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Using Machine Learning Algorithms and the ARIMA Model to Predict and Recognize the Determinants of External Debts to Egypt

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ABSTRACT

This study aims to identify the main determinants of external debt in general and in Egypt in particular, as well as predict the volume of this debt in the future. This study is one of the first studies that used Machine Learning Algorithms to know the determinants of the external debt of the Egyptian economy during the period from 1970 to 2019 and to predict the volume of these debts to the Egyptian economy using the ARIMA Model during the period from 2020 to 2030. The study showed that the most important determinants that lead to an increase or decrease in the volume of external debt in countries in general are gross domestic product, current balance deficit, trade openness, foreign direct investment, gross fixed capital formation, government expenditure, foreign reserves, inflation rate, and exchange. As for the Egyptian economy, the study found that the main determinant behind the increase in the Egyptian external debt is gross fixed capital formation, followed by the inflation rate, then government expenditure, and finally the current balance deficit. As for the rest of the determinants, such as foreign reserves, exchange rate, gross domestic product, trade openness, etc., they have no insignificant influence on the decision taken by the government to borrow from foreigners.

INTRODUCTION

Over the past four decades, the external debt of many developing countries has increased dramatically due to the chronic deficit in the balance of payments, specifically in the current balance, the growing savings and investment gap, dependence on raw materials in export and the interest rate system, and the increase in debt service, especially short-term, in addition to financial imbalances. (Beyene and Kotosz, 2020a). These increasing external debt pressures and large debt service payments are an ongoing

problem for the Whole world, but an even greater challenge for developing countries (Duodu and Baidoo 2020a; Baidoo et al. 2021).

Several studies (Udoh and Rafik 2017; Chiminya etal., 2018; Odhiambo, 2018; Adamu, 2019; Brafu-Insaidoo etal. 2019; Fatukasi etal., 2020; Iqbal etal.,2022; Dilanchiev etal., 2023; Osei etal., 2023) looked for common determinants of external debt, and these studies concluded that the most important of these determinants are economic growth, imports, population, foreign exchange reserves, total debt service, poverty, income instability, currency depreciation, balance of payments deficit, exchange rate, trade openness, terms of trade, inflation, interest rate, savings rate. and financial development. According to (Beyene and Kotosz, 2020), government spending is one of the main factors that increase external debt as a result of financing the public budget deficit, which forces governments to borrow. What is more, the study of (Harold, 2019) showed that these factors Political stability represented in democracy, political stability, control of corruption, and the quality of laws are among the main determinants of external debt. (Azolibe, 2020) indicates that corruption, foreign aid, government spending, foreign exchange reserves, population growth, economic growth, and the unemployment rate are determinants. External debt: Some current studies also indicate that economic growth is the main determinant of external debt, as the slow growth of the economy imposes upward pressure on external debt (Murwirapachena and Kapingura, 2015; Globan and Matosec 2016).

As for the Egyptian economy, we find that external debt is an essential source for providing foreign currency and achieving stability in the national economy by controlling speculation that foreign currency may be exposed to, providing strategic commodities and then achieving stability in prices, as well as providing the necessary financing for the comprehensive and sustainable development process that It was adopted by the Egyptian government in accordance with Vision 2030. From here, we find that Egypt is one of the developing countries that has suffered and is still suffering from the problem of external debt throughout its modern history. The Egyptian external debt witnessed a clear increase during the period (1980-2021), as shown in Figure No. From about 19.13 billion dollars in 1980 to about 41.74 billion dollars in 2014, then there was a steady increase in it, reaching about 143 billion dollars in 2021, meaning that it increased by three times over the last eight years, which is a burden on the Egyptian economy. In general, the period that followed the 2011 revolution was one of the most important periods that witnessed a clear increase in the Egyptian foreign debt, as Egypt's request for loans during that period coincided with the political turmoil in Egypt, the decrease in the volume of foreign investments, as well as the decrease in the volume of remittances of Egyptians abroad, and what the sector witnessed. Egyptian tourism is declining, making it the fastest growing country in the region in terms of external debt, and these accumulated debts will not have a positive impact on the economic situation in Egypt unless it is translated into meaningful economic growth.

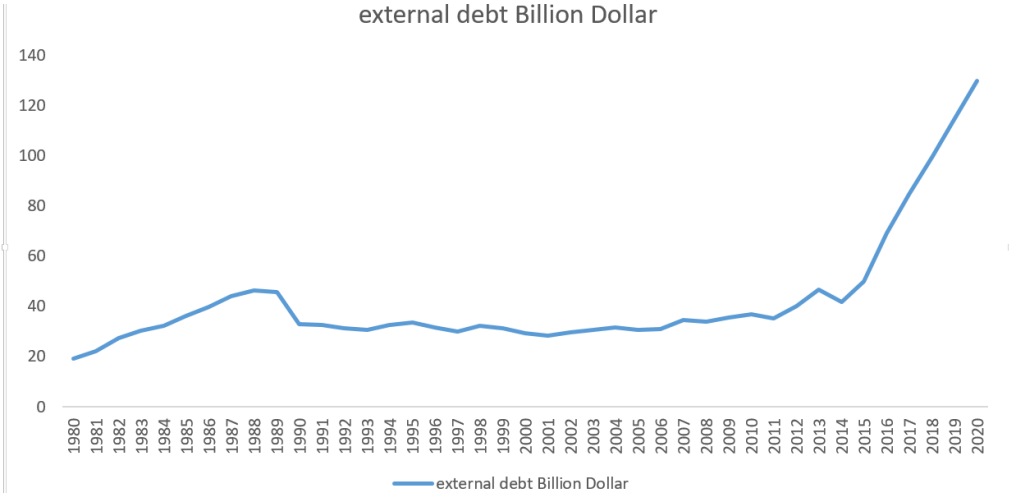

Figure 1. The Egypt's external debt during the period from1980 until 2020

Source: World bank data base

This study is characterized as being one of the first studies that applied machine learning methods in economics. Where this study seeks to try to identify the main determinants of external debt in Egypt using machine learning on the one hand and to predict the size of external debt in the future using the ARIMA model on the other hand. To achieve this purpose, the study was divided into Three main sections. The first section deals with the introduction and theoretical study. The second section covers data and methodology. The third section deals with the results and discussion, and the last section deals with the conclusion.

1. LITERATURE REVIEW

According to the literature, there are various studies explored the determinants of external debt over the past years. (Udoh and Rafik, 2017) examined the determinants of Malaysia's external debt during the period from 1970 to 2013. The results found that Gross Domestic Product (GDP) impacts external debt. When GDP rises, capital spending rises first, next by external debt. It is also noticeable that the Malaysian government relies on the gross domestic product to repay the external debt. Additionally, numerous studies such as (Gokmenoglu and Rafik, 2018; Beyene and Kotosz, 2020) found that Economic growth has a negative and significant impact on external debt. Hence, governments rely on economic growth to make foreign debt payments. In addition, (Reinhart and Rogoff, 2010) indicated that economies with a debt-to-GDP ratio of more than 90% suffer from a weak GDP growth rate. On the contrary, (Brafu-Insaidoo etal., 2019) found that economic growth affected external debt in Ghana positively. Where the increase in economic growth leads to an increase in short-term external debt as a result of the increase in total spending and high imports, which increases the demand for foreign exchange, which may lead to an increase in short-run borrowing to finance those imports.

Many studies show that trade openness is a determinant of external debt and has a positive impact on it, (Mahara and Dhakal, 2020; Dawood etal., 2021). This is since imports are more important than exports in the measure of trade openness, and therefore the increase in imports increases the external debt. Also, the countries with high rates of trade openness borrow and lend among themselves, making borrowing and lending easier (BÖLÜKBAŞ, 2016). On the other hand, (Falade, 2020) investigated the determinant of external debt in Nigeria spanning from 1981 to 2018. The empirical results found that trade openness affects external debt in Nigeria inversely. the economic benefits of trade openness represent Increased technology transfer, skills transfer, total factor productivity, and economic growth. In the same context, (Ogeh et al., 2019) examined Macro-determinants of short-run external debt in Ghana from 1970 to 2012. The results demonstrated that increased trade openness leads to reducing the short-run external debt stock in Ghana. Trade openness is likely to improve the government's ability to its short-term foreign debt repayment obligations.

Numerous pieces of literature indicate that the inflation rate is a determinant of external debt and affect positively, such as (Waheed, 2017; Beyene and Kotosz, 2020). the empirical results indicated that inflation has a significant and positive impact on external debt. where the increase in inflation rates reduces exports and thus increases the trade balance deficit and decreases foreign exchange earnings. In addition, inflation leads to a decline in the value of the local currency, which increases the nominal value of the external debt denominated in the local currency. Inflation also reduces the real value of public revenues, which contributes to the increase in the public budget deficit, which ultimately leads to an increase in external borrowing (KIZILGÖL and Evren, 2014). In contrast, other studies such as (Omrane and Omrane, 2017; Beyene and Kotosz, 2020; Sağdiç and Yildiz, 2020) found that inflation affected external debt negatively. The explanation for this might be that inflation has decreased investment, thus shrinking the savings-investment gap. additionally, Countries with high inflation rates have a greater difficulty borrowing on generous terms. In the same context, (Aizenman and Marion, 2011) found that inflation reduces the debt value.

In the same context, many applied studies have indicated the exchange rate variable as a determinant of the external debt (Gokmenoglu and Rafik, 2018; Wahyuni etal., 2019; Omarand Ibrahim, 2021). Those researchers found that the exchange rate has a positive impact on external debt. Accordingly, the currency exchange rate has a crucial role in raising the level of external debt. A higher exchange rate indicates that

the local currency is less in comparison to other currencies. A weak currency indicates weakness in the local economy, which may need more external borrowing. and a depreciation of the domestic currency increases the amount of external debt.

Prior studies on the impact of foreign currency reserves on external debt have been studied through various econometric methods and different periods, concentrating on developed and developing economies, For instance (Qian and Steiner, 2017; Wahyuni etal., 2019; Azolibe, 2021) The findings that foreign currency reserves positively link with foreign government debt. Foreign Reserves are a form of insurance that decreases the default risk for creditors by lowering the probability of default. therefore, Higher Foreign reserves may decrease foreign debt costs by reducing the risk level of the loan agreement. Foreign Reserves appear to be beneficial to financial stability. On the other hand, some empirical studies found that foreign currency reserves impact external debt negatively such as (KIZILGÖL and Evren, 2014; Murwirapachena and Kapingura, 2015). Because large foreign currency reserves cause reduced demand for external borrowing.

Many empirical studies found the negative impact of foreign direct investment on External debt (BEYENE and KOTOSZ, 2020). As a result of foreign capital inflows in the country, finance increases, thus reducing the recourse to external borrowing. Conversely, external debt has a significant negative impact on foreign direct investment. Also, it damaged foreign investors' vision and produced pessimistic expectations about the future economy, all of which resulted in a reduction in investment in the economy (Ostadi and Ashja, 2014).

Nemours empirical research indicated that Government Spending is the main determinant of foreign debt such as (Gokmenoglu and Rafik, 2018; Sağdiç and Yildiz, 2020; Azolibe, 2021; Dawood et al., 2021). As a result, recurrent and capital expenditure cause higher external debt. Thus, high levels of foreign debt are because of an increase in government spending on infrastructure, especially in developing countries. Additionally, Government spending is one of the main drivers of foreign debt growth, as raised budget deficits push governments to borrow.

Another important factor that influences economies' external debt is gross fixed capital formation, which supports domestic investment. Where much of the empirical literature confirmed that. (Omrane and Omrane, 2017; Dawood etal., 2021). in the same context, Murwirapachena and Kapingura, 2015) found that government spending on capital formation (government spending on infrastructure) is the main determinant of foreign debt stock in South Africa from 1980 to 2013.

Finally, the current balance deficit is an important indicator that affects foreign debt. numerous applied studies have confirmed this, such as (Waheed, 2017; Beyene and Kotosz, 2020). They pointed out that the current account balance has a positive effect on foreign debt, which means that countries with a current account surplus do not need to borrow from other countries.

2. DATA AND METHODOLOGY

2.1 Data and variables

Table 1 shows the variables used in the model, where external debt is used as a dependent variable and expressed as a percentage of the gross national income. As for the rest of the variables in the table, they express the independent variables. The data for these variables was obtained from UNCTAD data base and world bank data base.

Table 1. Variables of the model

Variables	*Symbol*	*Indicator*
External debt	ED	External debt stocks (% of GNI)
Gross Domestic Product	GDP	GDP growth (annual %)
current balance deficit	CD	External balance on goods and services (% of GDP)
Trade openness	TP	Trade (% of GDP)
Foreign direct investment	FDI	net inflows (% of GDP)
Gross fixed capital formation	GFC	Gross fixed capital formation (% of GDP)
Government expenditure	GE	general government final consumption expenditure (% of GDP)
Foreign reserves	FR	Total reserves minus gold (current US$)
Inflation rate	INF	consumer prices (annual %)
exchange rate	ER	Official exchange rate (LCU per US$, period average)

Source: author

Random forest, (SVM), logistic regression, naive Bayes (KNN), and gradient boosting models are used in this study. All of the models use supervised machine learning models, which evaluate data using training data before creating a data prediction function.

In two stages, the model will be used. The first step will be determine which of the six models listed above is the most accurate at forecasting external debt for the Egyptian economy. The period covered by this stage starts from 1970 to 2019. In the second stage, the ARIMA model will be used to forecast the size of the external debt in the future For the period from 2020 to 2030.

The machine learning algorithms utilized in this study were written in Python language using the Scikit-Learn package.

2.2 Models

2.2.1 Random Forest

The fundamental random forest model is written as follows: (Tiffin, 2016):

$$F_0(x) = \frac{1}{n}\sum_{i=1}^{n} (y_i - \gamma)^2 \quad (1)$$

where γ indicates the expected value, and y_i indicates to the observed value.

2.2.2 Support Vector Machine (SVM)

The SVM regression model was proposed by Vapnik as a non-parametric approach (1995). The SVM linear function is shown in the following equation (Awad and Khanna, 2015):

$$f(x) = (w, x\rangle + b \quad (2)$$

where

$$\langle \mathbf{w}, \mathbf{x} \rangle = \sum_{j=1}^{q} w_j x_j$$

W indicates to weight vector, x is the input or feature vector, and b denotes the bias. Depending on its sign, this function $f(x)$ divides the data space into two half-spaces. The SVM's learning job is to determine the optimal parameter values for w and that distinguish both classes and allow for accurate pattern classification; it is also referred to as a linear classifier (Kramer, 2013).

$$f_{\mathrm{LIN}}(\mathbf{x}') = \begin{cases} +1, & \text{if } f(\mathbf{x}') \geq 0 \\ -1, & \text{if } f(\mathbf{x}') < 0 \end{cases}$$

The optimal linear decision hyperplane has a large distance to its closest patterns. This distance, which can be written as $1/\| \mathrm{w} \|^2$, is called margin. The hard margin SVM defines a linear decision hyper plane that correctly classifies all patterns (Kramer, 2013). The optimization problem is defined as

$$\begin{aligned} &\text{minimize}_{\mathbf{w},b} \ \frac{1}{2} \| \mathbf{w} \|^2 \\ &\text{subject to } y_i(\langle \mathbf{w}, \mathbf{x}_i \rangle + b) \geq 1 \\ &\text{for } i = 1, \ldots, N. \end{aligned}$$

So to keep the function as flat as feasible, i.e., a small WW. Minimizing the usual, i.e., w2, is one technique to do this (Richardson etal., 2018). Defined the function as a convex optimization problem (Richardson et al., 2018):

$$0.5 \| \mathrm{w} \|^2 + \mathrm{C} \sum_{\mathrm{i}=1}^{\mathrm{l}} \left| \left(\mathrm{y_l} - \mathrm{f}(\mathrm{x_l}) \right) \right|_{\epsilon} \quad (3)$$

2.2.3 Logistic Regression

The following equation is used in the Probit or Logit model (Sperandei, 2014; Rajkumar,2017):

$$\mathrm{Pr}_{(y=1)} = 1\text{-}\mathrm{F}\ (\text{-}X'\beta) \quad (4)$$

$$\mathrm{Pr}_{(y=0)} = \mathrm{F}\ (\text{-}X'\beta)$$

where F takes values between 0 and 1. As for β, it is an array of parameters and takes a vector as follows:

where F takes values ranging between 0 and 1. β, is an matrix of parameters and takes a vector as follows:

$$\beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{bmatrix}$$

The parameters of the function are estimated through the maximum likelihood method as follows (Weiand Fei, 2010; Dawood, 2016):

$$\log_{\mathbf{e}} \mathrm{L}(\boldsymbol{\beta}) = \sum_{\mathbf{i}=1}^{\mathbf{n}} \mathrm{Y_i} (\mathbf{X_i'}\boldsymbol{\beta}) - \sum_{\mathbf{i}=1}^{\mathbf{n}} \log_{\mathbf{e}} [1 + \exp(\mathbf{X_i'}\boldsymbol{\beta})] \quad (5)$$

In addition to the above, the X′β function has one of two forms:

$$(Pr_{Y=1}) = \wedge (X'\beta) = \frac{e^{x\beta}}{1 + e^{x\beta}} \quad (\mathrm{A})$$

$$(Pr_{Y=1}) = \ \phi(X'\beta) = \int_{-\infty}^{x\beta} \emptyset(z) \ \mathrm{dz} \quad (\mathrm{B})$$

The difference between the two forms is that the first is a logit fixed model which ∧ (X′β) follows a logit-distributed clustering function (CDF) with logit distribution. In the second form, the probit model has ϕ(X′β) that follows a cluster distribution function (CDF) with a normal distribution.

2.2.4 Naïve Bayes

The formula for the Bayes Theorem is given by (Nugraha,2019):

$$P(\Phi \mid X) = \frac{P(X|\Phi)\cdot P(\Phi)}{P(X)}, \quad (6)$$

X refers to Unknown class information, Φ refers to hypothesis (X) as a specific class, $P(\Phi \mid X)$ refers to the probability of the (Φ) hypothesis refers to (X), $P(X \mid \Phi)$ refer to Probability (X) in the hypothesis (Φ), $P(\Phi)$ refer to Probability of the hypothesis (Φ), and $P(X)$ refers to Probability (X).

2.2.5 K-nearest neighbors

Let $\{(x_1, y_1), \ldots, (x_N, y_N)\}$ be the set of observations of q-dimensional patterns $\mathcal{X} = \{x\}_{i=1}^{N} \subset \mathbb{R}^q$ and a corresponding set of labels $\mathcal{Y} = \{y_i\}_{i=1}^{N} \subset \mathbb{R}^d$. The goal of K-nearest neighbors is to learn a functional model f that allows a reasonable prediction of class label y' for an unknown pattern x'. Unlabeled patterns should be allocated to the labels of patterns with known assignments that are comparable (Kang, 2021; Zhang, 2016; Kramer, 2013).

K-nearest neigh bours (KNN), is based on the idea that the patterns closest to a target pattern x' for which we are looking for a label provide valuable label information. KNN labels the majority of the K-nearest patterns in data space with a class label. To do this, we must be able to define a measure of similarity in data space. In $\mathbb{R}^q$, it is reasonable to employ the Minkowski metric (p-norm) (Kramer, 2013):

$$\|\mathbf{x}' - \mathbf{x}_j\|^p = \left(\sum_{i=1}^{q} \left| (x_i)' - (x_i)_j \right|^p \right)^{1/p},$$

which corresponds to the Euclidean distance for $p = 2$. In other data spaces, adequate distance functions have to be chosen, e.g., the Hamming distance in $\mathbb{B}^q$. In the case of binary classification, the label set $\mathcal{Y} = \{1, -1\}$ is employed, and KNN is defined as (Kramer, 2013):

$$f_{KNN}(x') = \begin{cases} 1 & \text{if } \sum_{i \in \mathcal{N}_K(x')} y_i \geq 0 \\ -1 & \text{if } \sum_{i \in \mathcal{N}_K(x')} y_i < 0 \end{cases}$$

with neighborhood size K and with the set of indices $\mathcal{N}_K(x')$ of the K-nearest patterns (Kramer, 2013).

KNN can also be applied to multi-class classification problems. For an unknown pattern x', KNN for multi-class classification predicts the class label of the majority of the K-nearest patterns in data space (Kramer, 2013):

$$f_{KNN}(\mathbf{x}') = \arg \max_{y \in \mathcal{Y}} \sum_{i \in \mathcal{N}_K(\mathbf{x}')} \mathcal{I}(y_i = y)$$

with indicator function $\mathcal{I}(\cdot)$ that returns one, if its argument is true I and zero otherwise Kramer, 2013).

2.2.6 Gradient Boosting (Gb model)

Gradient enhancement is a way of producing an advanced preview from a range of models of low quality. In most situations, these approaches start with applying a loss function to an initial model in the target variable. At a high level, we're iterating through the stages below (Richardson etal., 2018):

$$F_m(x) = F_{m-1}(x) + v\Delta_m(x), \quad (7)$$

In Fm(x), when the new mapping x shows the target, Fm−1(x) specifies the preceding model. The term Δm(x) signifies the low learner, and v represents the reduction parameter.

3.EMPIRICAL RESULTS AND DISCUSSION:

In this section, I will describe the main results of our analysis and determine the accuracy of our model.

Table 2. Machine Learning algorithms performance (data from 1990-2019)

Model	*AUC*	*CA*	*F1*	*Precission*	*Recall*
gradient boosting (GB)	0.854	0.72	0.721	0.723	0.72
KNN (k- nearest neighbors)	0.821	0.68	0.669	0.679	0.68
lodistic regression	0.812	0.7	0.695	0.693	0.7
naïve bayes	0.828	0.64	0.642	0.65	0.64
neural network	0.852	0.66	0.633	0.666	0.66
random forest	0.828	0.66	0.662	0.665	0.66
SVM (support vector machine)	0.816	0.62	0.625	0.664	0.62

Source: python results by author.

As seen in table No. (2), The Gradient Boosting model is the most accurate, with an accuracy rate of 85.4 percent, followed by a neural network at 85.2 percent. Random forest, Nave Bayes, at 82.8 percent. Despite the model's near-perfect accuracy, I'll rely on gradient boosting for G.D.P prediction.

Table 3. Gradient boosting prediction for actual external debts value

Year	*External debts (actual value) (as percentage of GNI)*	*Gradient boosting prediction value (as percentage of GNI[1])*
1970	22.582	22.8502
1971	24.00535	23.6167
1972	21.15058	21.2551
1973	19.96703	19.9532
1974	24.25357	24.2203
1975	42.45989	42.7401
1976	49.00067	49.0376
1977	83.95617	83.3714
1978	90.87635	90.9823
1979	87.93194	88.0311
1980	94.65882	94.6386
1981	107.849	107.666
1982	105.6142	105.441
1983	103.8676	103.932
1984	100.8752	101.334
1985	100.9928	101.312
1986	106.545	106.486
1987	110.5619	110.347
1988	132.7187	132.52
1989	116.3821	116.278
1990	78.84577	79.2681
1991	86.64197	86.4006
1992	74.08965	73.8456
1993	65.49239	65.4358
1994	62.36213	62.2645
1995	55.34388	55.6234
1996	46.29687	46.4276
1997	37.94021	37.908

[1] Gross National Income

Year	External debts (actual value) (as percentage of GNI)	Gradient boosting prediction value (as percentage of GNI[1])
1998	37.75137	37.4152
1999	34.11638	33.8033
2000	29.14367	29.2329
2001	28.98199	29.0826
2002	34.80889	34.6816
2003	37.99841	37.813
2004	39.96561	39.6531
2005	34.22134	34.3279
2006	28.73847	29.0086
2007	26.28473	25.901
2008	20.65543	20.8994
2009	18.69919	18.8023
2010	17.13506	17.5466
2011	15.2975	15.5586
2012	14.68185	15.273
2013	16.54697	16.2039
2014	13.99159	14.4483
2015	15.40047	15.4121
2016	21.0885	20.8273
2017	36.65019	36.7501
2018	41.15543	40.9532
2019	39.4012	39.1968

Source: python results by author

Table No. (3) shows that the predicted values using gradient boosting are almost close to the actual values of the Egyptian external debts, indicating the accuracy and high quality of the forecast.

Feature Importance an help you determine which explanatory variables have the most significant impact on the independent variables.

Table 4. Feature importance indicators

Independent variables	Importance (percentage%)
TP	0.1%
GFC	84%
INF	3.9%
CD	2.2%
FDI	0.72%
GDP	0.48%
G.E	3.3%
ER	1.9%
FR	3.4%

Source: python results by author

The table No. 4 shows that the main determinant of the size of external debts in Egypt is gross fixed capital formation. Where the results show that the importance of its impact amounted to about 84%, while the rest of the variables such as trade openness, foreign direct investment and other variables have little impact on the decision taken by the government to borrow form the foreigners. This is due to the fact that the main reason for this is the state's reliance on external debts to finance infrastructure projects, and this is supported by what has happened recently, that the Egyptian government followed a sustainable development strategy since 2014, according to which Egypt will enter the list of the top ten economies in the

world by 2030. The implementation of this strategy depends on the Egyptian state undertaking major infrastructure projects, which requires that it be financed in light of weak foreign exchange resources through external debts.

Table 5. Egypt external debts in the period (2020-2030) by using ARIMA Model

Year	*External debts forecasting*
2020	39.2
2021	39.7
2022	40.1
2023	40.6
2024	40.9
2025	41.3
2026	41.6
2027	41.9
2028	42.1
2029	42.4
2030	42.7

Source: python results by author

Table No. (5) shows the expected volume of external as percentage of GNI debts during the period from 2022 to 2030. The researcher used the ARIMA model to predict these debts.

Table 6. ARIMA Model performance

variables	*RMSE*	*MAE*	*MAPE*	R^2
External debts	0.258	0.213	0.13	0.79

Source: python results by author

The previous table shows the low value of a RMSE test, which means that the model is significant in predicting the size of Egypt's external debt in the future. The table also shows that R2 has a large value as it reached about 79%, which means that the variables mentioned in the model can be relied upon in determining the size of external debts.

CONCLUSION

For emerging economies to achieve sustained economic growth and development, external sources of financing have become essential. External financing sources are usually contracted to finance the capital expenditures that can generate long-term growth and development of debtor economies. Traditionally, sustainable economic growth and the development of economies around the world depends mainly on the rate of domestic savings, which stimulates the growth of domestic investment, as many studies have focused on analyzing the direct relationship between external debt and economic growth and attributed the negative relationship between variables to channels such as the cost of debt service, credit rationalization, debt accumulation, total factor productivity, and capital accumulation, among other factors. The only rationale behind the ever-increasing reliance on external sources of capital in the developing world is the wide gap between investment and saving, and the weak capacity to mobilize domestic savings in both the public and private sectors.

This study is one of the first to use Machine Learning Algorithms in economic research. Only very few studies have been done before. It is used because one of its features is that it arranges the independent variables according to the importance of their impact on the dependent variable, which is what the

researcher needs to explain the determinants of external debt in Egypt on the one hand, in addition to its ability to accurately predict the volume of external debt in the future on the other hand.

Hence, this study seeks to search for the main determinants of external debt in general and in Egypt in particular. The study showed that the most important determinants that lead to an increase or decrease in the volume of external debt are gross domestic product, current balance deficit, trade openness, foreign direct investment, gross fixed capital formation, government expenditure, foreign reserves, inflation rate and exchange rate. The study found that the main determinant behind the increase in the Egyptian external debt is gross fixed capital formation, as 84% of the reasons for the increase in the Egyptian external debt are due to this determinant.

From here, it can be said that the main determinants of external debt in Egypt are gross fixed capital formation, followed by the inflation rate, then government expenditure, and finally the current balance deficit. As for the rest of the determinants, such as foreign reserves, exchange rate, gross domestic product, trade openness, etc., they do not have a slight effect on the decision that is made The government borrows from foreigners.

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