation index and GSC position index	Elasticity of industry-level exports were significantly low with a negative sign for both Korea and China. Participating in GSC reduced the elasticity of exports between 18% and 33% in the case of Korea. However, it insignificantly affected the Chinese elasticity of exports.
Tan et al. (2019)	ASEAN economies	1995-2011	Panel data regression	Total goods and services exports	Share of foreign value added in total exports	Demand for total exports was elastic with a conventional elasticity sign. Depreciation may not boost ASEAN exports because on average, participating in GSC reduces 93% of the effect of exchange rate changes.
Guedidi & Baghdadi (2023)	Tunisia	1990-2017	Panel data regression	Total exports, domestic value-added exports, and sectoral-level exports	Share of foreign value added in total exports	Elasticity estimates were high with a negative sign in the case of total and domestic valued-added exports. The involvement of Tunisia in GSC with backward linkages resulted in a 21% decrease in the elasticity. The currency depreciation has a negative impact on manufacturing exports, in which Tunisia participates in their GSC.

Source: compiled by the authors

Given the ongoing changes in global and domestic business environment, this article aims to evaluate the impact of the Egyptian Pound depreciation on Egyptian exports by incorporating GSC participation into the model and estimating the elasticity of Egyptian automotive exports in the next section.

2. METHODOLOGY AND MODEL ESTIMATION

In this section, the elasticity of Egyptian automotive exports is estimated by formulating exports demand models on both aggregate and disaggregated levels. The models' variables are also specified. The method of estimation used is the PSS (2001) cointegration technique, which allows to estimate the elasticity in both the short- and long-run. Then estimation results are discussed in the next section.

2.1 Model Specification and Data Description

This section employs the widely used imperfect substitution model, because it is suitable for analyzing different types of exports and capturing the effects of explanatory variables on export behavior in both the short-and long-run (Vesilind & Ehrlich, 2001).

2.1.1 Formulation of Demand Models for Egyptian Automotive exports

This article estimates four demand models for Egyptian automotive exports, at the aggregate level and the disaggregated market level: Model 1 represents world demand for Egypt's automotive exports, while Models 2 to 4 represent the demand in the main export markets. These markets collectively account, on average, for 86% of total Egyptian automotive exports over the period 2015-2020. The models take the following form:

$$\mathrm{RX}_i = \mathrm{c} + \alpha_1 \mathrm{AREER} + \alpha_2 \mathrm{GSC} + \alpha_3 \mathrm{RGDP}_i + \alpha_4 \mathrm{ERP} + \alpha_5 \mathrm{Jan25} + \alpha_6 \mathrm{FC08} + \alpha_7 \mathrm{PSA} + \mathrm{e} \qquad (1)$$

where: RX_i is the real value of Egyptian automotive exports to the importing market (million dollar), AREER is the adjusted REER (foreign currencies/L.E.), GSC represents the participation in automotive GSC (%),

$RGDP_i$ is the real gross domestic product of the importing market (billion dollar), and **i** represents the importing market. Besides several dummy variables, such as ERP for the national economic reform program (NERP) since 2016, Jan25 for the January 2011 revolution, FC08 for the global financial crisis in 2008, and the PSA for the European-Egyptian Partnership Agreement[1]. e is the error term, assumed to be iid (0, σ^2), and $\alpha_1<0$, $\alpha_2>0$, $\alpha_3>0$.

2.1.2 Definition and Calculation of Variables

a. **Real Value of Egyptian Automotive Exports for Each Export Market (RXi):** calculated by deflating the nominal value in pounds by the producer price index (PPI) of transportation means. Then converted into dollars using the nominal exchange rate.
b. **Adjusted Real Effective Exchange Rate (AREER):** it involves calculating the pound exchange rate relative to the currencies of upstream countries supplying Egypt with automotive components, weighing each country's share in Egypt's total imported automotive components. The main suppliers are China, Thailand, Germany, Japan, and South Korea, accounting for an average of 60%[2] between 2015-2020. The adjusted REER is obtained by multiplying the adjusted NEER by the Egyptian consumer price index (CPI) to its counterpart in the supplier countries. Conventionally the sign is negative, but it turns to be ambiguous when considering GSC.
c. **GSC Participation (GSC):** is proxied by the percentage of imported components utilized in automotive export production relative to the total export value for each market (*i*). It is chosen because it matches the fact that the Egyptian automotive sector participates in GSC through backward linkages and due to data availability.
   The value of imported components used in automotive exports was calculated by multiplying the total imported inputs by the average share of exported production, which was 5% during the study period (Calculated from the CAPMAS, Annual Industrial Production Statistics-Private Sector). In disaggregated models, the value of imported components for each market is assumed due to data constraints, to be used in the same proportion as each market's share in total exports. This variable is expected to be positive if GSC participation results in trade creation (Bonham et al., 2004).
d. **Weighted Average Real Gross Domestic Product of the Importing Market (RGDPi):** represents the real income in each market (*i*). The world demand model includes the three largest importing countries accounting for 50% of Egyptian automotive exports. The shares of these countries are: the United Kingdom (30.3%), Cameroon (10.4%), and France (8.5%). In the EU model, the United Kingdom[3] and France compromise 89.7% of automotive exports to the EU. For the Arab countries model, Saudi Arabia and the United Arab Emirates (UAE) represent over 55% of automotive exports to this market. Finally, Cameroon and Niger make up a total of 57% of automotive exports to the African market (Calculated as an average of the period 2015-2020 from the ITC, Trade Map Online Database)[4]. It is expected to have a positive sign.
e. **Dummy Variables**:

---

[1] The COVID-19 pandemic was excluded because the model's span covers only the initial phase of the pandemic. Additionally, it had a transient impact due to the disruptions in the automotive GSC, which was confirmed by Boranova et al. (2022). This caused a temporary 17% decline in global automotive exports in 2020, a rapid recovery began in the subsequent year, with exports surpassing the pre-crisis levels by 5% in 2022. Similarly, Egyptian automotive exports faced a temporary decline of 43% since March 2020 and throughout 2021, followed by an 8% increase in 2022 (Calculated from the ITC, Trade Map Online Database). This volatility is not solely due to the pandemic, as the sector is inherently unstable and weakly linked to automotive GSC. Finally, the Chow test was unworkable due to the short timeframe.

[2] These countries represent the key five markets supplying Egypt with foreign components for automotive production. Their shares are as follows: China (19.5%), Thailand (11%), Germany (10.2%), Japan (9.8%), and South Korea (9.5%) (Calculated from the ITC, Trade Map Online Database).

[3] The UK officially existed the EU on January 31, 2020, commencing a transitional period of one year.

[4] This article is restricted to these specific countries due to data limitations. The high export concentration makes the chosen countries a good representative of their respective markets.

i. Economic Reform Program (ERP): signifies the impact of the monetary and fiscal policies applied within the NERP framework in 2016. It takes a value of one from the last quarter of 2016 until the end of 2019, and zero otherwise.
ii. January 2011 Revolution (Jan 25): represents the influence of the tensions accompanying the revolution that led to a decline in the automotive production rate by 30%[5] in 2011. It takes a value of one from the first quarter of 2011 until the end of the estimation period and zero otherwise.
iii. Global Financial Crisis in 2008 (FC08): denotes the effect of the decline in international trade during the crisis. It takes a value of one from the first quarter of 2007 until the second quarter of 2009, and zero otherwise.
iv. European-Egyptian Partnership Agreement (PSA)[6]: represents the outcome of trade liberalization and the reception of grants to modernize Egypt's industrial sector. It takes a value of one since June 2004 until the end of the period and zero otherwise.

2.1.3 Data Sources

This article uses quarterly data from 2000 to 2020 for the world demand model and only from 2006 to 2020 for the regional models due to data limitations. The Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS) provides data on automotive exports and its components import in the External Trade Statistics. Also, it issues the PPI for means of transportation [7] in the Monthly Bulletin of PPI. Finally, it supplies data on the share of automotive exports in total domestic production in the Annual Industrial Production Statistics. The IMF's International Financial Statistics Online Database provides data on exchange rates, CPI, GDP deflator, and GDP, except for the GDP of Cameroon, Saudi Arabia, and the UAE. They are sourced respectively, from the National Institute of Statistics Database in Cameroon, the OECD Online Database, and the Federal Competitiveness and Statistics Center in UAE. Lastly, the United Kingdom GDP deflator is obtained from the Bloomberg Database.

2.2 Estimating Demand for Egyptian Automotive Exports Models

In the following analysis, several steps are undertaken to estimate the short- and long-run elasticity of automotive exports, both at aggregate and disaggregated levels. Firstly, unit root tests are conducted. Secondly, dummy variables are selected for inclusion. Thirdly, the PSS (2001) cointegration method is employed. Fourthly, various diagnostic and stability tests are executed, followed by the estimation of elasticity in the four models.

2.1.1 Stationarity Tests

This section applies three different unit root tests for robustness, namely the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS), on the logarithms of the dependent and explanatory variables in Table 2. These tests found differences in the integration order of the variables between zero I(0) and one I(1) in each model.

Table 2. Stationarity Tests (at a 1% Significance level)

Model	*World*			*EU*			*Arab Countries*			*African Market*		
	ADF	*PP*	*KPSS*	*ADF*	*PP*	*KPSS*	*ADF*	*PP*	*KPSS*	*ADF*	*PP*	*KPSS*
Ln(RX)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Ln(AREER)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)
Ln(GSC)	I(0)	I(0)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)

[5] From website: https://www.oica.net/category/production-statistics/2011-statistics/.
[6] The impact of Egypt's accession to the Common Market for Eastern and Southern Africa in 1999 and to the Greater Arab Free Trade Area in 2005 are not examined as they preceded the study period. Also, the African Continental Free Trade Area is excluded as it came into force in 2021, after the study period.
[7] The quarterly means of transportation PPI is computed by taking the average of every three months PPI.

Ln(RGDP)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)

Source: Authors' estimation using EViews-10 software.

2.1.2 Selection of Dummy Variable

Based on the Chow Test results in Table 3, the insignificance of the dummy variables coefficients, and the lack of improvement in the residuals after adding these variables to each model[8], this article confirms the stability of the demand relationship for Egyptian automotive exports, with the exception of the 2011 revolution in the EU model.

The lack of a structural breakpoint for the NERP in 2016 can be attributed to prioritizing monetary and fiscal reforms over structural reforms that specifically stimulate exports. The absence of structural instability due to the PSA may be due to deficiencies in its provisions or the small share of automotive exports in Egypt's non-petroleum exports to the EU, which was only 0.3% when the agreement went into force and averaged 0.7% thereafter (Calculated from the UNCTAD, Online Database).

Table 3. Chow Test Results[9]

Dummy Variable	*ERP*	*FC08*	*Jan25*	*PSA*
Breakpoint	2016(1)	2008(1)	2011(1)	2004(3)
World Model	1.01 (1.95)	1.62 (1.95)	0.96 (1.95)	0.96 (1.95)
EU Model	1.11 (2.14)	-	2.44 (2.14)	-
Arab Countries Model	1.95 (2.14)	-	1.31 (2.14)	-
African Market Model	1.22 (2.16)	-	1.17 (2.16)	-

Source: Authors' estimation using EViews-10 software.
Notes: In parentheses ( ) are the critical values of the F-distribution at a 5% significance level.

Furthermore, this article shows that external and domestic shocks do not affect the structural stability of the demand relationship for automotive exports. The 2008 global financial crisis had minimal impact on Egypt's automotive exports due to their non-competitiveness. Their global share ranges between 0.013% and 0.019% during the crisis. The 2011 revolution had a limited effect too, except in the EU model, Egypt's largest automotive export market, which averaged a 38% share from 2015-2020 (Calculated from the ITC, Trade Map Online Database).

2.2.3 The Cointegration Approach

This section employs the PSS (2001) cointegration technique, which integrates short-run dynamics into the estimation of the long-run relationship. Pesaran et al. (2001) initially estimated an autoregressive distributed lag (ARDL) model and conducted bounds testing. However, they modified the ARDL model by incorporating a lagged error-correction term (ECT), creating a linear combination of lagged level variables. This reformulated the equilibrium relationship, as depicted in Equation (1), into an unrestricted error-correction format as shown in Equation (2), to test the long-run relationship among the variables of the export demand function.

The PSS (2001) conditions were confirmed: First, the integration order of all variables is less than I(2) as shown in Table 2. Second, the ARDL models do not suffer from first-order serial correlation as seen in

[8] The residual plotting is not included due to space limitation but is available upon request.
[9] The Chow Test is not applicable for the global financial crisis except for the world model. Also, it is not feasible to test the impact of the PSA, as the study period starts after the agreement comes into effect.

Table 6[10], where the calculated χ2 values are less than the critical values at a 1% significance level. Third, the estimated coefficients are stable over the estimation period, since the values of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive squared residuals (CUSUM²) tests are within the critical values at a 5% significance level, as illustrated in Figures 1 to 4 in the Appendix. Hence, the four models are valid for making long-run decisions.

The PSS (2001) bounds test as depicted in Table 4, confirms the presence of a long-run equilibrium relationship among the variables in each model as the calculated F-statistic is higher than the critical upper bound at a 1% significance level. Therefore, this article rejects the null hypothesis of the absence of cointegration.

Table 4. Results of Pesaran-Shin-Smith (2001) Bounds Test

Models	*World*	*EU*	*Arab Countries*	*African Market*
Null Hypothesis (H0): $\beta_1=\beta_2=\beta_3=\beta_4=0$ (No Cointegration Relationship)				
Bound Test F: Calculated F-Statistics Value	9.73	8.52	6.93	49.03
Critical Values at 1% significance level				
Lower Bound I(0):	4.56	4.82	-1	4.82
Upper Bound I(1):	5.96	6.19	-1	6.19

Source: Authors' estimation using EViews-10 software.

With a statistically proved cointegrating relationship among the variables, the elasticity of exports can be determined using the unrestricted error-correction models (ECM) for the demand of Egyptian automotive exports. These models are estimated using the OLS method, outlined as follows:

$$D\left(LnRX_{i_t}\right) = \alpha + \beta_1\left(LnRX_{i_{t-1}}\right) + \beta_2(LnAREER_{t-1}) + \beta_3(LnGSC_{t-1}) + \beta_4\left(LnRGDP_{i_{t-1}}\right) + \sum_{j=1}^{n} \delta_j D\left(LnRX_{i_{t-j}}\right) + \sum_{j=0}^{n} \theta_j D\left(LnAREER_{t-j}\right) + \sum_{j=0}^{n} \varphi_j D\left(LnGSC_{t-j}\right) + \sum_{j=0}^{n} \lambda_j D\left(LnRGDP_{i_{t-j}}\right) + \mu_t \quad (2)$$

where: D represents the first differences, and the variables LnRX*i*, LnAREER, LnGSC, LnRGDP*i* denote the natural logarithms of the real value of exports, the adjusted REER, GSC participation, and RGDP, respectively, for each market *i*. Here, *t* denotes time, and *j* denotes the lag order, which is determined by the Akaike Information Criterion.

Equation (2) consists of: First, a linear combination of the one-period lagged level of the logarithm of the variables $(\beta_1\left(LnRX_{i_{t-1}}\right) + \beta_2(LnAREER_{t-1}) + \beta_3(LnGSC_{t-1}) + \beta_4\left(LnRGDP_{i_{t-1}}\right))$ constituting the ECT and representing the long-run dynamics. Second, the first difference (D) in lags of the logarithm of the variables $(\sum_{j=1}^{n} \delta_j D\left(LnRX_{i_{t-j}}\right) + \sum_{j=0}^{n} \theta_j D\left(LnAREER_{t-j}\right) + \sum_{j=0}^{n} \varphi_j D\left(LnGSC_{t-j}\right) + \sum_{j=0}^{n} \lambda_j D\left(LnRGDP_{i_{t-j}}\right))$, depicting the short-run dynamics.

The estimated unrestricted ECM illustrated in Table 5, indicates that changes in the real value of the Egyptian automotive exports are influenced by variations in adjusted REER, GSC participation, and RGDP

[10] Refer to Page 154.

of importing markets, with different lag periods, in addition to the 2008 global financial crisis and the January 2011 Egyptian revolution. The lagged ECT capturing the long-run relationship, is also estimated. The estimation of the first differences of the lagged logarithm variables shows negative coefficients for adjusted REER, aligning with conventional trade theory. However, they turn positive in the lagged ECT due to extended adjustment period in the long-run, allowing for both direct and indirect effects of exchange rate changes.

Table 5. Estimation of the Unrestricted ECM of the Demand for Egyptian Automotive Exports

Model/ Variable	*World*	*EU*	*Arab Countries*	*African Market*
constant	-5.09 (-5.34)*	-51.70 (-3.29)*		3.30 (1.71)***
$LnRX_{it-1}$	-0.38 (-5.40)*	-0.91 (-4.90)*	-0.58 (-4.73)*	-0.69 (-6.89)*
$LnAREER_{t-1}$	0.92 (4.99)*	-1.80 (-2.11)**	1.95 (3.12)*	0.70 (0.87)
$LnGSC_{t-1}$	-0.38 (-5.30)*	-1.43 (-3.68)*	-0.40 (-1.73)***	-0.34 (-1.15)
$LnRGDP_{it-1}$	1.27 (6.01)*	7.72 (3.30)*		
$LnRGDP_{it}$ ••			0.92 (3.59)*	-0.54 (-0.52)
$D(LnRX_{it-1})$		0.41 (2.27)**	0.03 (0.62)	-0.17 (-1.85)***
$D(LnRX_{it-2})$		0.33 (2.22)**	0.15 (3.44)*	
$D(LnRX_{it-3})$		0.37 (3.1)*		
$D(LnRX_{it-4})$		0.36 (3.31)*		
$D(LnRX_{it-5})$		0.14 (2.21)**		
$D(LnAREER_{t})$	0.79)*50.3(	-0.03 (-0.01)	3.89 (3.09)*	-2.77 (-1.82)***
$D(LnAREER_{t-1})$	-0.81 (-2.97)*		-1.48 (-1.13)	
$D(LnAREER_{t-2})$	-0.58 (2.08)**		-2.19 (1.80)***	
$D(LnGSC_{t})$	-1.00 (-91.44)*	-1.21 (-5.92)*	-0.83 (-4.71)*	-0.52 (-2.79)*
$D(LnGSC_{t-1})$	-0.02 (-2.61)**	0.72 (2.49)**		-0.29 (-1.68)***
$D(LnGSC_{t-2})$		0.54 (2.57)**		
$D(LnGSC_{t-3})$		0.50 (3.19)*		
$D(LnRGDP_{i\,t})$	0.61 (1.92)***	-0.41 (-0.21)		
$D(LnRGDP_{i\,t-1})$		-5.50 (-2.14)**		
$D(LnRGDP_{i\,t-2})$		-7.84 (-2.57)**		
FC08		-3.91 (-4.24)*		

Jan25		-0.47 (-1.80)***		
R_2	0.99	0.83		0.84
$\bar{R}_2$			0.80	
F- Statistics	1165.82*	8.59*		30.09*
SER	0.13	0.67	0.58	0.76

Source: Author's estimation using EViews-10 software.

Notes: *i* denotes the market, where "w" corresponds to the world, "eu" to the EU, "ac" to the Arab countries, and "afc" to the African market.

**equals = $LnRGDP_{it-1} + D(LnRGDP_{it})$

Values in parentheses ( ) indicate the calculated t-statistic.

Significance levels: *(1%), **(5%), ***(10%), no symbol (insignificant).

Selection of lag order is based on the Akaike Information Criterion.

Meanwhile, most of the estimated coefficients for GSC participation are negative, indicating that joining the GSC does not lead to trade creation. This is due to the fact that Egyptian exports participate in downstream, low value-added tiers of the automotive GSC, while importing intermediates with higher value-added. The sign of the estimated coefficients of RGDP is positive as expected, except for the EU market, suggesting that European consumers, may abandon Egyptian goods as their income increases.

The estimated coefficients of the global financial crisis and the January 2011 revolution are significant only in the EU market because of its greater openness and deeper integration into the global market, as well as, its closer economic ties with Egypt, being Egypt's main trade partner.

Furthermore, the speed of adjustment in the short-run, measured by the estimated coefficient of the logarithm of real automotive exports ($LnRX_{it-1}$) in the lagged ECT in the unrestricted ECM in Table 5[11], is significantly high. Particularly, the EU model exhibits a rapid disequilibrium correction, with 91% of the previous quarter's disequilibrium fixed in the current quarter, resulting in a stable state within six months. The Arab and African models show high adjustment speed too, at 58% and 69%, respectively, while the world model's rate decreases to 38%. The correct negative sign of the coefficient of ($LnRX_{it-1}$) in all models confirms the return to equilibrium in the long-run. As a result, demand deviation from equilibrium in the short-run significantly affects the dynamic export behavior.

The calculated t-statistics confirm the significance of all coefficients in the world model, as well as most of them in the regional models[12]. However, in the African market model the exchange rate has a limited influence on the long-run demand for Egyptian automotive exports compared to demand fluctuations over shorter periods.

Finally, the calculated F-statistics reveal a significant overall relationship between the dependent and the explanatory variables at a 1% significance level. The high goodness-of-fit (R^2)/determination coefficient ($\bar{R}^2$) for all models emphasizes the explanatory power of the demand models, particularly the world model.

2.2.4 Diagnostic Tests for the Estimated Models

In Table 6, the results of the diagnostic tests at a 1% significance level validate the estimated models. There is no evidence of serial correlation among residuals according to the Breusch-Godfrey LM test. The White and Breusch-Pagan-Godfrey tests confirm the acceptance of the null hypothesis of no heteroskedasticity. The residuals exhibit a normal distribution according to Jarque-Bera statistics.

The four models, following Klein's initial rule, show inexact multicollinearity, which is unproblematic for the estimates. The (R^2) values for the auxiliary regressions[13] are lower than those in the unrestricted ECM. This is further confirmed by the predominantly low coefficients values in the correlation matrices[14].

Additionally, the calculated F-statistics in the Ramsey RESET test in Table 6, are lower than the critical values, accepting null hypothesis that the dependent variable is linearly related to the independent

[11] Which is similar to the coefficient of the lagged ECT (Ect_{t-1}) in the restricted ECM. The estimation of the restricted ECM of the demand for Egyptian automotive exports is not included due to space limitations but is available upon request.

[12] The insignificant coefficients are kept to maintain the ARDL model with the highest goodness of fit.

[13] Not included due to space limitations, but are available upon request.

[14] Not included due to space limitations, but are available upon request.

variables. This affirms the models' linear specifications. Finally, the stability of the export demand relationship in all models is confirmed by the CUSUM and CUSUM^2 tests, as shown in Figures 1 to 4 in the Appendix.

Table 6. Diagnostic Tests for the Estimated unrestricted ECM Models

Test/Model	*World*	*EU*	*Arab Countries*	*African Market*
Serial Correlation Test: Breusch-Godfrey LM Test	1.32 (9.21)	0.25 (9.21)	1.03 (9.21)	0.82 (9.21)
Heteroskedasticity Test: White Test	4.30 (23.20)	13.61 (36.19)	4.09 (23.20)	5.71 (20.09)
Heteroskedasticity Test: Breusch-Pagan-Godfrey Test	2.99 (23.20)	17.70 (36.19)	5.03 (23.20)	5.29 (20.09)
Normality Test: Jarque-Bera Statistics	0.89 (9.21)	0.15 (9.21)	1.27 (9.21)	1.01 (9.21)
Specification Test: Ramsey RESET Test	1.01 (7.08)	1.36 (7.56)	1.43 (7.31)	1.4 (7.31)

Source: Authors' estimation using EViews-10 software.

Note*s:* In parentheses ( ) are the critical values for the $\chi 2$ distribution at a 1% significance level for the first four tests, and for the F distribution at a 1% significance level for the last test.

Accordingly, the four models explain effectively the changes in demand of Egyptian automotive exports across markets throughout the estimation period. The convergence between the actual and estimated time series of the dependent variable, as shown in Figures 5 to 8 in the Appendix, and the decrease in the estimated standard error in Table 5 further validate the models.

2.2.5 Estimation of Elasticity of Exports in the short and long-run

Based on the diagnostic of the models, the estimated unrestricted ECM is highly reliable for obtaining elasticity estimates of Egyptian automotive exports for each market. The short-run elasticity of exports is derived from the average of the estimated coefficients for the first differences of the lagged logarithm of the adjusted REER in the restricted ECM[15]. While the long-run elasticity of exports is calculated by estimating the logarithmic form of equilibrium export demand models as in Equation (1), using the OLS.

Table 7. Estimation of the Elasticity of Egyptian Automotive Exports

Model	*Elasticity of Exports*	
	Short-run	*Long-run*
World	-0.20 (1%)	2.40 (1%)
EU	-0.03 (insignificant)	-1.97 (5%)
Arab Countries	0.07 (5%)	3.36 (1%)
African Market	-2.77 (10%)	1.01 (insignificant)

Source: authors' estimation (long-run elasticity extracted from EViews-10 software outputs, while the short-run elasticity was calculated by the authors from the restricted ECM).

Notes: The parentheses ( ) show the significance level. For the short-run elasticity, the significance level was determined by the Wald Test.

3. DISCUSSION OF THE RESULTS

[15] Not included due to space limitations, but is available upon request.

This section analyzes the short- and long-run elasticity of Egyptian automotive exports estimated for the world and the major markets. Also, the estimates will be compared to other studies' findings on the elasticity of exports for developing nations within the GSC context. Finally, special emphasis is given to Egyptian studies.

3.1 Aggregate Model (World Demand)

Table 7 reveals that the world demand for Egyptian automotive exports is inelastic in the *short-run*. The estimate is statistically significant and negative, as per the conventional elasticities approach. Its modest value is expected due to the short timeframe. A 10% real depreciation in the pound, given the GSC participation, only leads to, *ceteris paribus*, a 2% increase in real automotive exports. This implies the limited effectiveness of exchange rate fluctuations in improving automotive export performance.

Nevertheless, the *long-run* elasticity of Egyptian automotive exports rises to 2.4 due to several factors, including: First, the long-run period allows for adjustments in production, consumption, and government policies. Second, Egypt's minimal share in the world's automotive exports 0.007% during the study period (Calculated from the ITC, Trade Map Online Database). Finally, the substantial and continuous rise in nominal exchange rate from 3.47 pounds per dollar to 15.76 pounds per dollar during the study period (IMF, International Financial Statistics Online Database), creates a strong incentive for consumers to adjust their purchasing habits.

The long-run estimate of elasticity of exports is positive, challenging conventional elasticities approach but aligning with earlier theoretical analysis on the impact of participating in GSC through backward linkages, particularly within low value-added downstream tiers and importing high value-added inputs, as seen in Egyptian automotive sector. With foreign content in Egypt's automotive industry exceeding 70%, the favorable impact of pound depreciation on domestic value-added exports is eroded. This affirms Cheng et al.'s (2016) finding that elasticity of exports becomes positive when the foreign content share surpasses 60%. Thus, under a floating exchange rate policy, pound depreciation may be ineffective or even harmful to export competitiveness and earnings.

The positive sign of the long-run elasticity of Egyptian automotive exports is consistent with estimates of some previous studies listed in Table 1, although they, contrary to this article, are inelastic. Yamashita (2011), for example, found the elasticities of total final exports and exports of machinery and transport to be 0.6 and 1.0, respectively. The elasticity of manufactured exports in Ahmed et al. (2017) is 0.002 in countries with backward linkages in GSC. This dissimilarity can be attributed to Egypt's extremely low share of global automotive market. Also, the article's estimate contradicts Zaki et al.'s (2019)[16], which found a negative inelastic demand for automotive exports and attributed the ineffectiveness of pound depreciation in boosting export earnings to technical trade barriers and technologically intensive nature of its production.

3.2 Disaggregated Models (Demand of the Main markets)

Table 7 shows that Egyptian automotive exports have a significant *short-run* elasticity in major importing markets except for the EU. Factors such as safety standards, quality specifications, accessories, and geographical proximity, which are more effective than relative price, may account for this exception. However, the disaggregated models coincide with the inelastic world demand model, except for the African market, where demand is highly elastic. This may be due to African consumers' perception of automotive goods as luxury items, particularly in the short-run, relative to other markets with higher income and development levels.

[16] Zaki et al. (2019) does not incorporate the GSC participation in its model.

The short-run elasticity of exports in the Arab countries is positive, possibly because their consumers view Egyptian exports as an experience good; When its relative price drops, they may switch to other substitutes, fearing lower quality. However, over time, consumers reassess the quality of these exports as ordinary goods only after consumption.

The *long-run* elasticity of Egyptian automotive exports is statistically significant, with high estimates in both the EU and Arab markets. However, despite a high estimate in the African market too, it is statistically insignificant, as seen in Table 7. Transportation costs and accessibility to the African countries likely overshadow the exchange rate in explaining changes in export demand. The European and Arab markets' high sensitivity can be attributed to the low share of Egyptian automotive exports in their total automotive imports, averaging 0.008% and 0.08%, respectively during the estimation period (Calculated from ITC, Trade Map Online Database). This highly elastic demand in major markets highlights the intense competition facing Egyptian exports from other developing countries in East and South Asia, Morocco, and South Africa.

Finally, in the Arab market, the exchange rate relationship with Egyptian automotive export contradicts the conventional theory. Pound depreciation, *ceteris paribus*, leads to a significant decline in export earnings, unlike the EU market. The conventional sign of the elasticity of exports in the latter market may result from the dominance of other factors such as proximity or could be due to observation errors. This unexpected sign requires further research.

CONCLUSION

This article examines the impact of GSC participation on the relationship between exchange rate fluctuations and Egypt's automotive export performance. To estimate the elasticity of exports, the article uses the PSS (2001) cointegration technique over a span of quarterly data from 2000 to 2020. Export demand models were estimated at both the world level and the disaggregated geographical distribution level, including the EU, the Arab countries, and the African markets.

The findings highlight the ambiguous impact of exchange rate movements on export performance, particularly in the context of international production fragmentation. Egyptian automotive exports exhibit high long-run elasticity, though with a sign inconsistent with conventional elasticities approach, except for the EU model. This positive sign is due to the indirect negative effect of pound depreciation on foreign components imported from upstream tiers in the automotive GSC, which outweighs the direct positive counterpart on domestic value-added exports. Consequently, pound depreciation may not necessarily lead to export expansion.

The key policy implication is that relying *solely* on the flotation policy and pound depreciation will not succeed in stimulating automotive exports. Depreciation will have a desirable impact *only if* domestic value-added is raised, while foreign content is reduced. Furthermore, the Egyptian automotive sector needs to become engaged in automotive GSC through forward linkages rather than the mere current backward linkages. This could be achieved through a number of recommendations, as follows:

First, as part of the AIDP, the efficiency of the automotive industry and its feeding sectors should be raised through *process upgrading*. This entails reorganizing productive activities and adapting advanced technologies in production, communications, and transportation to improve the competitiveness of the final output. Second**,** *functional upgrading* that requires turning to pre- and post-manufacturing services for higher value-added, focusing on design, innovation, research and development, marketing, and engineering services. Third, the automotive industry should invest in *product upgrading* areas, specifically high-tech components such as tier "1" software components. Moreover, it should align with the global trend towards environmentally friendly vehicles by integrating into high value-added tiers in the GSC and leveraging the expertise of OEMs, such as Mercedes-Benz and Brilliance Auto, who are offering to share their e-mobility expertise and produce electric vehicles in Egypt.

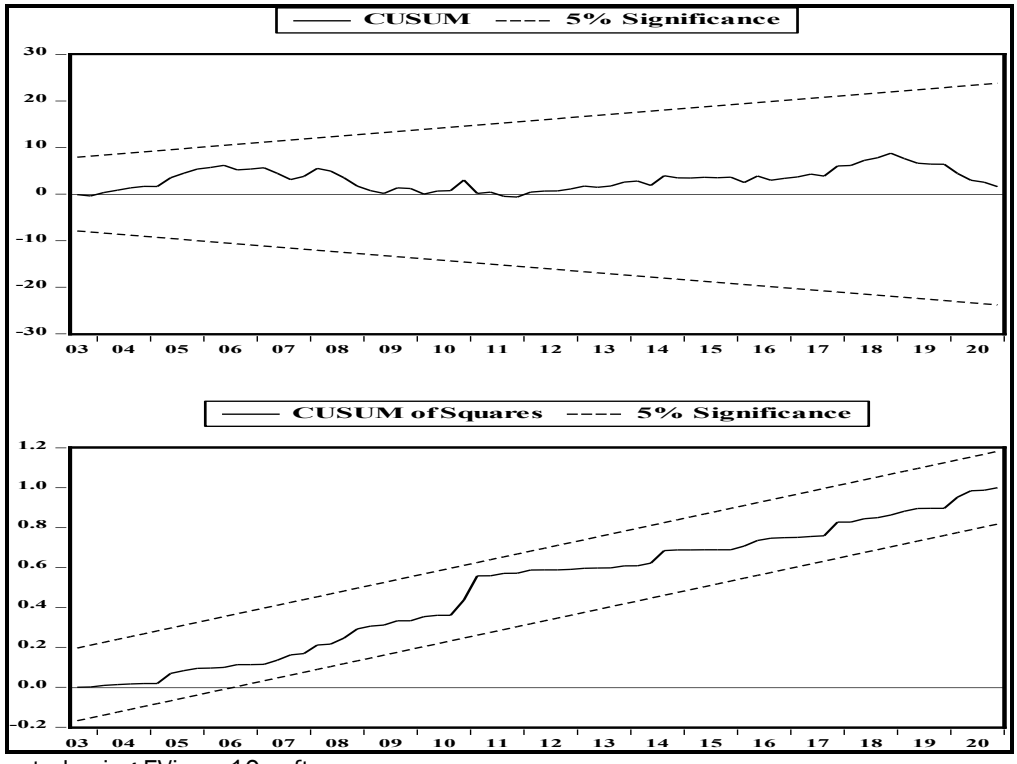
These measures aim to promote a shift towards GSC participation through forward linkages to support balanced and sustainable growth for the automotive industry and its feeding sectors. This industry could, in turn, act as an engine of growth through high value-adding, job creation, technological advancement, and reducing external deficits.

Finally, it is crucial to emphasize that the effectiveness of these measures is *conditional* on the transformation of nominal pound depreciation into real depreciation. However, as illustrated in Figure 9 in the Appendix, the real value of the pound actually increased by 8.65% between 2000-2020.

For further research, estimate demand models for domestic value-added exports in the automotive sector or other manufacturing sectors, where data availability allows. Additionally, using the corrected REER could enhance the analysis precision. Lastly, empirically examine the impact of different trade agreements on automotive exports.

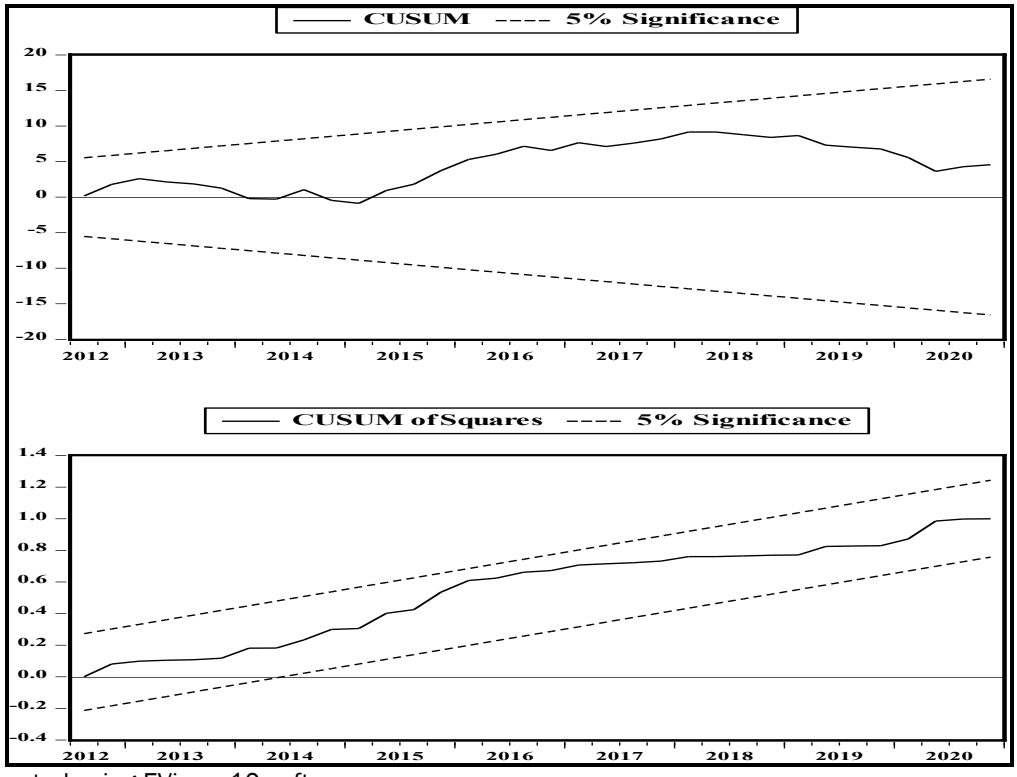
APPENDIX

Figure A1. CUSUM and CUSUM^2 in the World Model



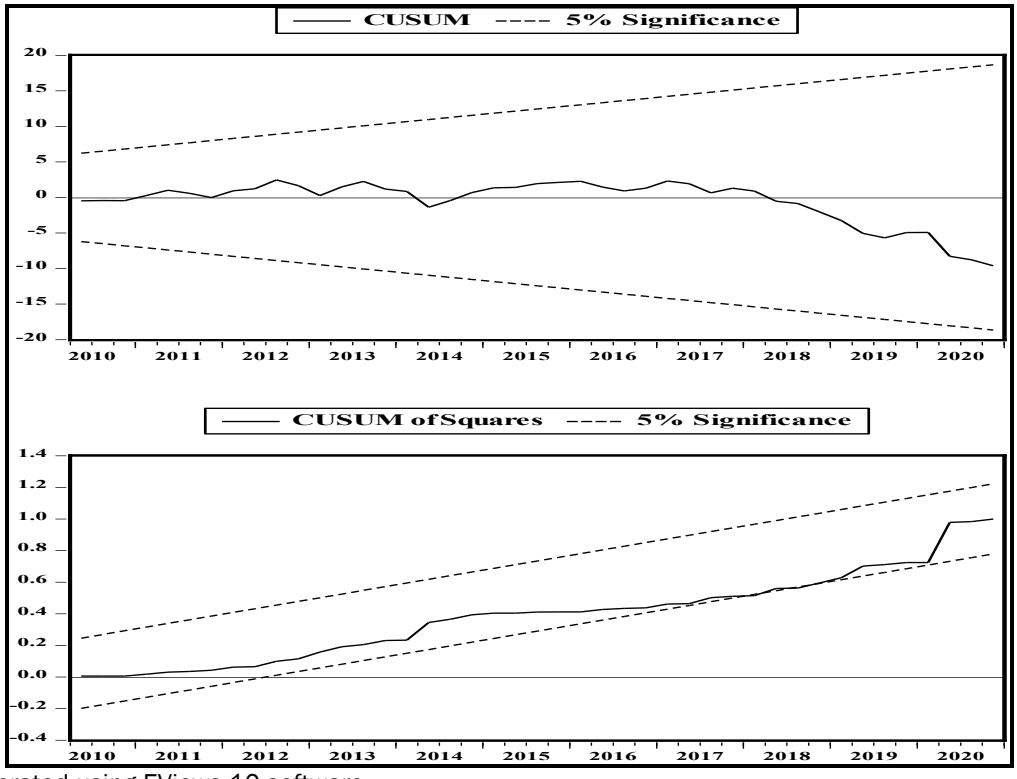
Source: Generated using EViews-10 software.

Figure A2. CUSUM and CUSUM² in the EU Model



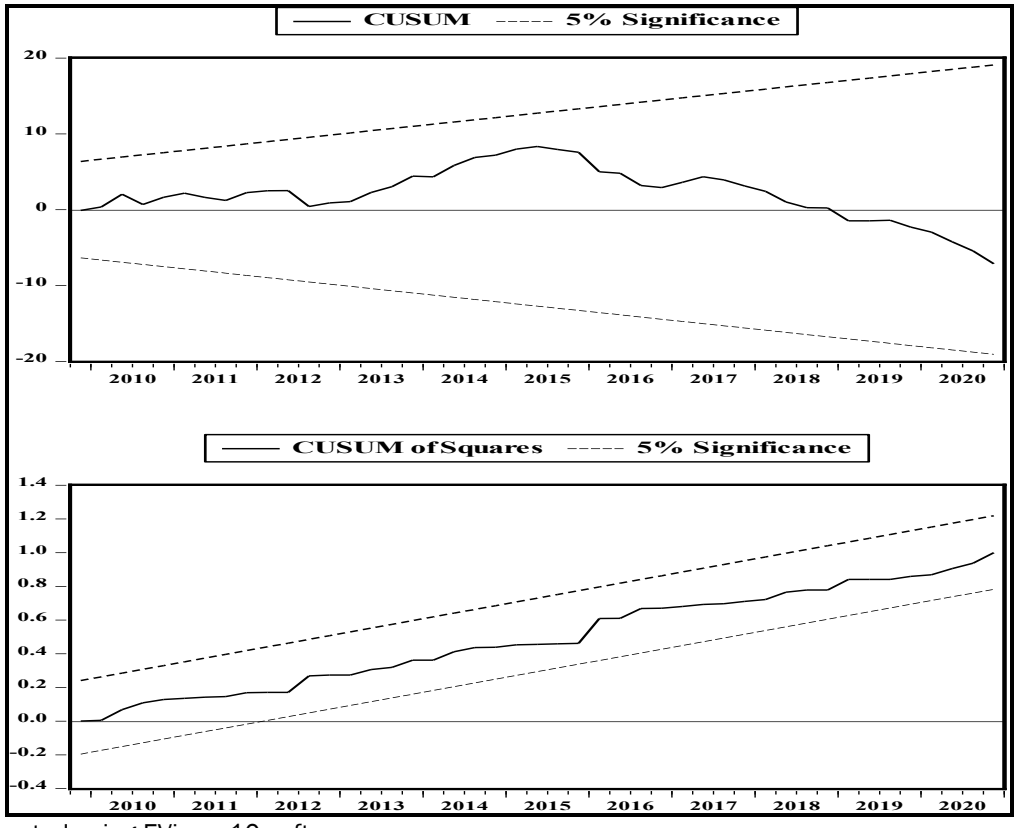
Source: Generated using EViews-10 software.

Figure A3. CUSUM and CUSUM² in the Arab Countries Model



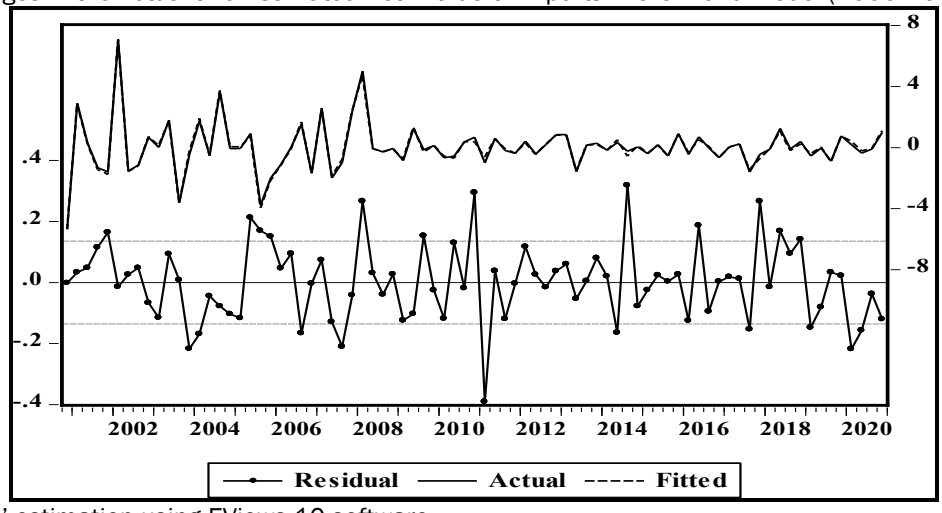
Source*:* Generated using EViews-10 software.

Figure A4. CUSUM and CUSUM² in the African Market Model



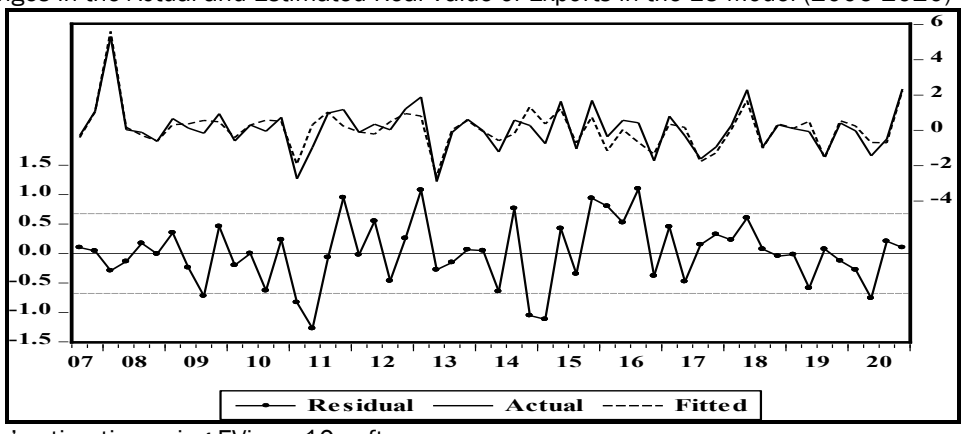
Source: Generated using EViews-10 software.

Figure A5. Changes in the Actual and Estimated Real Value of Exports in the World Model (2000-2020)



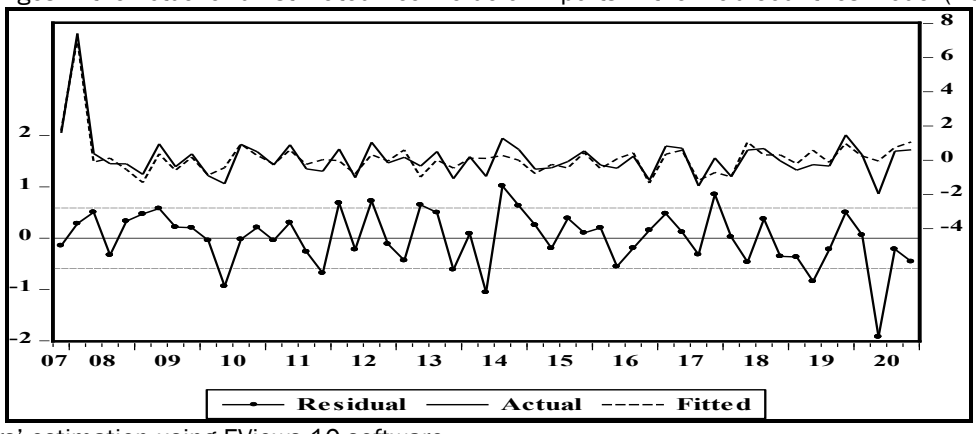
Source: Authors' estimation using EViews-10 software.

Figure A6. Changes in the Actual and Estimated Real Value of Exports in the EU Model (2006-2020)



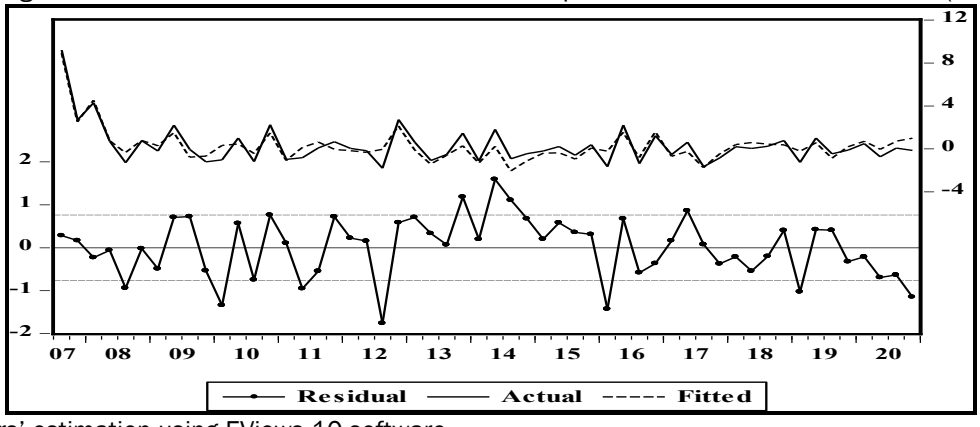
Source*:* Authors' estimation using EViews-10 software.

Figure A7. Changes in the Actual and Estimated Real Value of Exports in the Arab Countries Model (2006-2020)



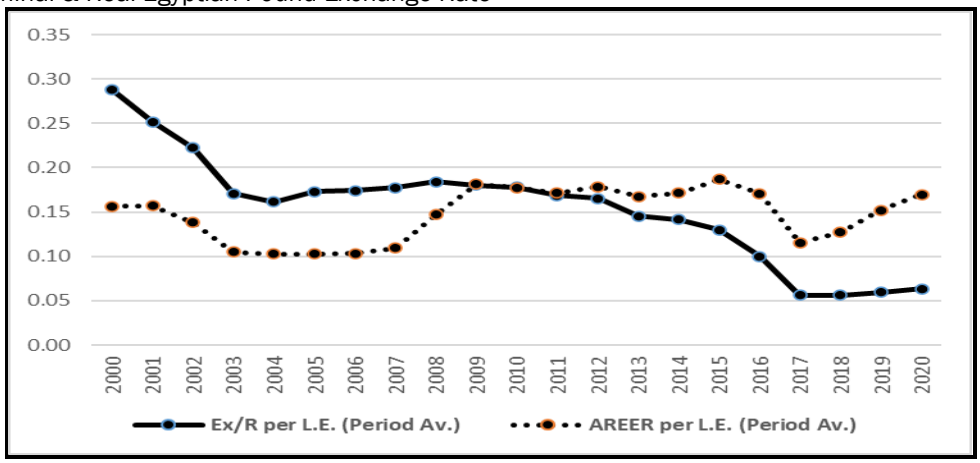
Source*:* Authors' estimation using EViews-10 software.

Figure A8. Changes in the Actual and Estimated Real Value of Exports in the African Market Model (2006-2020)



Source: Authors' estimation using EViews-10 software.

Figure A9. Nominal & Real Egyptian Pound Exchange Rate



Source: Constructed by the authors based on data from IMF, IFS Online Database and ITC, Trade Map Online Database.

ACKNOWLEDGEMENTS

The authors disclose the use of language models; ChatGPT 3.5 and QuillBot for the purpose of translation, grammar check, and summary.

REFERENCES

Adams, J., Metwally, A. (2021), "Testing for the Marshall-Lerner condition in Egypt: An empirical analysis", *African Journal of Economic and Management Studies*, Vol. 12, No. 1, pp. 151-170. https://doi.org/10.1108/AJEMS-01-2020-0001

Ahmed, S. (2009), "Are Chinese exports sensitive to changes in the exchange rate?", *International Finance Discussion Papers*, No. 987, Board of Governors of the Federal Reserve System, December, https://www.federalreserve.gov/pubs/ifdp/2009/987/ifdp987.pdf (accessed 20 March 2019).

Ahmed, S., Appendino, M., Ruta, M. (2017), "Global value chains and the exchange rate elasticity of exports", *B.E. Journal of Macroeconomics*, Vol. 17, No. 1, pp. 1-24. https://doi.org/10.1515/bejm-2015-0130

Aly, H., Hosni, R. (2018), "Examining the nexus between exchange rate volatility and export performance: Empirical evidence from the Egyptian experience", *Business and Economic Horizons*, Vol. 14, No. 3, pp. 542-560. https://doi.org/10.15208/beh.2018.39

Al-Shawarby, S. (2000), "Estimating the impact of the Egyptian exchange rate on exports", in Nassar, H., Aziz A. (Ed.), *Egyptian exports and challenges of the 21st century*, Proceedings of the Conference organized by Center for Economic and Financial Research and Studies (CEFRS), Cairo University, in Cooperation with Konrad Adenauer Stiftung, Development Economic Policy Reform Analysis Project (DEPRA) & Egyptian Exporters' Association (EXPO LINK), pp. 76-138.

Anukoonwattaka, W. (2016), "Global value chains and competitiveness of the integrated regions", in Jetin, B., Mikic, M. (Ed.), *ASEAN economic community: A model for Asia-wide regional integration?*, Palgrave Macmillan, New York, pp. 127-151.

Arndt, S.W. (2004), "Global production networks and regional integration", in Plummer M. (Ed.), *Empirical methods in international trade: Essays in honor of Mordechi Kreinin*, Edward Elgar, pp. 129-143.

Bahmani-Oskooee, M., Gelan, A. (2018), "Exchange-rate volatility and international trade performance: Evidence from 12 African countries", *Economic Analysis and Policy*, Vol. 58, pp. 14-21. https://doi.org/10.1016/j.eap.2017.12.005

Bang, H., Park, M. (2018), "Global value chain and its impact on the linkage between exchange rate and export: Case of China, Japan and Korea", *The World Economy*, Vol. 41, pp. 2552-2576. https://doi.org/10.1111/twec.12595 , https://bba.bloomberg.net/ (accessed 16 January 2021).

Bonham, C., Gangnes, B., Assche, A.V. (2004), "Fragmentation and East Asia's information technology trade", *Economics Working Paper*, No. 04-9, University of Hawaii, October, https://www.economics.hawaii.edu/research/workingpapers/WP_04-9.pdf (accessed 23 April 2019).

Boranova, V., Huidrom, R., Ozturk E., Stepanyan, A., Topalova, P., Zhang, S. (2022), "Cars in Europe: Supply chains and spillovers during COVID-19 Times", *IMF Working Paper*, No. WP/22/6, International Monetary Fund, January, available at: https://www.imf.org/en/Publications/WP/Issues/2022/01/14/Cars-in-Europe-Supply-Chains-and-Spillovers-during-COVID-19-Times-511743 (accessed 23 December 2022).

Central Agency for Public Mobilization & Statistics, *Annual Industrial Production Statistics Online Database*, https://bba.bloomberg.net/http://www.msrintranet.capmas.gov.eg/database.aspx?parentid=354&free=11 (accessed 10 January, 2021).

Central Agency for Public Mobilization & Statistics, *External Trade Statistics Online Database*, https://bba.bloomberg.net/http://www.msrintranet.capmas.gov.eg/database.aspx?parentid=2375&free=11 (accessed 10 January, 2021).

Central Agency for Public Mobilization & Statistics, *Monthly Bulletin of Producer Price Index* (different issues).

Cheng, K.C., Hong, G., Seneviratne, D., Elkan, R. (2016), "Rethinking the exchange rate impact on trade in a world with global value chains", *International Economic Journal*, Vol. 30, No. 2, pp. 204-216. http://dx.doi.org/10.1080/10168737.2016.1148418

Egyptian Ministry of Trade & industry (2016), "Industry and Trade Development Strategy (2016-2020)", https://andp.unescwa.org/sites/default/files/2021-05/Industry%20and%20Trade%20Development%20Strategy%202016%20%202020.pdf (accessed 22 March 2020) (in Arabic).

Egyptian Council of Ministers (2023), "Automotive Industrial Development Program (AIDP)" (in Arabic).

El Ebiary, H. (2009), *Estimating the price elasticity of Egyptian non-fuel exports (1975-2006)* [Unpublished Master's Thesis], Faculty of Economics & Political Science, Cairo University (in Arabic)

Federal Competitiveness & Statistics Center, UAE, *Statistics*, https://fcsc.gov.ae/en-us (accessed 17 January 2021).

Gereffi, G., Fernandez-Stark, K. (2011), *Global value chain analysis: A primer* (1st ed.), Center on Globalization, Governance and Competitiveness, Duke University. https://gvcc.duke.edu/wp-content/uploads/2011-05 31_GVC_analysis_a_primer.pdf (accessed 22 March 2020).

Georgiadis, G., Gräb, J., Khalil, M. (2020), "Global value chain participation and exchange rate pass-through", *Discussion Paper*, No. 67/2020, Deutsche Bundesbank, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3767294 (accessed 2 July 2021).

Guedidi, I., Baghdadi, L. (2023), "Global value chain participation and real effective exchange rates: Insights from Tunisia", *Working Paper*, World Trade Organization (WTO) Chairs Program, February, https://wtochairs.org/sites/default/files/Global-Value-Chain-Participation-and-Real-Effective-Exchange-Rates-Insights-from-Tunisia.pdf (accessed 4 August 2023).

Hooy, C.-W., Baharumshah, A.Z., Brooks, R.D. (2016), "The effect of exchange rate volatility on the nexus of technology sophistication and trade fragmentation of ASEAN5 exports to China", *Journal of Asia-Pacific Business*, Vol. 17, No. 3, pp. 206-228. http://dx.doi.org/10.1080/10599231.2016.1203717

Information & Decision Support Center (2023), "Stimulating the automobile industry in Egypt", *Public Policy Observatory*, Year 2, No. 5, Egyptian Council of Ministers, December, https://idsc.gov.eg/upload/DocumentLibrary/AttachmentA/8940/Stimulating%20the%20automotive%20industry.pdf (accessed 22 January 2024). (in Arabic)

International Monetary Fund, *International Financial Statistics Online Database*, available at: https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b (accessed 19 January 2021).

International Trade Center (ITC), *Trade Map Online Database*, available at: https://www.trademap.org (accessed 14 January 2021).

Ke, Y.-X. (2022), "Impact of real effective exchange rate of RMB on China's value adding in global value chains", *International Journal of Business Studies & Innovation*, Vol. 2, No. 4, pp. 31-46. https://doi.org/10.35745/ijbsi2022v02.04.0004

National Institute of Statistics of Cameroon, *Open Data*, https://nso.cameroon.opendataforafrica.org (10 January 2021).

Organization for Economic Co-operation & Development (OECD), *Online Database*, https://stats.oecd.org/ (accessed 12 January 2021).

Oktaviani, D., Shrestha, N. (2021), “Exchange rates elasticity of exports in ASEAN: The role of global value chains”, *Buletin Ilmiah Litbang Perdagangan*, Vol. 15, No. 1, pp. 1-26. https://doi.org/10.30908/bilp.v15i1ddd.538

Patel, N., Wang, Z., Wei, S.-J. (2014), “Global value chains and effective exchange rates at the country sector level”, *NBER Working Paper Series*, No. 20236, National Bureau of Economic Research, June, available at: https://www.nber.org/system/files/working_papers/w20236/w20236.pdf (accessed 11 May 2019).

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), “Bounds testing approaches to the analysis of level relationships”, *Journal of Applied Econometrics*, Vol. 16, No. 3, pp. 289–326. https://doi.org/10.1002/jae.616

Ponte, S., Gibbon, P. (2005), “Quality standards, conventions and the governance of global value chains”, *Economy and Society*, Vol. 34, No. 1, pp. 1-31. https://doi.org/10.1080/0308514042000329315

Saygili, H., Saygili, M. (2011), “Structural changes in exports of an emerging economy: Case of Turkey”, *Structural Change & Economic Dynamics*, Vol. 22, pp. 342-360. https://doi.org/10.1016/j.strueco.2011.08.001

Shokry, N., Abdelraouf, N., El-Shawarby, Y. (2020), “Currency depreciation and the intensive margin of export trade: Firm and product level evidence from Egypt”, *ECES Working Paper*, No. ECES-WP210-E, Egyptian Center for Economic Studies, June, https://eces.org.eg/en/currency-depreciation-and-the-intensive-margin-of-export-trade-firm-and-product-level-evidence-from-egypt/ (accessed 25 May 2021).

Tan, K.G., Duong, L.T., Chuah, H.Y. (2019), “Impact of exchange rates on ASEAN's trade in the era of global value chains: An empirical assessment”, *The Journal of International Trade and Economic Development*, Vol. 28, No. 7, pp. 873-901. https://doi.org/10.1080/09638199.2019.1607532

Thorbecke, W., Smith, G. (2010), “How would an appreciation of the RMB and other East Asian currencies affect China's exports”, *Review of International Economics*, Vol. 18, No. 1, pp. 95-108. https://doi.org/10.1111/j.1467-9396.2008.00799.x

Thorbecke, W. (2016), “Understanding the flow of electronic parts and components in East Asia”, *RIETI Discussion Paper Series*, No. 16-E-072, The Research Institute of Economy, Trade and Industry, June, available at: https://www.rieti.go.jp/jp/publications/dp/16e072.pdf (accessed 26 July 2019).

United Nations Conference on Trade & Development (UNCTAD), *Online Data Center*, available at: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en (accessed 12 January 2021).

Vesilind, A., Ehrlich, L. (2001), “Determinants of Estonian export of goods: An econometric analysis and comparison with Latvia and Lithuania”, *Bank of Estonia Working Papers*, No. 2001-1, Estonian Bank, January, https://ideas.repec.org/p/eea/boewps/wp2001-01.html (accessed 10 May 2019).

Yamashita, N. (2011), “The currency of the people’s republic of China and production fragmentation”, *ADBI Working Papers Series*, No. 327, Asian Development Bank Institute, November, https://www.adb.org/sites/default/files/publication/156182/adbi-wp327.pdf (accessed 11 May 2019).

Zaki, C., Ehab, M., Abdallah, A. (2019), “How do trade margins respond to exchange rates? The case of Egypt”, *Journal of African Tarde*, Vol. 6, No. 1, pp. 60-80. https://doi.org/10.2991/jat.k.190528.001