External debt in time of inflation in Egypt: a vector error correction model

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Abstract:

Egypt's external debt has grown at a rapid pace. Meanwhile, higher indebtedness is related to rising inflation. Therefore, this study investigates the impact of Egypt's inflation on its external debt, as well as the interaction between these variables, notably the mutual impulse response. A “vector error correction model” (VECM) has been used to evaluate the variables of external debt stocks, final consumption expenditure, consumer price index, broad money, gross capital formation, and net trade in goods and services. Egypt's annual data has been used from 1976 to 2020. The results of the cointegration test using "Johansen's approach" show that cointegration occurs, confirming the adoption of the VECM technique. The major findings imply that inflation has a declining impact on external debt and a positive inflation shock initially reduces the external debt in the short and long term. Furthermore, the finding indicates a long-run equilibrium relationship between foreign debt and inflation, as well as bidirectional causality.

Keywords: External Debt, Inflation, Vector Error Correction Model, Final consumption expenditure, Gross capital formation, impulse response function.

Introduction:

To achieve their economic goals, emerging economies rely substantially on external debt, which is defined as "debt owing to a nonresident that involves future interest and principal payments; this obligation implies a future demand on the resident's economic resources" (IMF,2013). As a result, significant external loans and debt servicing costs accumulate. In many nations, especially noticeable in developing countries, inflation is a key economic concern that dominates policy deliberations, where governments frequently print money to pay deficits. Thus, Understanding and analyzing the relationship between inflation and external loans is critical in a world where emerging nations house the vast majority of the globe's population (Assibey-Yeboah & Mohsin, 2014). Inflationary pressures are perceived as a threat to the development of emerging economies. However, to fund budget deficits and sustain economic development, the majority of these countries have to borrow (Gathendu, 2021). Significant inflation may emerge as a result of the government's tremendous debt and deficits. (Reinhart, & Rogoff, 2010). Many developing economies, such as Egypt, have chosen to borrow to pay the expenditures necessary to meet their development drives. The fundamental concern with debt, particularly external debt, is that if it becomes unmanageable, it would cause significant currency rate changes, compel foreign money to fly, and stifle prospective foreign direct investment (Helmy, 2021). The government holds the vast bulk of the external debt, which is substantial in proportion to exports and tax receipts. Depreciation increases activity and hence government revenue modestly, but it drastically increases debt-service costs. The history of macroeconomic uncertainty exacerbates liquidity issues and increases the probability of default (Hemming, Kell & Schimmelpfenning, 2003). Debt tends to be connected to market interest rate reactions when governments reach their debt threshold limitations. As a result of substantially rising interest rates, severe budgetary adjustments such as tax increases and spending cuts, or, in extreme circumstances, real default, is required. The

fact that unexpectedly strong inflation may reduce the real cost of debt payment is one clear link in terms of inflation. The maturity structure of debt has a considerable impact on the efficiency of the inflation route. In general, the way debt accumulates can have a substantial impact (Reinhart, & Rogoff, 2010).

Consequently, in developing market countries, high debt levels are associated with higher inflation. The effect of debt on inflation may arise when government debt-financed expenditure enhances macroeconomic demand in the short term while rising inflation in the medium and long run. Furthermore, monetary easing may cause currency depreciation, higher import costs, and, ultimately, inflation. Moreover, forecasts for inflation topics may have an impact on contemporary price trends. In contrast, the effect of inflation on debt may be determined by seigniorage, which simplifies government debt financing. As a result, inflation has diminished the nominal value of the national debt (inflation tax). Rising prices reduce the real worth of nominal debt when the nominal value is discussed. Furthermore, an expansionary monetary policy boosts the economy in the short term, leading to increased government income and decreased government spending. As revenue collections rise, a progressive tax system is necessary (Nastansky & Strohe, 2015).

Ignoring the fact that economic theory presents evidence for the association between public debt and inflation, almost no research, has attempted to explore the effect of inflation on external debt in Egypt, except for a study by Helmy (2021) that investigates the effect of external debt on inflation, not the reverse effect. Alternatively, the current study uses an extended annual time series of Egyptian data from 1976 to 2020 to explore the two-way relationship between Egypt's external debt and inflation to investigate the effect of inflation on external debt and vice-versa, as well as other external debt factors such as final consumption expenditure, consumer price index, broad money, gross capital formation, and net trade in goods and services, to address this challenge and fill a

noteworthy gap in the literature. Furthermore, previous studies of external debt determinants used the gross domestic product as one of the external debt determinants without distinguishing between its main components that affect external debt, whereas this study separately measured the effect of final consumption and net trade on external debt. The following question will be empirically investigated. What is the impact of inflation on external debt? We analyze empirical evidence on the relationship between external debt and inflation. Furthermore, the two themes will be experimentally studied for Egypt using a cointegration paradigm. A vector error correcting model is thought to exist. The Johansen method is used to analyze and estimate the cointegration of the model's variables. The data is then subjected to generalized impulse response analysis and variance decomposition.

The remnants of the paper are arranged as follows: Second section examines the theory behind the debt and inflation relationship, and the third section provides a literature review. The fourth section provides a look at debt and inflation in Egypt. The fifth part discusses the data sources and processes that were used. The sixth section explains the paper's findings, and the final section is conclusions and policy recommendations.

Theoretical Review:

The literature on the relationship between public debt and inflation has a variety of perspectives. The most frequently held belief about inflation is that it is a monetary phenomenon driven by monetarists. Friedman advocated that an expansionary monetary policy will boost both real output and the general price level in the near term, but only the price level would grow in the long run (Aimola & Odhiambo, 2020). Therefore, the government should keep printing money to cover budget deficits and utilize budget surpluses to pay the debt. If the government changed its expenditure and tax rates to balance the budget at full employment, the resulting adjustments in the money supply would stabilize the economy (Cagan, 1991). According to Neoclassical theory, increasing public debt

enhances wealth while decreasing capital and this increase in wealth stimulates consumption while constraining investment. As a result, this will reduce capital accumulation and productivity growth (Phelps, 2022).

The Ricardian Equivalence Theorem states that the method of supporting any specific route of government expenditure is immaterial. The option of levying lump-sum taxes or expanding public debt does not affect consumer demand or capital development (Abel, 1991).

On the other hand, Keynes led to the establishment of a proactive intervention approach, which compelled the state to identify alternate sources of funding for government spending, with a concentration on deficit financing. The classical school's arguments for limiting the use of deficit financing are rejected by Keynesian theory (Zahariev, 2012). Deficit spending, according to the Keynesian school of thinking, stimulates output. Thus, macroeconomic public and private demand drive short-term cyclical development. Wages and prices in the economy are not entirely adjustable. Government spending can impact output by influencing aggregate demand (Nastansky & Strohe, 2015). According to crude Keynesianism, accumulating public debt is not a concern: the cost to the public of paying the more taxes required to pay the debt's interest is offset by the additional interest income obtained by retaining the debt (Phelps, 2022).

Various theoretical economic models have investigated how substantial budget deficits may cause inflation to rise in the medium to long term (Nastansky & Strohe, 2015). According to Sargent and Wallace (1981); the first to differentiate between monetary and fiscal dominance; a restrictive monetary policy can result in such a rapid increase in government debt, as a result, a higher base money growth rate in the future to pay off the burgeoning public debt. Monetary dominance arises when monetary authorities are primarily concerned with controlling inflation and fiscal authorities are primarily concerned with being solvent in the absence of external injection of seigniorage. Fiscal dominance, on the

other hand, occurs when monetary policy is limited by the requirement to ensure the government's solvency through adequate seigniorage provision (Jeanne & Wang, 2013). Seigniorage is defined as the government revenue derived from the generation of money (Haslag, 2020). In other words, while monetary policy manages inflation to reduce government debt, fiscal policy must preserve national debt stability by raising taxes or restraining government expenditure. The fiscal theory of the price level, on the other hand, believes that fiscal authorities' budgetary decisions have an impact on the price level. Fiscal policy determines the direction of budget surpluses and deficits, but monetary policy generates the seigniorage necessary to sustain national solvency and avoid default (Nastansky & Strohe, 2015). According to Leeper (1991), when monetary policy shocks induce sharp rises in interest rates, the decline in money stock equals the rise in debt outstanding, resulting in pure asset exchange. Higher interest rates, on the other hand, encourage clients to borrow rather than pay cash. This transaction has no effect on the total stock of government liabilities or the current price level. Massive debt payments will necessitate more tax revenues in the coming years, which direct taxes will not be able to provide. Instead, these resources are obtained through economic inflation and money creation. Sims (1994) concluded broadly that inflation in a monetary system is more of a fiscal concern than a monetary issue.

As noted, the exceptionally high level of public debt hampers macroeconomic policy. There are substantial doubts about governments' ability to change fiscal policy in managing and containing public debt. Concerns have been raised concerning the inflationary repercussions of budget deficits, as well as central banks' capacity to regulate inflation (Pekarski, 2015).

Empirical Evidence:

Government deficits were highly related to inflation in emerging economies. According to Sill (2005), monetary and fiscal policies are intimately connected since money expansion provides income to fund the government's deficit. The amount to which monetary authorities must adjust to changes in fiscal financing while planning and implementing policy goals influences whether deficits produce inflation. Developing countries frequently employ seigniorage income to address their fiscal budgetary demands. As a result, in these countries, there is a strong correlation between budget deficits and eventual inflation. Catao and Terrones (2005) conclude that the debt-inflation association is substantial across a wide range of emerging economies; employing panel approaches using 107 countries' data between 1960 and 2001.

The impact of inflation on external debt has been explored in inadequate studies. The study of Assibey-Yeboah & Mohsin (2014) which used an intertemporal optimal model, concluded that boosting the inflation rate decreases the stock of external debt. In the long run, it reduces consumption, employment, capital accumulation, and productivity. In the study by Mensah, Aboagye, Abor & Kyereboah-Coleman (2017), data from 24 African nations were collected and examined using a "panel vector autoregression estimation technique" from 1980 to 2010. The study revealed that changes in government investment expenditure, consumer spending, and national borrowings had a favorable effect on foreign debt growth rates. Over the medium term, shocks to tax income, inflation, and economic growth rates hurt external debt growth rates. Furthermore, the study concludes that Africa's external debt is most likely being used for consumption purposes rather than investment purposes.

In Egypt, there has been no research to evaluate if external debt is affected by inflation. The study of Helmy (2022) demonstrates the reverse impact of the effect of external debt on inflation and concludes that external debt worsens inflation in both the short and long run, using the

ARDL cointegration model on the monthly wholesale pricing index and inflation determinant variables.

Contradictory, various studies have discussed the effect of external debt on inflation. Karakaplan (2009) used the GMM approach to a panel data collection of 121 nations from 1960 to 2004 which concluded that external debt is more inflationary in countries with developing financial markets. The correlation between external debt and inflation in Kenya was assessed by Okech, Mweni& Njuguna, (2016) using ordinary least square regression from 1972 to 2012, revealing that foreign debt and inflation are adversely connected. According to Arisa (2020), a change in the external debt of one standard deviation has a negative influence on inflation using the SVAR technique in Kenya on data from 1993 through 2018. Gathendu (2021) employed the VECM in Kenya, Uganda, and Tanzania from 1988 until 2018. According to the research, external debt has a positive long-term effect on inflation, and there is a unidirectional link between external debt and inflation. El Aboudi & Khanchaoui (2021) explored that low inflation makes debt repayment harder using the ARDL model from 1985 through 2019 in Morocco.

Inadequate studies have investigated the effect of public debt on inflation as Dumitrescu et al., (2022) examined the nonlinear impact of government debt on inflation in 22 emerging nations and get to the conclusion that an increase in government debt appears to stimulate inflation when the shadow economy reaches a critical mass. Sunder-Plassmann (2020) concluded that inflation boosts seigniorage income while decreasing the total debt load. The calibrated model was used to investigate how debt portfolio structure affects debt levels, inflation, and default rates. Only nominal foreign debt influences inflation and domestic debt ownership is the primary driver of debt growth since default incentives are smaller internally.

Regarding the determinants of external debt, several common determinants have been identified in the literature. According to Abdullahi, Bakar, & Hassan (2015), Nigeria's external debt is determined by saving, interest rate, budget deficit, and exchange rate in both the short and long-term using the ARDL approach. According to Abdullahi, Bakar, & Hassan (2016), external debt has had a detrimental way of stimulating capital formation growth, which is one of the most significant macroeconomic components for long-term economic growth. According to Bittencourt (2015), the panel study indicates that inflation, trade openness, and money supply significantly affect the external debt in South America. Other studies used the ARDL analysis as Al-Fawwaz, (2016) shows that trade openness has a significant positive influence on Jordan's external debt in the long term, whereas GDP per capita has a significant negative effect on external debt. Moreover, the finding of Awan, Anjum, & Rahim (2015) in Pakistan conclude that trade openness, budget deficit, and exchange rate are significant drivers of foreign debt. According to Omrane Belguith & Omrane (2017), inflation and capital formation reduce public debt, while real interest rates, trade openness, and budget deficit are the major drivers of Tunisia's public debt increase using the VECM methodology. The study by Murwirapachena & Kapingura (2015) revealed that South Africa's external debt, according to the VECM approach, is mostly the outcome of poor economic growth and high levels of government infrastructure spending.

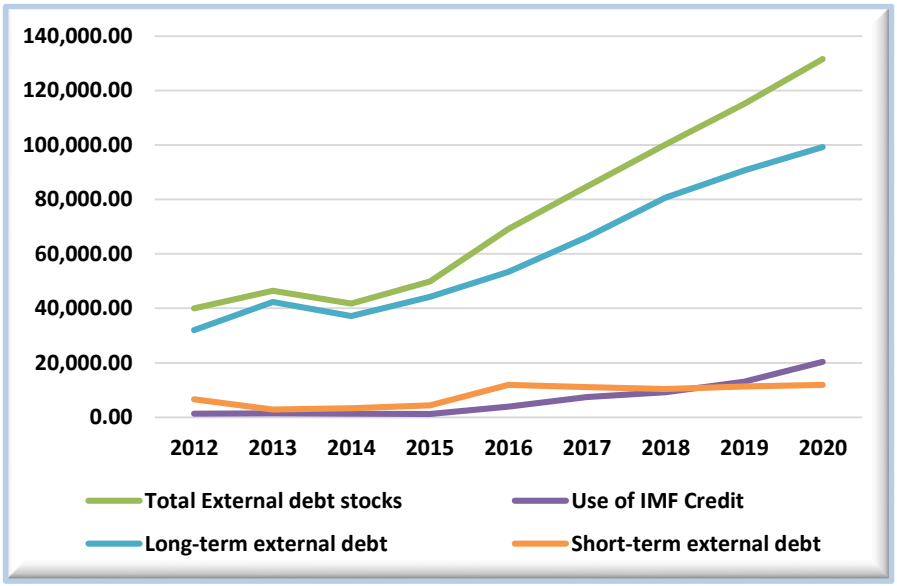
As aforementioned, the impact of inflation on external debt has received little attention in general, and no study has been uncovered so far to examine whether or not inflation affects external debt in Egypt. To address this challenge and fill a significant gap in the literature, the current study examines an extended yearly time series of Egyptian data from 1976 to 2020 to investigate the influence of inflation on foreign debt and vice versa using the (VECM) technique.

Debt and inflation in Egypt:

Over the previous 50 years, Egypt's external debt has significantly expanded. Until the late 1960s, external debt was not a significant concern. Only with greater borrowing in the 1970s and 1980s did debt become a persistent concern. Egypt's overall external debt stock consist of "long-term public, publicly guaranteed, and private nonguaranteed debt, as well as IMF credit utilization and short-term debt." (World Bank). Following the 1973 war, new external public guaranteed debt was issued, with totals of $1.5 billion in 1974 and $3.6 billion in 1975, rising to $29 billion in 1985, an almost tenfold rise. The external public guaranteed debt peaked in 1988 when it reached $38 billion. As a result, Egypt, like many other emerging countries, started the 2000's saddled with massive debt. Furthermore, from the 1990s to the end of the 2000s, the external public guaranteed debt curve was fairly constant. However, external indebtedness started to expand in 2013. Following the severe depreciation in November 2016, Egypt's total external debt has risen dramatically (IMF,2020). Furthermore, in 2020, Covid-19 affected negatively the Egyptian economy and increase the external debt. Egypt's external debt stock climbed 14 percent in 2020, owing mostly to government Eurobond issues and a $2.5 billion IMF acquisition. Despite the extensive efforts to boost foreign direct investment diversification, including an agreement to establish a $16 billion Saudi-Egypt investment program across many industries, inflows to Egypt fell 35 percent to $5.9 billion in 2020. The oil and gas industry now draws the bulk of Egypt's foreign direct investment (International Debt Statistics, 2022). Contrariwise, the private sector's share of total external debt stocks is negligible, having been 0.5 percent in 2012 and falling to 0 percent in 2019, suggesting that Egypt's external debt is almost exclusively publicly guaranteed.

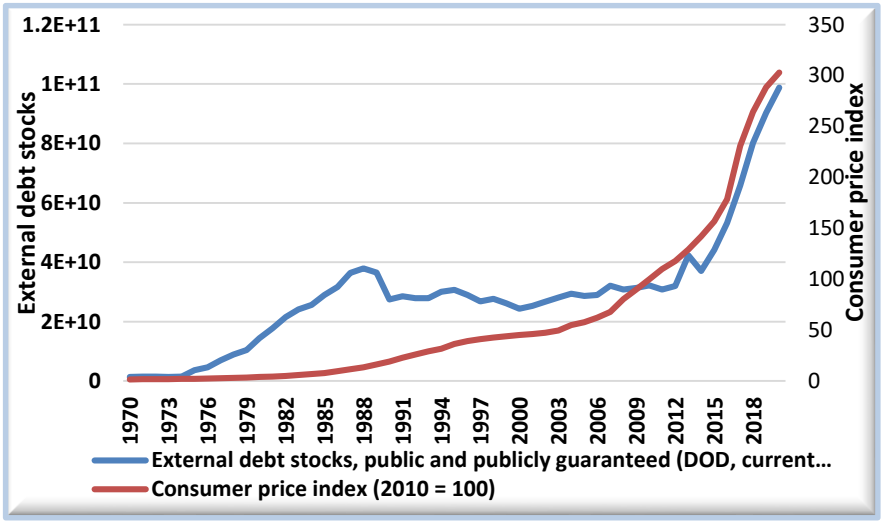
As shown in figure (1), Egypt's overall external debt stock has risen from approximately $69 billion in 2017 to $100 billion in 2018, $131 billion in 2020, and almost $138 billion by the end of 2021. (International Debt Statistics, 2022; CBE,2022). The majority of foreign loans were long-term debt, which increased from $80 billion in 2018 to $90 billion in 2019 to 99 billion in 2020, accounting for 80 percent, 79 percent, and 75 percent of total external indebtedness, respectively. Furthermore, the International Monetary Fund's (IMF) utilization as a proportion of total external debt holdings has climbed from 9 percent in 2017 to 11 percent and 15 percent in 2019 and 2020, respectively. In terms of short-term debt, its share of total external debt stocks has declined from 13 percent in 2017 to 10 percent in 2019 and 9 percent in 2020.

Inflationary pressures have been one of the most serious problems confronting emerging economies. In fact, reducing inflation is the major priority of macroeconomic policy in many developing market economies. Preceding the Ukraine war, external accounts were already stressed, and domestic prices started to grow gradually, hitting a historic level of 13.5 percent in May 2022 (CBE,2022). Currency depreciation, imported inflation, supply constraints, and an increase in retail fuel prices all contribute to increased inflation (World Bank, 2022). As shown in figure (2), the consumer price index and the Public and publicly guaranteed external debt stocks have had an increasing trend from 2016 to 2020. Furthermore, as a result of currency depreciation in March 2022, as well as the effects of higher international prices and monetary tightening, the budget deficit increased (World Bank, 2022).



Source: World Bank. International Debt Statistics 2022.

Figure (1): Egypt's external debt stock from 2012 to 2020



Source: World Bank. International Debt Statistics 2022.

Figure (2): Public and publicly guaranteed external debt stocks, and Consumer price index from 1970 till 2020

Model specification and Data description:

Data:

Our dataset contains annual indicators for Egypt from 1977 through 2020. Time-series data were gathered from the World Bank's database. The following model underpins our empirical analysis based on the theoretical analysis of the relationship between external debt and inflation, and the empirical analysis of external debt determinants.

LEXD= f (LCE, LCPI, LBMG, NTRA, LGCGL)

Where,

LEXD = External debt stocks

LCE = Final consumption expenditure

LCPI = Consumer price index

LBMG = Broad money

LGCGL = Gross capital formation

NTRA = Net trade in goods and services

External debt stocks: "the categories of debt are government debt, publicly guaranteed debt, private nonguaranteed debt, and use of IMF credit" (World Bank database).

Final consumption expenditure (% of GDP): "is the sum of household final consumption expenditure (private consumption) and general government final consumption expenditure (general government consumption)" (World Bank database).

The consumer price index (CPI): "evaluates changes in the cost to the average consumer of receiving a basket of goods and services at regular intervals, such as yearly" (World Bank database).

Broad money growth (annual %): "is the sum of currency held outside of banks, demand deposits other than those held by the central government, time, savings, and foreign currency deposits held by non-central government resident sectors, bank and traveler's checks, and other securities such as certificates of deposit and commercial paper" (World Bank database)

Gross capital formation: "is the sum of expenditures on additions to the economy's fixed assets plus net changes in the stock of inventories" (World Bank database).

Net trade in goods and services: "Commodity and service exports and imports include any transactions that involve the transfer of ownership of products and services between inhabitants of one nation and the rest of the globe" (World Bank database)

The natural logarithm is represented as L and a vector error correction model is used to estimate the mutual connection between these variables.

Methodology:

This study empirically investigates the relationship between external debt and inflation in Egypt. The relationship between external debt and inflation is thought to constitute a sort of long-run equilibrium or cointegration. The occurrence of one or more integrated variables with a shared long-run evolution is known as cointegration (Nastansky & Strohe, 2015). If a set of variables contains one or more cointegrating vectors, the "Vector Error Correction Model" (VECM) is an appropriate estimating technique that responds to both short-run variations in variables and deviations from equilibrium (Andrei & Andrei, 2015).

$$\boldsymbol{Y_t = \beta_0 + \beta_1 x_t + \varepsilon_t}$$

The most frequent VECM model form is

$$\boldsymbol{\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \sum_{i=0}^{n} \mu_i \Delta X_{t-i} + \lambda ECT_{t-1} + \varepsilon_t}$$

Where; $\boldsymbol{\mu_i}$ are the (n X n) variables vectors of the lagged stationary differences, $\boldsymbol{\lambda ECT_{t-1}}$ is the long-run model, $\boldsymbol{y_{t-i}}$ is endogenous Vector variable with first lag and $\boldsymbol{\varepsilon_t}$residual.

The "Vector Error Correction Model "is composed of a VAR model with p - 1 variables difference and an error-correction term generated from the predicted cointegrating term (Winarno, Usman, & Kurniasari, 2021). The VECM allows for the assessment of long-term repercussions as well as the examination of the short-term adjustment process all within one model. It is vector stationary if $\boldsymbol{x_t}$ is vector integrated of order 1 (I(1)). It entails conducting a regression of the series' initial difference against the series lagged once, as well as lagged difference terms (Mishra, 2011). In this study, we will use the augmented Dickey-Fuller-test (ADF) and the Phillips Perron (PP) to test each variable for integration and stationarity individually; however, we will rely on the ADF as the primary test. The main difference between (PP) and ADF unit root tests is how they handle serial correlation and heteroskedasticity in the errors. The PP tests disregard the serial correlation in regression estimates, but the ADF tests employ parametric autoregression to reproduce the ARMA structure of the test correlation errors (Zivot & Wang, 2006).

The long-run model:

$$\boldsymbol{ECT_{t-1} = y_{t-1} - \beta_0 - \beta_1 x_{t-1}}$$

Cointegrating relations can include an intercept in addition to a deterministic temporal trend. The greatest lag p may be calculated using the Schwarz information criterion. Identification of the cointegration test form and lag order is required for a successful cointegration test. To explore the cointegration relationship between variables in a VAR model, The Johansen approach is extensively employed to estimate all cointegrating vectors when there are more than two variables (Dwyer, 2015). The Johansen tests are based on the eigenvalues of data transformations and indicate the most correlated linear combinations of

data (Winarno et al., 2021). The selected sequences are linear trend terms, and the test form of the cointegration equation is just the intercept (Zou, 2018). The error correction term represents the long-run relationship. A long-run causal relationship is shown by a negative and significant error correction term coefficient. Bi-directional causality is inferred if both coefficients of error correction terms in both models are significant (Mishra, 2011). The compounding impact of a one-unit shock in one variable on the future values of the other endogenous variables is calculated using the impulse response function (Winarno et al., 2021).

Based on the above, the current research will estimate the VECM model for the identification of short long-run dynamics. To explore the two-way relationship between Egypt's external debt and inflation, as well as other external debt variables, to investigate the impact of inflation on external debt and conversely, the study analyzes the external debt as the dependent variable and the other variables including CPI as the explanatory variable in the first equation and the CPI as the dependent variable in second equation as following:

$$\boldsymbol{D(LEXD)_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta LEXD_{t-i} + \sum_{i=1}^{p} \alpha_2 \Delta LCPI_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta LCE_{t-i} + \sum_{i=1}^{p} \alpha_4 \Delta LBMG_{t-i} + \sum_{i=1}^{p} \alpha_5 \Delta LGCGCL_{t-i} + \sum_{i=1}^{p} \alpha_6 \Delta NTRA_{t-i} + \varphi ECT_{t-1} + \varepsilon t}$$

$$\boldsymbol{D(CPI)_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta LEXD_{t-i} + \sum_{i=1}^{p} \alpha_2 \Delta LCPI_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta LCE_{t-i} + \sum_{i=1}^{p} \alpha_4 \Delta LBMG_{t-i} + \sum_{i=1}^{p} \alpha_5 \Delta LGCGCL_{t-i} + \sum_{i=1}^{p} \alpha_6 \Delta NTRA_{t-i} + \varphi ECT_{t-1} + \varepsilon t}$$

Empirical results:

In this section, the study presents and analyzes the empirical results and findings of the conducted empirical analysis.

Unit root analysis:

The unit root tests shown in table (1) reveal that all variables are not stationary at the level when the variables are stated in log levels except the net trade in goods and services. To reduce data instability, all variables are subjected to first-order differences. The variables are stationary at the first difference as shown in table (1) and are integrated in first order depending on the ADF test.

Lag-Order Selection Criteria:

Whenever the model's lag differs from the actual lag-length, the model and impulse responses yield contradictory VAR-coefficient estimations, which have ramifications for policy studies that employ derived impulse responses and variance decompositions (Braun & Mittnik, 1993). As a result, precisely estimating the lag length is crucial. To obtain the required lag length, the Lag-order selection model is employed, which is a common method for determining the lag length of VAR models (Stock & Watson 2015).

To determine the appropriate lag length, indicator information criteria such as the “sequentially modified LR test statistic” (LR), “Final Prediction Error” (FPE), “Akaike Information Criterion” (AIC), “Schwarz Information Criterion” (SIC), and “Hannan-Quinn Information Criterion” (HQ) are utilized. The results are shown in table (2), where all the criteria suggest that the optimal lag length for the model is one lag.

Table (1): Unit Root Test

Variables	ADF		PP	
	level	first differences	level	first differences
External debt stocks (LEXD)	-0.515437	-3.818142**	-1.405130	-3.805284**
Final consumption expenditure (LCE)	-2.819225	-7.068255***	-2.788862	-7.128637***
Consumer price index (LCPI)	-2.067186	-3.362959*	-1.711131	-3.323798*
Broad money (LBMG)	-0.675670	-6.824093***	-0.659687	-8.393387***
Gross capital formation (LGCGCL)	-3.173731	-3.173731***	-3.370359*	-4.638519***
Net trade in goods and services (NTRA)	-0.960923	-5.018061***	-0.877327	-4.990623***

(*) Significant at the 10%, (**) Significant at the 5%, (***) Significant at the 1%.

Table (2): lag length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-939.207	NA	4.26E+12	46.10765	46.35842	46.19897
1	-674.882	438.3928*	63265229*	34.96985*	36.72521*	35.60905*
2	-644.964	40.86356	95541174	35.26653	38.5265	36.45363
3	-603.124	44.90138	99257857	34.98166	39.74622	36.71665

*** indicates lag order selected by the criterion**

Cointegration Test:

The cointegration test was used to assess if the variables had a long-term equilibrium relationship. To demonstrate cointegration, the probability ratio must be larger than the Mackinnon critical values (Zaagha, 2021). The "Johansen co-integration test" shown in table (3) indicates that at the 5% level of significance, both the trace and maximum eigenvalue tests reveal that the null hypothesis is accepted and one

cointegration exists. This implies the presence of a long-run linear combination of variables, as well as the presence of a long-term relationship between variables.

To compute the cointegration association, we normalize the cointegrating vector to an external debt coefficient. As a result, the following equation might be thought of as an external debt function.

The external debt equation (LEXD):

$$\begin{aligned} D(LEXD) \;=\; & C(1) * (\, LEXD(-1) \;-\; 3.18053330712 * LCPI(-1) \\ & +\; 33.3280182673 * LCE(-1) \;-\; 1.5710800057 \\ & * LBMG(-1) \;+\; 2.37207926303 * LGCGCL(-1) \\ & +\; 2.04185160877e - 10 * NTRA(-1) \\ & -\; 213.829445633\,) \;+\; C(2) * D(LEXD(-1)) \\ & +\; C(3) * D(LCPI(-1)) \;+\; C(4) * D(LCE(-1)) \\ & +\; C(5) * D(LBMG(-1)) \;+\; C(6) * D(LGCGCL(-1)) \\ & +\; C(7) * D(NTRA(-1)) \;+\; C(8) \end{aligned}$$

$$\begin{aligned} D(LEXD) = & -0.09123\; ect_{t-1} + 0.231857 \Delta LEXD_{t-1} \\ & - 1.320288 \Delta LCPI_{t-1} \;+\; 2.28495\; \Delta LCE_{t-1} \\ & - 0.09006 \Delta LBMG_{t-1} \;+\; 0.35723 \Delta LGCGCL_{t-1} \\ & -\; 0.0000000000138 \Delta NTRA_{t-1} \;+\; 0.1397 \end{aligned}$$

The long-term connection indicated below is obtained when the vector error correction model is built.

Where ECT

$$\begin{aligned} ECT_{t-1} = & \; 1.0000\; LEXD_{t-1} - 3.180533 LCPI_{t-1} \\ & +\; 33.32802\; LCE_{t-1} \;-\; 1.57108\; LBMG_{t-1} \\ & +\; 2.372079\; LGCGCL_{t-1} \\ & -\; 0.000000000204\; NTRA_{t-1} \;-\; 213.8294 \end{aligned}$$

The findings of the vector error correction model in the short term shown in table (3) demonstrate that Inflation (LCPI) has a negative significant estimated impact on external debt at a 1% level of significance. Where the Consumer price index increases by 1% external debt declines by 1.3% on average ceteris paribus which is consistent with the finding of Bittencourt (2015), Omrane Belguith & Omrane (2017) and Okech, Mweni & Njuguna, (2016). The correlation between inflation and external debt is theoretically negative. A rise in general prices should slow the rate of increase in foreign debt. Rising prices enhance productivity, resulting in a reduction in external debt (Mensah et al., 2017). However, if productivity does not grow owing to other considerations, debt will rise in tandem with imports. Since to counteract high inflation, years of nominal interest rate restrictions were utilized, while other years used complete indexation, variables that may have changed how inflation impacts government external debt. Broad money (LBMG) has unexpected significant negative indicators as Broad money lowers the external debt by 0.09%. This is attributable to the fact that broad money includes residents' foreign currency, which lessens the expansion of external loans. Final consumption expenditure (LCE) has a positive significant estimated impact on external debt at a 1% level of significance, as it increases the external debt by 2.2% on average which is consistent with the finding of Mensah et al., (2017). Gross capital formation (LGCGCL) has a positive significant estimated impact on external debt at a 10% level of significance as it increases the debt by 0.3% which is consistent with the finding of Murwirapachena & Kapingura (2015). Finally, the net trade (NTRA) increases the debt by 1.38E-11 which is consistent with the finding of Al-Fawwaz (2016) and Omrane Belguith & Omrane (2017). The R-squared of the LEXD model is 0.478574.

The ECT coefficient in the LEXD equation is statistically significant and has a negative sign at the 1% level of significance. Confirming the Granger causality in long term from dependent variables to independent variable and confirming that there is no detrimental in long-term equilibrium correlation between independent and dependent variables; however, its value (-0.09) indicates the rate of convergence to the equilibrium state per year. To be more explicit, the annual rate of adjustment of any disequilibrium towards a long-run equilibrium is roughly 9%. (The previous year's deviation from the Long-run equilibrium is restored at a speed of 9%.)

The Consumer price equation (LCPI):

$$\begin{aligned} \boldsymbol{D(LCPI)} = {} & \boldsymbol{C(9)} * (\boldsymbol{LEXD(-1)} - \boldsymbol{3.18053330712} * \boldsymbol{LCPI(-1)} \\ & + \boldsymbol{33.3280182673} * \boldsymbol{LCE(-1)} - \boldsymbol{1.5710800057} \\ & * \boldsymbol{LBMG(-1)} + \boldsymbol{2.37207926303} * \boldsymbol{LGCGCL(-1)} \\ & + \boldsymbol{2.04185160877e-10} * \boldsymbol{NTRA(-1)} \\ & - \boldsymbol{213.829445633}) + \boldsymbol{C(10)} * \boldsymbol{D(LEXD(-1))} \\ & + \boldsymbol{C(11)} * \boldsymbol{D(LCPI(-1))} + \boldsymbol{C(12)} * \boldsymbol{D(LCE(-1))} \\ & + \boldsymbol{C(13)} * \boldsymbol{D(LBMG(-1))} + \boldsymbol{C(14)} \\ & * \boldsymbol{D(LGCGCL(-1))} + \boldsymbol{C(15)} * \boldsymbol{D(NTRA(-1))} \\ & + \boldsymbol{C(16)} \end{aligned}$$

The findings of the error correction model, in short term, shown in table (4) demonstrate that external debts (LEXD) have a negative insignificant estimated impact on inflation. Broad money (LBMG) has an insignificant estimated impact on inflation which is consistent with the finding of the European Central Bank (2015) that inflation develops in lockstep with broad money during the medium to long term. Final consumption expenditure (LCE) has a positive significant estimated impact on inflation at a 5% level of significance, as it increases inflation by 0.7% which is consistent with demand-pull inflation theory. Gross capital formation (LGCGCL) has a positive significant estimated impact on inflation at a 1% level of significance as it increases inflation by 0.19%.

Finally, the net trade (NTRA) has a positive significant estimated impact on inflation at a 5% level of significance as it increases the increases inflation by 6.29E-12 which is consistent with the finding of Zakaria (2010).

At the 1% level of significance, the coefficient of ECT in the LCPI equation is statistically significant and has a negative sign, confirming the long-run equilibrium relationship between the independent and dependent variables and confirming the Granger causality in long term from dependent variables to the independent variable. The adjustment of any disequilibrium towards a long-run equilibrium is around 4% each year. The R-squared of the LCPI model is 0.678646.

Table (3): Vector Error Correction Estimates for LEXD

	Coefficient	Std. Error	t-Statistic	Prob.
ECT t-1	-0.09123	0.024823	-3.67525	0.0003
D(LEXD(-1))	0.231856	0.151912	1.526257	0.1285
D(LCPT(-1))	-1.32029	0.420678	-3.13848	0.0019
D(LCE(-1))	2.284952	0.822056	2.779557	0.006
D(LBMG(-1))	-0.09006	0.045267	-1.98945	0.048
D(LGCGCL(-1))	0.35723	0.16102	2.218542	0.0276
D(NTRA(-1))	1.38E-11	8.13E-12	1.696775	0.0913
C	0.1397	0.046351	3.013958	0.0029

Table (4): Vector Error Correction Estimates for CPI

	Coefficient	Std. Error	t-Statistic	Prob.
ECT t-1	-0.04057	0.009681	-4.19019	0
D(LEXD(-1))	-0.05324	0.059247	-0.89862	0.3699
D(LCPT(-1))	0.135246	0.164067	0.824334	0.4107
D(LCE(-1))	0.730163	0.320608	2.277431	0.0238
D(LBMG(-1))	0.017623	0.017654	0.998215	0.3194
D(LGCGCL(-1))	0.190328	0.062799	3.030739	0.0028
D(NTRA(-1))	6.29E-12	3.17E-12	1.985413	0.0484
C	0.072557	0.018077	4.013704	0.0001

According to the results of the error correction model, the ECT coefficient for (LEXD) is negative and significant, as is the ECT coefficient for (LCPI). Bidirectional causality is implied as per Mishra (2011) if both coefficients of error correction terms in both equations are significant. Consequently, there is bidirectional causality between external debt and inflation. If the series deviates from long-term equilibrium, the variables will return to equilibrium. The equation (1/coefficient) is used to determine the time necessary to reestablish variable equilibrium (Samad, 2019).

Diagnostic Tests:

Diagnostic tests are compulsory after model estimation to authorize that the model is appropriately exhibited. Diagnostic tests include the Serial correlation LM test, normality test, and heteroskedasticity test.

Serial correlation:

Table (5) displays the results of the serial correlation LM-test, which reveals that there is no autocorrelation in the residuals.

Normality Test:

The objective of this test is to identify whether the residuals from the data are regularly distributed or not. To assess normality, the Jarque-Bera (JB) Test of Normalcy can be utilized. In this test, the skewness and kurtosis metrics were used. We compare the Jarque-Bera (JB) value to the value of chi-square with two degrees of freedom to see if the null hypothesis is rejected (Usman, Fatin, Barusman, & Elfaki, 2017). The test result shown in table (6) reveals that the residuals are normally distributed.

Heteroskedasticity Test:

Because the null of "No heteroskedasticity" cannot be rejected at the usual significant level, the heteroskedasticity test shown below reveals no heteroskedasticity in the residuals.

Chi-sq	df	Prob.
299.9247	294	0.3935

Table (5): Serial Correlation LM Test

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	27.60902	36	0.8408	0.740366	(36, 103.8)	0.8468

Table (6): Normality Tests

Component	Skewness	Chi-sq	df	Prob.*
1	-0.41237	1.190335	1	0.2753
2	0.41847	1.225823	1	0.2682
3	0.297434	0.619267	1	0.4313
4	0.592924	2.460916	1	0.1167
5	0.697986	3.41029	1	0.0648
6	0.169793	0.201809	1	0.6533
Joint		9.10844	6	0.1676
Component	**Kurtosis**	**Chi-sq**	**df**	**Prob.**
1	3.31601	0.174759	1	0.6759
2	2.441966	0.544954	1	0.4604
3	3.761156	1.013876	1	0.314
4	4.031598	1.862341	1	0.1724
5	3.589795	0.608752	1	0.4353
6	3.589915	0.608999	1	0.4352
Joint		4.813681	6	0.5679
Component	**Jarque-Bera**	**df**	**Prob.**	
1	1.365094	2	0.5053	
2	1.770776	2	0.4126	
3	1.633144	2	0.4419	
4	4.323257	2	0.1151	
5	4.019042	2	0.1341	
6	0.810807	2	0.6667	
Joint	13.92212	12	0.3057	

Stability test:

A stability test is run to investigate the stability of the residuals in the VEC model. Figure (3) shows that the estimated model is stable since all of the AR roots are contained within the circle. As a consequence, it is plausible to infer that the model has been adequately defined and that there are no concerns about autocorrelation or heteroskedasticity. In addition, the model is stable and satisfactory.

Granger causality

Granger causality is a technique for determining if a change in one series will have an impact on the other. This is accomplished by reflecting the change in the second series with different delays than the first (Winarno et al., 2021). Given the variables' cointegration, the VECM framework should be utilized to examine the strength and direction of the causal relationship (Ali & Chowdhury, 2018). VEC Granger Causality/Block Exogeneity Wald Tests can be used in the short run and its result reveals in table (7). When External debt (LEXD) is the dependent variable, there is a short-run causality relationship from inflation to external debt as well as from final consumption expenditure, broad money, and gross capital formation to external debt. However, there is no short-run causality relationship from net trade in goods and services to external debt. On the other hand, when inflation (LCPI) is the dependent variable there is a short-run causality relationship from final consumption expenditure, gross capital formation, and net trade in goods and services to inflation. Then again there is no short-run causality relationship from external debt and broad money to inflation.

Impulse function:

The impulse response function computes the compounding impact of a one-unit shock in one of the variables on the future values of the other endogenous variables (Winarno et al., 2021). It also attempts to determine the length of the shock's impact on one variable in comparison to the others (Usman, et al., 2017). Figure (4) displays the impulse response functions derived from VECM. A one standard deviation positive shock to the LCPI has a negative impact and causes decreases in the LEXD. A one standard deviation positive shock to the LCE and NTRA has a negative impact on the LEXD. A one standard deviation positive shock to the LGCGCL has an increasing impact from period one to three than it has no effect.

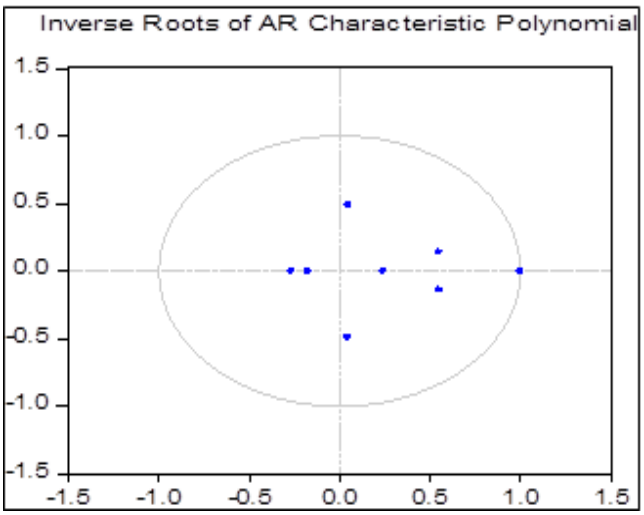


Figure (3) Stability test

Table (7): VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: (LEXD)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(LCPI)	9.850061	1	0.0017
D(LCE)	7.725922	1	0.0054
D(LBMG)	3.9579	1	0.0467
D(LGCGCL)	4.921916	1	0.0265
D(NTRA)	2.879037	1	0.0897
All	12.87394	5	0.0246

Dependent variable: D(LCPI)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(LEXD)	0.807516	1	0.3689
D(LCE)	5.186692	1	0.0228
D(LBMG)	0.996434	1	0.3182
D(LGCGCL)	9.185378	1	0.0024
D(NTRA)	3.941863	1	0.0471
All	12.26277	5	0.0314

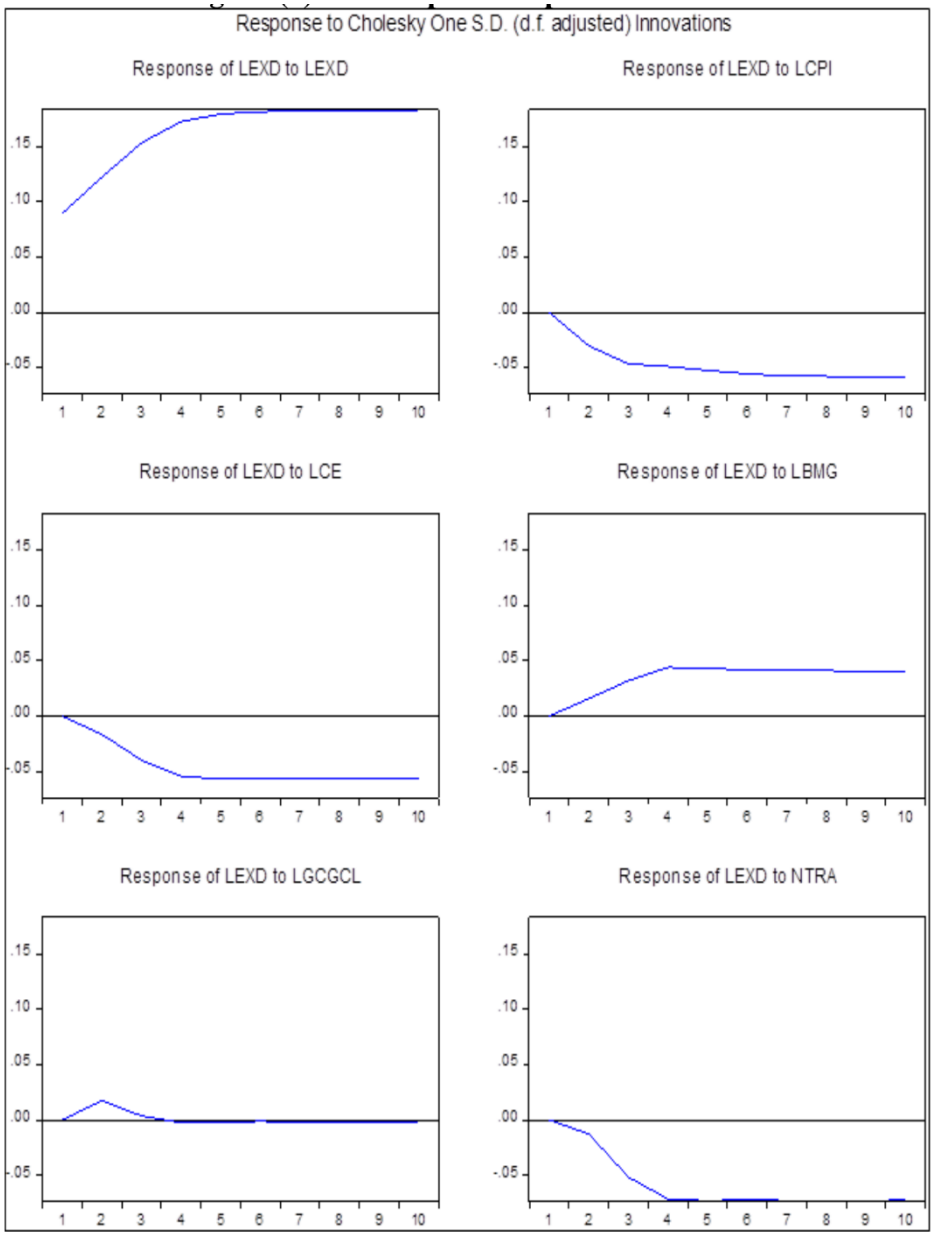


Figure (4): The impulse response functions

Variance decomposition:

The findings of variance decomposition are revealed in Table (8). The purpose of this analysis is to provide more precise information on the variance associations between the selected macroeconomic variables. The variance decomposition analyzes how much variation in one variable's prediction error can be clarified by external shocks to the other variables (Epaphra, 2017). The variance decomposition of external debt reveals that in the first period, 100 percent of external debt variance can be explained by itself, however, this figure declines to 73 percent near the end of the tenth period. LCPI, LCE, LBMG, LGCGCL, and NTRA account for 6.5 percent, 6.3 percent, 3.5 percent, 0.1 percent, and 10.5 percent of the variation in the forecast error of foreign debt at the completion of the tenth period, respectively.

Table (8): Variance decomposition of external debt

Period	S.E.	LEXD	LCPI	LCE	LBMG	LGCGCL	NTRA
1	0.089288	100	0	0	0	0	0
2	0.157595	92.30125	3.710196	1.081419	1.011287	1.251537	0.644311
3	0.236149	83.24881	5.534908	3.289349	2.304453	0.583187	5.039289
4	0.312923	77.81019	5.603229	4.884266	3.303071	0.337595	8.061649
5	0.378473	75.65259	5.748032	5.587254	3.567768	0.233	9.211352
6	0.435106	74.61707	5.989062	5.898133	3.61636	0.176902	9.702476
7	0.485863	73.93333	6.200614	6.078248	3.622583	0.143024	10.0222
8	0.532068	73.4582	6.355322	6.198407	3.618686	0.120809	10.24858
9	0.574449	73.13833	6.475591	6.27726	3.605945	0.104965	10.39791
10	0.613736	72.91408	6.574315	6.329825	3.58978	0.093032	10.49897

Conclusion:

In this study, the association between Egyptian external debt and inflation has been investigated. The study stabs to examine the impact of inflation on external debt using VECM on annual data from 1976 to 2020. This is, as far as we know, the first contribution to the impact of inflation on external debt in Egypt. The "Augmented Dickey-Fuller unit root analysis" is performed to determine time-series stationarity, which demonstrates that the series are I(1). The findings of the cointegration test based on "Johansen's approach" show that cointegration exists. As a result, the external debt and inflation have a long-term equilibrium relationship. According to the study, the consumer price index decreases external borrowing in both the short and long run. The negative and significant error correction term in the external debt and inflation equations suggests the presence of a long-run equilibrium relationship between foreign debt and inflation, along with the existence of bidirectional causality. Furthermore, the causal relationship from inflation to external debt in the short term has been proved according to the Granger causality test. The impulse response functions derived from VECM conclude that a positive shock of one standard deviation to the consumer price index has a negative impact and causes decreases in external debt. Moreover, the study concludes that, in the short term, broad money has unexpected significant negative indicators on external debt by 0.09%. Final consumption expenditure, gross capital formation, and net trade have a positive significant estimated impact on external debt and inflation.

As noted, identifying the mechanisms that influence external debt behavior is becoming increasingly essential for emerging economies. This economy may borrow from the foreign market at a frequency equivalent to its debt level. Interest rates on foreign debt climb in lockstep with the amount owing. In such an economy, a steady rise in the rate of inflation reduces consumption, productivity, and the stock of foreign debt. According to the findings, an inflationary shock might assist these

countries to decrease their foreign debt. Debt relief may be performed in two ways. First, currency depreciation can raise inflation and hence diminish domestic demand; second, currency depreciation can boost foreign demand, improving the trade balance and assisting in the reduction of capital account debt obligations (Helmy, 2021). Rising prices theoretically should boost productivity, which lowers external debt (Mensah et al., 2017). However, if productivity does not expand as a result of other causes, as in the case of the Egyptian economy, debt will rise with increasing imports and due to the use of these external debts for consumption rather than productive purposes.

Furthermore, because Egypt's growing external debt necessitates large debt payments, this will increase demand for foreign currency while decreasing demand for the Egyptian pound, which may be forced to fall again in the future. This is most likely because Egypt has greater inflation rates than its trade partners, causing the effective exchange rate to rise once more. Because inflation and all internal and external variables are linked, lowering Egypt's inflation rate may assist to alleviate future inflationary pressures (Helmy, 2021). Therefore, inflation as a strategy of ensuring sovereign solvency may have negative macroeconomic implications.

If a government has external debt, it carries a tangible burden that, if huge enough may be insurmountable. The expense of such external debt must be carefully evaluated against any income earned by the wealth or assets that may have been supported by the debt (Eisner, 1991). Moreover, appropriate debt management measures must be devised since exceeding these limitations is detrimental to meeting economic growth objectives. The government should borrow for constructive purposes to develop sufficient resources to repay. To address the issue of high external debt, governments should reduce the budget deficit. To lessen the country's debt load, policymakers should increase exports while cutting luxury imports. (Awan et al.,2015)

As a result, governments must efficiently manage foreign debt to avoid severe economic implications that might affect other countries in the region (Gathendu, 2021). Likewise, prudent external debt management entails using external debt to increase productivity and enhance elevated exports, thereby increasing supply, lowering prices, and assuring consistent inflows of international currency from sustainable resources to meet Egypt's domestic foreign exchange demands, as well as repaying accrued external debt (Helmy, 2021).

Thus, the interaction of monetary and fiscal policies emphasizes the significance of coordination through achieving broad policy goals, and institutional and practical procedures. Policy coordination strives to create stable financial conditions, particularly price stability, in the short term. The primary areas of concentration should be monetary policy and public debt management. Long-term policy coordination difficulties include identifying how to adopt a balanced monetary and fiscal policy combination that keeps the economy on its development path while restraining inflation and fostering long-term growth-friendly financial conditions. This entails restricting the fiscal deficit to a level that can be covered by capital market operations without excessive external borrowing (Laurens & De la Piedra, 1998).

Consequently, we can derive the following:

- The government should effectively balance between short and long-term external debts.
- Using external debt to stimulate local production (not for consumption purposes) to improve exports, resulting in more supply and lower prices.
- Consider other financing sources, such as increased tax collection rather than increasing the tax burden.
- National savings should promote long-term productive investment.
- Manage borrowing by correctly managing borrowing possibilities, expenditures, and threats.
- Maintain a low and stable inflation rate.

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الدين الخارجي في زمن التضخم في مصر: نموذج متجه تصحيح الخطأ

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الملخص:

نمى الدين الخارجي لمصر بوتيرة سريعة. وفي الوقت نفسه، يرتبط ارتفاع المديونية بارتفاع التضخم. لذلك، تبحث هذه الدراسة في تأثير التضخم في مصر على ديونها الخارجية، وكذلك التفاعل بين هذه المتغيرات، لا سيما الاستجابة المتبادلة. تم استخدام "نموذج متجه تصحيح الخطأ " (VECM) لتقييم متغيرات أرصدة الديون الخارجية، ونفقات الاستهلاك النهائي، ومؤشر أسعار المستهلك، والنقود العامة، وتكوين رأس المال الإجمالي، وصافي التجارة في السلع والخدمات. تم استخدام البيانات السنوية لمصر من ١٩٧٦ إلى ٢٠٢٠. تظهر نتائج اختبار التكامل المشترك باستخدام "نهج جوهانسن" حدوث تكامل مشترك، مما يؤكد اعتماد تقنية (VECM). تشير النتائج الرئيسية إلى أن التضخم له تأثير هبوطي على الدين الخارجي وأن صدمة التضخم الإيجابية تقلل من الدين الخارجي على المدى القصير والطويل. علاوة على ذلك، تشير النتيجة إلى وجود علاقة توازن طويلة المدى بين الدين الخارجي والتضخم، وكذلك العلاقة السببية ثنائية الاتجاه.

الكلمات المفتاحية: الدين الخارجي، التضخم، نموذج تصحيح الخطأ المتجه، الإنفاق الاستهلاكي النهائي، تكوين رأس المال الإجمالي، وظيفة الاستجابة الاندفاعية.