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Egypt's Inflation determinants: An Empirical Study

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Abstract

The study analyzes the impact of a number of macroeconomics factors, which represent both sides of supply and demand, on Egypt's inflation rate during a specific time frame (1990-2022). This study examined whether the exchange rate, lending interest rates, monetary supply, and investment effect Egypt's Inflation symmetrically or asymmetrically. Semi-annual data was analyzed using Nonlinear Autoregressive Distributed Lag (NARDL) econometric method. The study's findings, Egypt's local currency devaluation negatively affects long-term and short-term inflation. Results also show that negative shocks to lending interest rates are insignificant in long and short - run. Findings also show illiterate that positive shocks to lending rates have negative long-term impacts on inflation and positive short-term one. Money's negative effect on inflation suggests that Egypt's long-term and short-term inflation is caused by other variables. The research also showed that positive shocks to gross fixed capital formation lower long-term inflation. Short run negative shocks were insignificant, Inflation decreases as Egypt's gross fixed capital formation rises. Long-term inflation rates would drop with increased government spending, the data showed. The results indicated that government spending increases would result in a long-term decline in inflation rates.

Keywords: Egypt, inflation, NARDL, nominal exchange rate, lending interest rates, monetary supply, gross fixed investments, and government spending.

Introduction

Annual inflation rate is among the most significant economic challenges facing policymakers. In reality, a great number of researchers are attempting to identify the critical factors influencing inflation in numerous countries. These drivers have really been separated into supply and demand side groups from an economic standpoint. The supply side variables are economic factors that generate inflation by raising input costs. Important influences on the supply side including increasing output, capital formation, food and imports costs, tax and wage rates, exchange rates, and interest rates. Conversely, increased goods and services demand in economy is one way that demand side factors lead to higher inflation. Money growth, expenditures on goods and services by consumers, producers, and governments, as well as overall fixed capital formations are significant demand side drivers. (Mahabadi & Kiaee, 2015).

The Central Bank of Egypt (CBE) has one of its main jobs to stabilize prices; this requires a comprehensive understanding of both internal and external variables that may be influencing short- and long-term inflation. Considering that Egypt's inflation has been persistently high relative to regional and national norms at comparable phases of development, the importance of achieving this goal increases. (Hosny, 2013).

The study problem is to pinpoint most influential macroeconomic factors that have the greatest impact on Egypt's inflation rates, and to determine whether the Central Bank of Egypt has employed monetary policy instruments effectively and efficiently to manage inflation.

The study aims to evaluate the impact of a number of economic factors, which represent both sides of supply and demand, on the inflation rate in Egypt, and to identify which of these variables is the most important and significantly contributes to the change in inflation rate.

This study examined whether the exchange rate, lending rate, supply of money, government spending, and investment affect inflation in Egypt symmetrically or asymmetrically. Simi-annual observations from (1990 - 2022) were analyzed by Nonlinear (ARDL) econometric approach.

The research was divided into an introduction and four sections, the first section dealt with the theoretical and applied economic literature related to the factors determining inflation, the second section dealt with the empirical methodology and data employed in the model, whereas the third section addressed how to interpret the model's outcomes in both short-run and over time, for the fourth section it dealt with evaluation of the Model's Quality and Efficiency and finally the conclusion.

1. Literatures Review

According to (El Baz, 2014) and other studies, Egypt's inflation is caused by several factors. These researchers found that demand-side, monetary, supply-side, and external factors cause inflation. Demand side forces will increase prices as government spending rises. Demand pull inflation comes from this. Population size influences inflation. Demand for goods and services exceeds production capacity in countries with large populations. Consequently, inflation rises (Shammari & Sabaey, 2012). In wealthy countries, population determines inflation, not in emerging countries.

Supplies side inflation results from inefficient supply and rising oil prices, which raise food prices (Ahmed et al, 2014). Oil—petrol, gasoline, and diesel—is used in production. Thus, rising oil prices increase the cost of goods and services. Cost-push inflation occurs (Ali, 2020). Egypt's rising oil costs raise the cost of transportation, which raises the price of many goods, including food. It's called imported inflation.

Inflation, on the other side, was caused by external variables such as currency rates. EGP depreciation, compared to US dollar raises buying costs for goods and services from abroad. The inflation rate is then boosted. This kind of price increase is called import inflation. (Helmy & Hussien, 2018). Furthermore, Inflation can also be driven by monetary variables as money supply and interest rates. Money quantity theory, moreover, highlighted the direct connection between money quantity and price level. A growth in the supply of money causes high inflation. On the contrary, the link between inflation and interest rates is inverse. Therefore, a decline in interest rates reduces the cost of borrowing.

Consequently, greater borrowing and high inflation will occur (Hosny, 2013).

The analysis of (Mahamadu & Phillip, 2003). Use the Error Correction Method to explore the association among Ghana's money expansion, currency value, and growing prices. The findings suggest that real income, money supply, inflation, and exchange rates are all in a long-term equilibrium. The findings are consistent with the hypothesis that, over time, Ghana's inflation is favorably correlated with monetary supply & currency values have a negative association with income.

The Study of (Eftekhari & Kiaee, 2015). Primarily focuses on developing models to assess significant factors affecting overall inflation for a panel country throughout 2008 to 2012. The findings show that key predictors with growing effects on the rate of inflation group for the following year are money growth, gross domestic product, oil prices, and income levels. When government spending, the exchange rate, and total fixed capital formations are also identified as significant inflation sources, the results are improved by using the categorical inflation response variable.

The study of (Iya & Aminu, 2014), examines Nigeria's inflation factors from 1980 to 2012. OLS was used to study time series variables. Supply of Money and interest rates positively affected price level, while government spending and currency depreciation negatively affected it. Thus, reducing money supply, interest rates, and exchange rate and raising government spending and exchange rate can improve price stability across the economy. This study suggests that policymakers should reduce monetary supply, interest rates, government expenditure, and exchange rate to stabilize price levels, with interest rates and currency value being the most essential.

The Research of (Abasimi & Vorlak, 2018), Invigilate the impacts of the interest rates, exchange rate, broad money on Ghana's inflation rate in long and short term, and the study found that any increase in either of them will increase the inflation rate. Despite monetary economists' claims that inflation consider monetary phenomena, money supply or expansion had no significant impact on price level in short or long term.

Using a Vector Auto- Regression model, (Ali, 2011) analyzed main drivers of inflation dynamics in Egypt among 1980 and 2009, finding that inflation inertia- lagged inflation- accounts for roughly 0.33 of the variations in inflation rates, followed by the demand-pull inflation 0.31, supply-side shocks 0.2, the fiscal deficit 0.15, and finally the exchange rates pass through effects, whose minor relative importance doesn't exceed 0.01.

Resulting from the study of (Kia & Sotomayor, 2020) Analyzes the effect of both domestic and international variables on inflation in Egypt and Mexico using empirical data. To do so, researchers employ quarterly data from Egypt (1975-2015) and Mexico (1976-2015) to estimate the model. Johansen-Juselius Maximum Likelihood estimate and FMOLS are used to create long-term estimates in this study. Researchers concluded that both domestic and international factors contribute to the nations' long-term pricing levels. Long-term price increases or decreases in both nations are influenced by their respective monetary and fiscal policies (government spending, deficit, and debt). Thus, both policies can control these two states' long-term inflation rates.

The study of (Reda & Nourhan, 2020) Examine the dynamic causal linkages between Egypt's GDP, inflation, exchange rate, and monetary supply from 2005's first quarter to 2018's second. We examine whether the inflation rate and three determinants have a long-run equilibrium relationship via bounds testing method through ARDL technique (exchange rate, monetary base, GDP). The findings show that impacts of real GDP on the inflation rate in Egypt were insignificant, whereas arise in exchange rates and monetary supply both exert significant impact.

2. Econometric Methodology

Typically, relationship among macroeconomics factors and inflation was explored via traditional approaches like ordinary least squares (OLS) and alternative methodologies including VAR, VECM, etc. Although the approaches allow for evaluation of both their long-term relationships and short-term interactions, they presuppose symmetric relationships between changes in inflation level and macroeconomic

indicators changes like unemployment rate (interest rate, broad money, exchange rate...etc.). Therefore, they are inadequate for capturing potential disparities in the dynamics of the inflation rate. (Shin & Greenwood-Nimmo, 2014) provide a nonlinear ARDL. (Pesaran & Shin, 1999) Introduced the widely used (ARDL) model of co-integration, and (NARDL) is an asymmetric extension of this method (Pesaran et al., 2001). As a means of simultaneously capturing target variables' short-term and long-run asymmetry.

The study employs that modeling strategy for analysis objective. Consequently, according to (Arize et al. 2017), a cointegrating NARDL. The model assesses the possibility of non-linear cointegration of the time series. This technique basically assesses long-run and short-term nonlinearities. Using regressors' partial sum decompositions that are both positive and negative. Additionally, utilizing asymmetric dynamic multipliers, it compares regressor responses to positive and negative shocks. (NARDL) is an asymmetric version of linear (ARDL) bounds testing technique developed by Pesaran et al. (2001).

2.1 Data and sample period

In this section, the dataset and methodological framework will be introduced. This study analyses five independent factors and one dependent variable. Semi-annual data from (1990 – 2022) gave a total of 66 observations for the time series used. All Data was gathered via World Bank database and the Central Bank of Egypt's yearly reports. Nominal Interest rates, Nominal exchange rate, monetary supply, government spending and gross fixed capital formations, were all examined in relation to inflation in Egypt employing (NARDL) introduced by (Shin et al. 2014). The data has been converted to logarithm form.

2-2 Model specification

Eviews 10 software was used to conduct empirical study and estimate the (NARDL) Model.

The model's econometric form is defined as follows:

$$LINF = f\,(LGEX, LMS^{+}\ LMS^{-}, LGFC^{+}\ \ LGFC^{-}, LEXR^{+}\ LEXR^{-}, LINR^{+}\ LINR^{-})$$

And the econometric equation is:

$$LINF_t = \theta_0 + \theta_1^+ LMS_{t-1} + \theta_2^- LMS_{t-1} + \theta_3^+ LGFC_{t-1} + \theta_4^- LGFC_{t-1} + \theta_5^+ LEXR_{t-1} + \theta_6^- LEXR_{t-1} + \theta_7^+ LINR_{t-1} + \theta_8^- LINR_{t-1} + \theta_9 LGEX_{t-1} + \sum_{i=1}^{n} \varphi_i \Delta LGEX_{t-1} +$$
$$\sum_{i=0}^{t} (\pi_i^+ \Delta LMS_{t-1+} \pi_i^- \Delta LMS_{t-1+} \pi_i^+ \Delta LGFC_{t-1+} \pi_i^- \Delta LGFC_{t-1+} \pi_i^+ \Delta LEXR_{t-1+} \pi_i^- \Delta LEXR_{t-1+} \pi_i^+ \Delta LINR_{t-1+} \pi_i^- \Delta LINR_{t-1}) + \varepsilon_t$$

Where:

***LINF* = Inflation rate, *LMS* = Money Supply "domestic liquidity", (% of GDP), *LGFC*= (% of GDP) for gross fixed capital formation, *LEXR* = Nominal Exchange rates, *LINR* = Nominal Interest rate, *LGEX* = General government spending on final consumption (% of GDP), ε = Error term.**

Where θ, θ^+, θ^- denotes the long-run estimation of the parameters, while φ, π^+, π^- denotes the short-run estimation of the parameters.

2-3 Unit Root Tests

According to (Gujarati, 2021), it is crucial to verify each variable's stationarity before performing cointegration tests. If the data set is not stationary, the regression analysis will produce inaccurate results. Regression analysis, according to (Gil, & Robinson 1997), will produce inaccurate results if the data set may not be stationary. The Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test are both unit root tests used to determine whether a time series is stationary or non-stationary. They examine whether a time series has a unit root, which indicates that it is not stationary and accepts the null hypothesis.

The ADF test is primarily based upon a linear regression model, in which time series is regressed on its own lagged values and a constant term, according to (Dickey, & Fuller, 1979). The null hypothesis that the coefficient on the lag values is equal to 1 is tested to determine the test statistic. The series gets classified as stationary if the null hypothesis was rejected.

According to (Phillips, P.1988). The PP test is an ADF tests variant that uses a non-parametric methodology. By utilizing a modified t-statistic, it takes serial correlation and heteroskedasticity in the data into consideration.

As per Table 1, the results of tests (ADF) and (PP) for unit roots indicate that none of model variables are I(2) and that there might be a combination of I(0) and I(1) variables.

Table 1. Unit Root Tests Outcome

(ADF) Test				(PP) Test			
Variables	t-Statistic	P-value	Decision	Variables	t-Statistic	P-value	Decision
LINF	-2.9541	0.045	I(0)	LINF	-3.1276	0.0294	I(1)
LMS	-3.4918	0.0117	I(0)	LMS	-4.0559	0.0022	I(1)
LEXR	-5.6484	0.0000	I(1)	LEXR	-5.5386	0.0000	I(1)
LINR	-4.394	0.0008	I(1)	LINR	-2.2613	0.0240	I(1)
LGFC	-3.6807	0.0069	I(1)	LGFC	-4.1702	0.0015	I(1)
LGEX	-3.5927	0.0087	I(1)	LGEX	-3.6713	0.0068	I(1)

Source: by Author using Eveiws 10 Software outputs

Table 1 displays outcomes of both (ADF) and (PP) tests. E-Views 10 is used to test for stationary variables. Using ADF test, we can see that at level, both variables LINF and LMS are stationary at the 0.05 level of significance, therefore we cannot accept the null hypothesis and claim that LINF and LMS does not have a unit root. Whereas the remaining model variables got stationary at 1st difference and with a significance level of less than 1%.

The conclusions of the (PP) unit roots indicate that model variables stationary at the 1st difference; therefore, rejecting the null hypothesis will be rejected and accepting the alternative hypothesis, suggesting that none of model variables have a unit root at the 2nd difference.

If, as indicated in table 1, certain variables are were stationary at 1st difference while others are not. Testing for cointegration among the non-stationary variables at level would be reasonable. It is crucial to do a cointegration test initially. This has been established by (Phillips, & Ouliaris, 1988). It is also a fundamental premise of the NARDL approach.

According to (Shin & Greenwood, 2014). (NARDL) framework is an extension of (ARDL) techinque that allows for nonlinearities in the relationship between the variables. As in ARDL technique, it is important to test out NARDL co-integration in order to figure out whether there is a long-term association among variables.

The presence of co-integration indicates that variables are become stationary at I(1) but not at I(0). This indicates that even if the variables' means may not be constant, they will typically change in parallel over time. (Tursoy, 2019).

If a co-integration relationship is discovered, it means that the model's variables are correlated over the long term and can be utilized to calculate the relationship's short-run dynamics via ECM. (Habibi & Rahim, 2009).

2-4 Estimate Bound Cointegration Test

According to (Pesaran et al., 2001). Bound test is a way to test co-integration in time series data. It is a helpful technique for figuring out whether elements in a model have a long-term relationship, which is crucial for evaluating the relationship's short-run dynamics.

The bound test is based upon unit roots concept, which argues that a variable is non-stationary if it has unit root and stationary if it does not. The test compares the estimated coefficients to a set of critical values after using the (ADF) test. The variables are considered to be co-integrated if the calculated coefficients are within the critical range. (Pesaran, et al. 2001)

Measuring the bound The NARDL model's cointegration test is crucial because it enables us to verify the presence of a long-term equilibrium connection which can then be utilized for the relationship's short-run dynamics estimating. (Kumar, et al. 2020).

In addition, it ensures that the non-linearity is not erroneous and that the relationship between the variables is actually non-linear and not only a result of their long-term linear relationship. (Narayan, 2005).

Table 2. Bound test Outcomes

Test Statistics	Value	Signifs.	I(0)	I(1)
F-statistics	14.15119	0.1	1.88	2.99
		0.05	2.14	3.3
		0.025	2.37	3.6
		0.01	2.65	3.97
Sample Size in Actual	61	Finite Samples: n=65		

Source: by Author using Eveiws 10 Software outputs

The table above clearly shows that computed F-statistics value exceeds lower and upper tabular critical values as determined by Pesaran, et al. (2001). Therefore, the null hypothesis cannot be Accepted, and alternative hypothesis can be accepted, which validates the cointegration association and long-term relationship among model variables, as per the bounds test's results, F-statistic being equal to 14.15119, which, at all levels of significance, exceeds the upper bound's critical values.

3- Results and discussion

3-1 Estimate Long- Run Relationship

Given that model variables are co-integrated, the NARDL approach was used to predict long-term relationship among variables.

Table 3. NARDL Long-Term Relationship outcomes

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEXR_POS	0.823300	0.142045	5.796052	0.0000
LEXR_NEG	-2.577174	0.497533	-5.179909	0.0000
LINR_POS	-2.822328	0.938653	-3.006786	0.0049
LINR_NEG	-0.538577	0.445446	-1.209072	0.2350
LMS_POS	-0.600203	0.128876	-4.657217	0.0000
LMS_NEG	0.539967	0.122883	4.394141	0.0001
LGFC_POS	-1.200239	0.441661	-2.717560	0.0103
LGFC_NEG	-0.385133	0.289506	-1.330311	0.1923
LGEX	-2.862500	0.921392	-3.106712	0.0038

Source: by Author using Eveiws 10 Software outputs

The NARDL model's long-run asymmetric estimation is presented in the table (3). The outcomes indicate that the positive shock of exchange rate significantly lowers inflation rate. Which indicates that when value of the US dollar increases in comparison to the Egyptian pound, the inflation rate will increase. In other words, Inflation in Egypt is negatively impacted by the local currency devaluation, and vice versa, if a shock on the opposite side of the nominal rate of exchange occurs. In other words, the appreciation of the Egyptian pound against the US dollar reduces inflation and hence results in a lower inflation rate.

Although the short-run impacts of the negative shock to the nominal interest rates appears insignificant. The findings show that impacts of the long-term positive shocks to the lending rate on inflation are negative. This suggests that the inflation rate will decline as interest rates rise. Therefore, changes in the interest rate, whether positive or negative, both reduce inflation. This finding also suggests that long-term inflation cannot be controlled by negative shock to the nominal interest rate. As a result, there is no need to raise interest rates for a long time because doing so would slow down economic growth and would perhaps result in higher inflation in the near future.

Additionally, the findings demonstrate that a supply of money lowers inflation, whereas a drop in the monetary supply raises inflation. The classical and monetarist beliefs that the money supply is what causes inflation are not supported by this conclusion. The fact that the money supply affects inflation negatively suggests that there are other causes of inflation in Egypt in addition to the liquidity. This outcome is consistent with earlier results of (Masih & Masih, 1996). It showed that ineffectively controlling Pakistan's inflation through changing the money supply

The absence of short-term impacts of money supply growth on inflation in Egypt indicates that any increases in money supply will not significantly affect long-term inflation since money supply does not directly raise overall demand for goods and services. Rather, the upward in monetary supply is used to profit from investment in high-interest saving accounts, providing depositors with a reasonably predictable income to offset the risk of inflation. This may be consistent

with the structure of the Egyptian economy, as the rise in money supply is channeled primarily toward savings certificates, with a rate of interest reaching 20% in 2018. (Ali, 2020), in addition to interest rates on investment certificates that reached 12 % in 2014 and 25% in December 2022, according to the Central Bank of Egypt (CBE).

The findings also revealed that positive shocks to gross fixed investment have a negative sign and contribute to lower long-term inflation. but the negative shock was insignificant, indicating that there is no clear evidence supporting that a fall in GFCF leads to a decline in long-run inflation. This is in accordance with the conclusions of (George-Anokwuru & Ekpenyong, 2020). Analysis of the causes of inflation in Nigeria

The GFCF is positively associated with inflation in general. As investment in physical capital increases, it can lead to higher economic growth, which could raise demand for products and services as well as inflation. However, in other economic conditions, such as a recession or a period of low economic growth. GFCF growth could lead to an increase in output and a rise in the goods and services supply, which could potentially lead to lower inflation. It's worth noting that that there is a complicated relationship among GFCF and inflation that can be impacted by a number of variables, such as monetary policy, labour market conditions, and global economic situations.

Regarding the GEX variable, the results concluded that government spending increases lead long term inflation to decrease; this matches the (Lim & Sek, 2015) study results. However, some economists as (Attari & Javed, 2013) argue that the way the government uses the funds for General government final consumption expenditure also has a significant part in reducing inflation; as an example, if the government uses the funds for infrastructure development, it can increase productivity and reduce the cost of production, which can lower inflation.

3-2 Estimate Short- Run Relationship

Checking for a short-term relation among dependent variable and explanatory variables and determining the rate at which short-term

deviations are corrected over time (i.e., the speed with which short-term errors are corrected and return to long-term equilibrium position), is what ARDL Error Correction Model's (ECM) aims to investigate (Pesaran, et al., 2001).

Table 4. Results of the NARDL Short-Term Relationship

ECM Regression				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.153079	0.011289	13.56062	0.0000
D(LEXR_POS)	0.703062	0.073675	9.542805	0.0000
D(LEXR_POS(-1))	-0.000252	0.066175	-0.003813	0.9970
D(LEXR_POS(-2))	0.154994	0.063782	2.430077	0.0205
D(LEXR_POS(-3))	0.201388	0.039521	5.095669	0.0000
D(LEXR_NEG)	-0.311168	0.344048	-0.904433	0.3721
D(LEXR_NEG(-1))	1.612987	0.365381	4.414529	0.0001
D(LEXR_NEG(-2))	2.966851	0.388197	7.642652	0.0000
D(LEXR_NEG(-3))	2.956256	0.386275	7.653244	0.0000
D(LINR_POS)	0.491459	0.262252	1.873992	0.0695
D(LINR_POS(-1))	2.160165	0.278908	7.745091	0.0000
D(LGFC_POS)	-3.383393	0.449343	-7.529650	0.0000
D(LGFC_POS(-1))	-1.873328	0.459469	-4.077158	0.0003
D(LGFC_POS(-2))	4.143579	0.411571	10.06772	0.0000
D(LGFC_POS(-3))	3.616731	0.475791	7.601518	0.0000
D(LGFC_NEG)	1.431385	0.242273	5.908147	0.0000
D(LGFC_NEG(-1))	1.485269	0.241565	6.148538	0.0000
CointEq(-1)*	-0.775984	0.058004	-13.37800	0.0000

Source: by Author using Eveiws 10 Software outputs

Table (4) illustrates that when CoinEq (-1) is equal to -0.775984, a value with a negative sign and high-level significance, this indicates that approximately 77.5% of short-term deviations have been corrected and returned to position of long-term equilibrium, Which in turn indicates that the independent factors' shocks to the dependent variable are absorbed and return to equilibrium again at a rate of 77.5% semi-annually, and thus the time needed for the variables to reach equilibrium is roughly nine months.

According to the study's findings, there exists a positive short-term association between a positive shock to exchange rate and price levels in Egypt from (1990 -2022), and each 10% rise in the value of the US dollar against the Egyptian pound causes the inflation rate to go up by about 7%, While, In the case of a negative shock to the exchange rate, the results showed an inverse relationship, but it is not statistically

significant. This means that a 10% rise in the pound's value against the dollar results to a 3% lower in inflation, which is comparable to what (Hosny, 2013) found as well as the results of a (Youssef, 2024) study, which confirmed that the overall depreciation of the EGP against the dollar caused short-term inflation to rise.

In terms of lending rates, the study found that positive shocks for interest rates cause an increase in short-term inflation, meaning that a 10% increase in the lending interest rate causes a rate of inflation increase of around 4.9%. The current study findings and this analysis conclusion are consistent with (Iya & Aminu, 2014) results.

Because higher interest rates make borrowing extremely expensive and therefore limit economic growth and reduce demand for goods and services, raising interest rates by the central bank to combat inflation can also result in higher inflation. Due to this, businesses may raise their prices to remain profitable, which would result in higher inflation. (Hamzah & Masih, 2018).

Various explanations exist for the mechanism through which interest rates affect inflation. Utilizing user capital costs is one technique. So, user investment cost rises as a result of the higher lending rates. (Branson, 1979), This leads to increased costs associated with production, then shifts the aggregate supply curve to left side; these modifications increase inflation. Additionally, by modifying the amount of money, the changing interest rate causes inflation. When the interest rate rises, the money supply in endogenous money models, in which the amount of money supply is a function of interest rates, the money supply growth is caused by increase interest rate increases. Because of this, the money quantity theory maintains that an increase in the money supply leads to inflation shortly and over time. Although the money supply does not affect inflation in a recession, it significantly and positively affects inflation over the medium and long term under normal circumstances. (Asgharpur & Karami, 2007).

The analysis found that, short term increases in Egypt's gross fixed capital formation is associated with lower inflation rates for the period (1990–2022), whereas a decrease in this rate follows a decrease in gross fixed investment.

An increase in gross fixed investment in physical capital such as machinery and infrastructure, can lead to increased productivity and capacity in the economy. This increased supply can lead to a decrease in prices, which is a measure of inflation. Additionally, an increase in investment can also lead to increased employment and wages, which can also help to decrease inflationary pressures. Therefore, short run increases in GFCF can help to reduce inflation levels.

The econometric model's conclusions showed that short-term inflation is unaffected by government spending and supply of money.

After running the Stepwise Regression model, the results will be utilized to conduct a Wald test to determine whether long-term and short-run association between the independent variables and dependent variable is symmetrical or asymmetrical.

Table 5. Results of Stepwise Regression Model

Dependent Variable: D(LINF)
Method: Stepwise Regression
Sample (adjusted): 1992S2 2022S2
Selection method: Uni-directional
Stopping criterion: p-value = 0.05

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	-0.074763	0.033857	-2.208192	0.0329
LINF(-1)	-0.661895	0.087831	-7.536007	0.0000
LEXR_POS(-1)	0.564197	0.112589	5.011108	0.0000
LEXR_NEG(-1)	-2.054265	0.316965	-6.481044	0.0000
LINR_POS(-1)	-0.754416	0.485786	-1.552980	0.1281
LINR_NEG	0.012189	0.308865	0.039464	0.9687
LMS_POS	-0.403669	0.110665	-3.647654	0.0007
LMS_NEG	0.332142	0.096503	3.441796	0.0013
LGFC_POS(-1)	-0.864293	0.335619	-2.575223	0.0137
LGFC_NEG(-1)	-0.047627	0.217668	-0.218805	0.8279
D(LINR_POS)	1.037582	0.437098	2.373796	0.0224
D(LINR_POS(-1))	1.028221	0.523570	1.963867	0.0564
D(LEXR_POS)	0.664728	0.138032	4.815736	0.0000
D(LGFC_POS(-2))	3.852548	0.658020	5.854759	0.0000
D(LGFC_POS(-3))	2.524589	0.659328	3.829035	0.0004
D(LEXR_NEG(-1))	2.371540	0.569062	4.167453	0.0002
D(LGFC_POS)	-2.608464	0.595962	-4.376899	0.0001
D(LGFC_NEG)	0.929964	0.363053	2.561512	0.0142
D(LEXR_NEG(-3))	2.700763	0.651118	4.147886	0.0002
D(LEXR_NEG(-2))	2.582631	0.654926	3.943396	0.0003

R-squared	0.894394	Mean dependent var	0.001772
Adjusted R-squared	0.845454	S.D. dependent var	0.046484
S.E. of regression	0.018274	Akaike info criterion	-4.908254
Sum squared resid	0.013691	Schwarz criterion	-4.216165
Log likelihood	169.7018	Hannan-Quinn criter.	-4.637018
F-statistic	18.27548	Durbin-Watson stat	2.081073
Prob(F-statistic)	0.000000		

Source: Eveiws 10 Software outputs

3-3 Testing for Asymmetry of the Long-Run Parameters

Long-term parameter symmetry testing includes ensuring that the parameters of a model remain consistent throughout time. In cointegrated time series, long-run parameters represent the long-term relationships between variables. (William, 2006).

if parameters are symmetric with a linear connection, it shows that the variables' long-term association is persistent throughout time, and this evidence can be used to develop more accurate forecasts and draw more conclusive conclusions about the data relationships. If the parameters are asymmetric with a nonlinear relationship, it indicates that the relationship between the variables is changing over time; this information can be used to acquire a deeper analysis of the relationship and the possible factors causing the shift. (Greene, W. H. 2003).

Table 6. Wald test results for long-run asymmetry

Test Statistics	Value	Prob	Value	Prob	Value	Prob	Value	Prob
t-Statistic	6.924201	0.00000	-2.005382	0.0516	-3.90216	0.0003	-1.980178	0.0544
F-statistic	47.94456	0.00000	4.021556	0.0516	15.22685	0.0003	3.921106	0.0544
Chi-square	47.94456	0.00000	4.021556	0.0449	15.22685	0.0001	3.921106	0.0477
Decision	*Asymmetric*		*Asymmetric*		*Asymmetric*		*Asymmetric*	

Source: by Author using Eveiws 10 Software outputs

The equality hypothesis has been rejected due to the p-value being below 0.05. The Wald test indicates the impact of nominal exchange rate, lending rate, broad money, and overall fixed capital formation on inflation in Egypt are asymmetrical over time. That agrees with the model's long-term forecasts. Further, it shows that these factors are nonlinearly related to inflation over the long run.

3-4 Testing for Asymmetry of the short-Run dynamic parameters

As evidenced by their research (Shin & Greenwood-Nimmo, 2014) testing for asymmetry of short-Run dynamic parameters is a valuable tool in econometrics as it provides information about the stability and reliability of the relationships in a cointegrated time series, which can be used to inform decisions and make more accurate predictions. Since the asymmetry test needs positive and adverse shocks for explanatory

variables on the dependent variable, the nominal interest rate and money supply were omitted because they had no short-term negative or positive shocks on inflation.

Table 7. Short-Run Dynamic Parameter Wald Test Results

Variables	*LEXR*		*LINR*		*LMS*		*LGFC*	
Test Statistics	**Value**	**Prob**	**Value**	**Prob**	**Value**	**Prob**	**Value**	**Prob**
t-Statistic	4.795788	0.00000	.....	.....	.....	.....	2.268674	0.0286
F-statistic	22.99958	0.00000					5.146882	0.0286
Chi-square	22.99958	0.00000					5.146882	0.0233
Decision	***Asymmetric***		***N/A***		***N/A***		***Asymmetric***	

Source: by Author using Eveiws 10 Software outputs

As Table 7 illustrates, that equality null hypothesis cannot be accepted due to the p-value being lower than 0.05. The Wald testing indicates an asymmetry in short-term impacts of exchange rate and gross fixed capital creation on inflation in Egypt during the period of study (1990-2022).

4. Evaluation of the Model's Quality and Efficiency

The results of a number of tests used to assess the model's quality and usability will be discussed in this section.

4-1 Specification error test for regression equations

Whether or not the Non- linear (ARDL) regression approach is correctly specified, as per (Ramsey, 1969) Regression Specification Errors Test (RESET) is used to determine the specification mistakes in a regression method.

Table 8. Results of RESET Test:

RaLMSey RESET Test
Equation: NARDL
Specification: LINF LINF(-1) LEXR_POS LEXR_POS(-1) LEXR_POS(-2) LEXR_POS(-3) LEXR_POS(-4) LEXR_NEG LEXR_NEG(-1) LEXR_NEG(-2) LEXR_NEG(-3) LEXR_NEG(-4) LINR_POS LINR_POS(-1) LINR_POS(-2) LINR_NEG LMS_POS LMS_NEG LGFC_POS LGFC_POS(-1) LGFC_POS(-2) LGFC_POS(-3) LGFC_POS(-4) LGFC_NEG LGFC_NEG(-1) LGFC_NEG(-2) LGEX C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.543244	33	0.1323
F-statistic	2.381601	(1, 33)	0.1323

Source: Eveiws 10 Software outputs

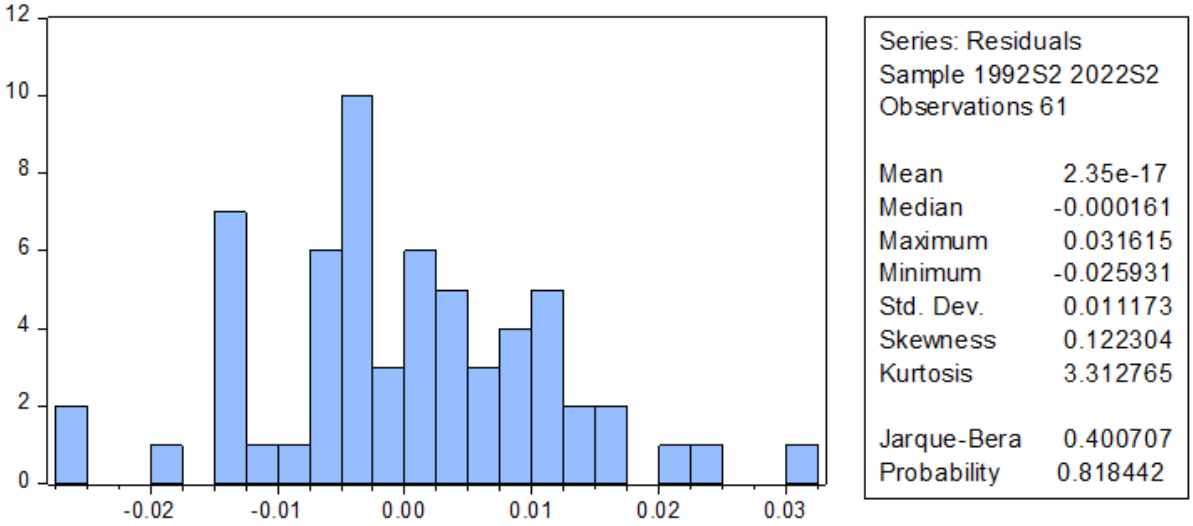
Table 8 displays Ramsey RESET results computed with EViews 10; if the resulting F-statistic p-value appears less than 5%, then, and then the null hypothesis can be rejected.

As shown above, the null hypothesis is acceptable at 0.05 significance level. Which means that nonlinear ARDL regression model can be considered to be free of specification error. The model parameters have been carefully considered.

4-2 Normal Distribution Test (Normality Test)

This test used to determine if model residuals do not adhere to a normal distribution. Even if the calculated t-ratios seem to be favorable, a non-normal residual distribution may make a choice unacceptable. The residuals series having a normally distributed nature is the test null hypothesis, whereas the alternative is that it does not. These are the residuals from the model that passed the normality test. (Gujarati, 2022).

Figure 1. the Jarque-Bera test



Source: Eveiws 10 Software outputs

Figure 1 demonstrates that Jarque-Bera value being 0.400707 and the associated p-value (0.818442) being above 0.05. Thus, we can't reject null hypothesis. The Nonlinear ARDL regression model errors are therefore normally distributed over the research periods, which assesses that Nonlinear ARDL modeling provides a solid outcome.

4-3 Serial Autocorrelation Test

Model residuals correlation is referred to as auto-correlation or serial correlation. This study examines serial correlation using the Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test.

Table 9. Breusch-Godfrey LM Test:

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.452055	Prob. F(1,33)	0.5060
Obs*R-squared	0.824325	Prob. Chi-Square(1)	0.3639

Source: by Author using Eveiws 10

Null hypothesis can be accepted due to p-value being over 5%. This indicates that under the Nonlinear ARDL regression technique, no serial correlation was found. In addition, it emphasizes that the findings of NARDL Regression are not erroneous or meaningless.

4-4 Heteroskedasticity Test

Findings of (Gujarati & Gunasekar, 2009) indicate that Heteroskedasticity is the condition when the residual variances are unequal. With heteroskedasticity, it is determined that the calculated of repressors coefficient appears insignificant The Breusch-Pagan-Godfrey heteroskedasticity test was used to identify Nonlinear ARDL regression model heteroskedasticity.

Table 10. Test Results for Heteroscedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.916179	Prob. F(26,34)	0.5865
Obs*R-squared	25.13046	Prob. Chi-Square(26)	0.5116
Scaled explained SS	9.028175	Prob. Chi-Square(26)	0.9992

Source: by Author using Eveiws 10

The Heteroskedasticity test result showed that P-Value being higher than 5%. So, no heteroskedasticity was found, therefore, we accept null hypothesis, as illustrated in Table 10.

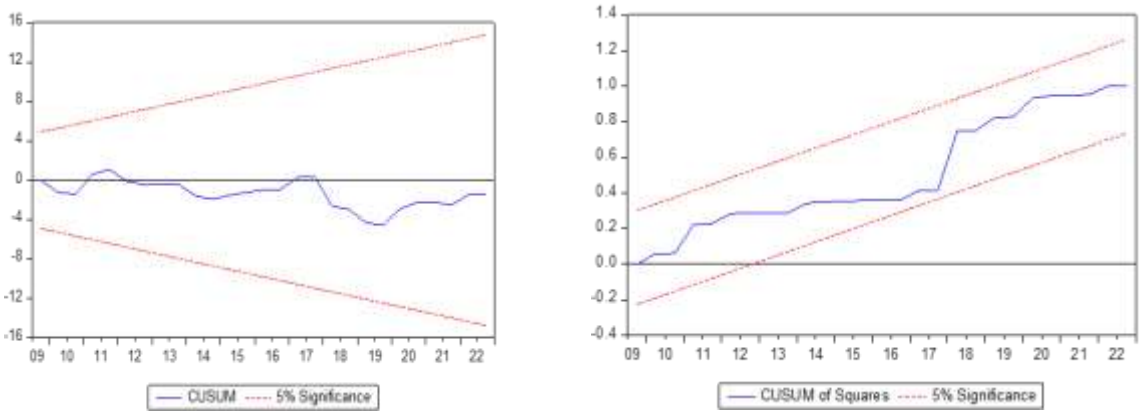
4-5 Test of Structural Stability

The implementation of the recursive estimate served to confirm structural stability. Two different tests exist for recursive estimating.

The structural stability the nonlinear ARDL model structural stability was assessed by the cumulative sum and cumulative sum of squares tests. Brown, et al. (1975).

Figure 2. demonstrates structural stability test's findings.

Figure 2. Structural Stability Test (CUSUM Test)



Source: Eveiws 10 Software outputs

If Cumulative Sum (CUSUM) line falls among two key lines at 5% significance, criteria specify that null hypothesis can't be rejected. In any other scenario, the null hypothesis would be acceptable; this implies that during the study period, NARDL model was structurally stable.

Conclusion

Long-term and short-term inflation in Egypt can be affected by nominal exchange rate. Depreciation of currency value makes imports more expensive, raising import prices. Inflation may rise as a result. However, an appreciation of nominal exchange rate might cut import prices, which can lower inflation. Egypt's nominal exchange rate and inflation are complicated, and other factors including monetary policy, supply and demand, and political stability can affect inflation.

The study suggests that the long-term relation among interest rates and inflation seems to be and depends on many factors, including the economy and consumer and business behavior. Higher interest rates can minimize demand-pull inflation, reduce spending, and slow economic growth by making borrowing money more expensive for individuals and businesses. In some situations, rising interest rates can cause inflation,

especially if commodity prices or demand for products and services rise. By making it cheaper for individuals and firms to borrow money, lower interest rates can stimulate inflation and economic growth. Since inflation is largely driven by external forces, the NARDL model concludes that interest rates cannot affect inflation.

The study suggests that short-term inflation cannot be controlled by interest rates, money supply, or government spending since it is exogenous. Egypt is an open emergent economy with a strong reliance on imports and exports, 27% and 20% of GDP, respectively (1990-2022) - Thus, the Egyptian government cannot only affect inflation rate through monetary policy because it depends on foreign demand for exports, which increases Egypt's domestic inflation, and imported commodity prices, which increases cost-push inflation as imported input costs rise. We also observe a heavy emphasis on managing the exchange rate, which is responsible for foreign trading activities.

In conclusion, demand-pull inflation happens when overall demand rises faster than the supply of goods and services is able to keep up, as seen in greater consumer spending. As a result of firms trying to raise prices to match the increased demand, prices may be under pressure to increase. Cost-push inflation, on the other hand, happens when the cost of manufacturing rises due to increasing costs for labour, raw materials, or energy. This kind of inflation can result in higher prices for products and services and can be brought on by a number of variables, including supply-side shocks, governmental policies, or exchange rate fluctuations. The study's findings suggest that Egypt is more likely to experience cost-push inflation as a result of supply-side shocks and Egyptian pound fluctuations. Therefore, tools must be used to deal with this type of inflation and to avoid expanding the use of tightening monetary policy.

Finally, Inflation remains a persistent challenge for the Egyptian economy, and the government will need to continue its efforts to maintain price stability and support economic growth. The interplay between these various factors and their impact on inflation highlights the complex and multifaceted inflation dynamics structure of and the necessity for a holistic approach to address this challenge.

References

Abasimi, I., Li, X., Salim, A., & Vorlak, L. (2018). The dynamics of inflation, money growth, exchange rates and interest rates in Ghana. Economic Research, 2(6), 21-32.

Ahmed, F., Raza, H., Hussain, A., & Lal, I. (2014). Determinant of Inflation in Pakistan: An Econometric Analysis, Using Johansen Co Integration Approach. University Library of Munich, Germany.

Ali, H. (2011). Inflation Dynamics: The Case of Egypt (No. 36331). University Library of Munich, Germany.

Ali, I. M. (2020). Asymmetric impacts of oil prices on inflation in Egypt: A nonlinear ARDL approach. Journal of Development and Economic Policies, 23(1), 5-28.

Al-Shammari, N., & Al-Sabaey, M. (2012). Inflation sources across developed and developing countries; Panel approach. International Business & Economics Research Journal (IBER), 11(2), 185-194.

Arize, A. C., Malindretos, J., & Igwe, E. U. (2017). Do exchange rate changes improve the trade balance: An asymmetric nonlinear cointegration approach. International Review of Economics & Finance, 49, 313-326.

Asgharpur, H., Kohnehshahri, L. A., & Karami, A. (2007). The relationships between interest rates and inflation changes: An analysis of long-term interest rate dynamics in developing countries.

Attari, M. I. J., & Javed, A. Y. (2013). Inflation, economic growth and government expenditure of Pakistan: 1980-2010. Procedia Economics and Finance, 5, 58-67.

Bhargava, A. (1986). On the theory of testing for unit roots in observed time series. The Review of Economic Studies, 53(3), 369-384.

Branson, W.H. (1979). Macroeconomic Theory and Policy. Princeton University.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. Journal of the Royal Statistical Society: Series B (Methodological), 37(2), 149-163.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), 427-431.

Eftekhari Mahabadi, S., & Kiaee, H. (2015). Determinants of Inflation in Selected Countries. Journal of Money and Economy, 10(2), 113-148.

Eftekhari-Mahabadi, S., & Kiaee, H. (2015). Determinants of inflation in selected countries. Journal of Money and Economy, 10(2), 113-143.

El Baz, O. (2014). The Determinants of Inflation in Egypt: An Empirical Study (1991-2012) (No. 56978). University Library of Munich, Germany.

George-Anokwuru, C. C., & Ekpenyong, B. I. (2020). Government expenditure and inflation in Nigeria. Journal of Economics and Management Sciences, 3(2), p29-p29.

Gil-Alaña, L., & Robinson, P. (1997). Testing of unit root and other nonstationary hypotheses in macroeconomic time series. Journal of Econometrics, 80(2), 241-268.

Greene, W. H. (2003). Econometric analysis. Pearson Education India.

Gujarati, D. N. (2021). Essentials of econometrics. SAGE Publications.

Gujarati, D. N. (2022). Basic econometrics. Prentice Hall.

Gujarati, D. N., Porter, D. C., & Gunasekar, S. (2009). Basic econometrics Tata McGraw-Hill Education.

Habibi, F., & Rahim, K. A. (2009). A bound test approach to cointegration of tourism demand. American Journal of Applied Sciences, 6(11), 1924.

Hamzah, N. H., & Masih, M. (2018). Revisiting effectiveness of interest rate as a tool to control inflation: evidence from Malaysia based on ARDL and NARDL.

Helmy, O., Fayed, M., & Hussien, K. (2018). Exchange rate pass-through to inflation in Egypt: a structural VAR approach. Review of Economics and political science, 3(2), 2-19.

Hosny, A. (2013). Inflation in Egypt: Internal or External Driven? Middle East Development Journal, 5(03), 1-15.

Iya, I. B., & Aminu, U. (2014). An empirical analysis of the determinants of inflation in Nigeria. Journal of Economics and Sustainable Development, 5(1), 140-150.

Kumar, N., Kumar, R. R., Kumar, R., & Stauvermann, P. J. (2020). Is the tourism–growth relationship asymmetric in the Cook Islands? Evidence from NARDL cointegration and causality tests. Tourism Economics, 26(4), 658-681.

Lim, Y. C., & Sek, S. K. (2015). An examination on the determinants of inflation. Journal of Economics, Business and Management, 3(7), 678-682.

Mahamadu, B., & Phillip, A. (2003). Monetary growth, exchange rates and inflation in Ghana: An error correction analysis. Working Paper, WP/BOG-2003/05.

Masih, A. M. M., & Masih, R. (1996). Does causality run from money to prices or vice versa in a developing economy? New but robust econometric evidence from Pakistan. Journal of International Development.

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. Applied economics, 37(17), 1979-1990.

Pesaran, H., & Shin, Y. (1999). An autoregressive distributed lag modelling approach to cointegration "chapter 11. In Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium. Cambridge University Press Cambridge.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics, 16(3), 289-326.

Phillips, P. C. B. (1988). Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Phillips, P. C., & Ouliaris, S. (1988). Testing for cointegration using principal components methods. Journal of Economic Dynamics and Control, 12(2-3), 205-230.

Ramsey JB (1969) Tests for specification errors in classical least squares regression analysis, Journal of the Royal Statistical Society, Series B 31, 350-71.

Reda, A. M., & Nourhan, E. (2020). Using the ARDL bound testing approach to study the inflation rate in Egypt. Economic consultant, (3 (31)), 24-41.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In Festschrift in honor of Peter Schmidt (pp. 281-314). Springer, New York, NY.

Tursoy, T. (2019). The interaction between stock prices and interest rates in Turkey: empirical evidence from ARDL bounds test cointegration. Financial Innovation, 5(1), 1-12.

William Wei. (2006). Time Series Analysis: Univariate and Multivariate Methods. Pearson Education, Inc. 3rd edition.

Youssef, W. M. (2024). Remittances and Inflation in Egypt: An Econometric Study Using an ARDL Model. Arab Journal of Administration, 44(4).