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Revisiting the Exchange Rate Pass- Through to Domestic Prices in Egypt

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Revisiting the Exchange Rate Pass-Through to Domestic Prices in Egypt

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Abstract

Exchange rate pass-through (ERPT) refers to the extent to which the movements in the exchange rate influence domestic prices. This study revisits the exchange rate pass-through in Egypt using quarter data from 2006 to 2022. The study employs a Structural Vector Autoregression (SVAR) model to estimate the degree of ERPT. The findings suggest that ERPT in Egypt is incomplete, meaning that changes in the exchange rate do not fully pass through to consumer prices. The study also investigates the role of the money supply in absorbing the shocks in the nominal exchange rate. The study has important implications for policymakers in Egypt, as a better understanding of ERPT can help them to design effective monetary and exchange rate policies.

Keywords: Pass-Through, Exchange Rate Pass-through, Inflation, Consumer Price Index, Producer Price Index, Import Price Index, SVAR, VAR, Devaluation.

Acronyms

ADF Augmented Dicky Fuller Test

AIC Akaike Information Criterion

ARDL Autoregressive-Distributed Lag

BIC the Bayesian Information Criterion

CBE Central Bank of Egypt

CPI Consumer Price Index

EGP Egyptian Pound

EMs Emerging Markets

ERPT Exchange Rate Pass-Through

FREED Federal Reserve Economic Data

GDP Gross Domestic Product

IFS International Financial Statistics

IMF International Monetary Fund

IMP Import Prices

IF Inflation Targeting

IRF Impulse Response Function

NEER Nominal Effective Exchange Rate

PPI Producer Price Index

SIC Schwarz's Bayesian Information Criterion

SVAR Structural Vector Autoregression

VAR Vector Autoregression

WPI Wholesale Price Index

HQC Hannan-Quinn Information Criterion

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1. Introduction

Inflation is, always and forever, a question and a topic of interest for economists in developing and developed countries alike. Therefore, several empirical and theoretical literature widely investigates the behavior and drivers of this inevitable phenomenon. The exchange rate pass-through (ERPT) is among those factors that have received considerable attention as it significantly contributes to the general price level rises. ERPT refers to the existence and magnitude of the relationship between exchange rate movements and domestic prices (Osbat et al., 2021). Intuitively, the depreciation or appreciation of the domestic currency is instantly reflected in the prices of imports valued by the domestic currency assuming open competitive markets, infinitely elastic prices, and zero cost mobility. However, the exchange rate can immediately or cannot be passed on to the final domestic goods through imported and intermediate goods, producer prices. Put simply, consumer prices respond directly to exchange rate appreciation or depreciation as imported products become more expensive or cheaper than domestic products. By substitution or income effect, consumers adjust their demand for domestic goods, leading suppliers to adjust their allocation of resources. Further reallocation of resources for tradable and non-tradable sectors is expected. The reallocations of resources and adjustments in prices of production inputs affect the producer prices (Kashiwagi, 2014). The producers pass the higher production cost to consumers based on market conditions. The magnitude and time needed for this transition in the price chain is defined as exchange rate pass-through to prices, namely, prices of goods and services from abroad, IMP, intermediate goods prices, PPI, or final consuming prices, CPI.

Moreover, exchange rate pass-through has other implementations on monetary policies, international trade and financial stability. Comprehending ERPT enables policymakers to implement more sustainable monetary policies. The degree of ERPT determines the impact of interest rate changes on the economy. The higher ERPT to prices, the greater the effect of the interest rate on the exchange rate changes. If an economy experiences high degrees of ERPT, the increase in the interest rate leads to an appreciation in the domestic currency and, in turn, the domestic prices decrease (Alderman et al., 2018). This conclusion is consistent with the assumption that the higher the interest rate, the more attractive the economy to foreign investments which means the demand for the domestic currency increases and the economy becomes more competitive in the global economy.

Based on the preceding analysis, we can pursue the analysis to understand the importance of studying ERPT to the stability of the financial system. As the degree of the ERPT impacts the value of the domestic currency in the foreign exchange markets, financial stability accordingly responds to the potential impacts of the foreign currency-based assets and liabilities. For example, if the financial system is burdened by high levels of foreign depts, the depreciation in the exchange rate leads to more pressure on the financial system. Therefore, policymakers should consider the sensitivity of exchange rate movements to domestic prices to implement the most effective monetary strategies.

This object of this paper is assessing the ERPT in Egypt using the SVAR model with a focus on data covers the 2006Q1: 2022Q4. The core object of the study is tracking the mechanism by which the variations in the nominal exchange rate transit to the domestic prices through the price chain. In addition, it estimates the magnitude and time framework of this transition. Moreover, what are the implications of the justification behind the findings? These findings will provide a comprehensive analysis for policymakers to address the appropriate policies to deal with the impact of exchange rate movements on the prices and other economic factors. This reminder sections of the study are divided as follow: The first section reviews the theoretical and empirical studies examined the exchange rate pass-through to prices as well as a focus on empirical studies applied to Egypt's case. In the second section, the study overviews the dynamics of inflation and exchange rate in Egypt during the period of study. In addition to the overview of data used in the study, the third section explores the suggested order of variables in the system and runs some preliminary tests to explore its proprieties. The fourth section determines and justifies the empirical analysis based on the suggested methodology with focus on model specification and model results. Lastly, the paper draws some conclusions and policy recommendations.

2. Literature Review

According to economic theory, production, and import pricing changes eventually pass to consumer goods as the cost and markup determine retail prices. Therefore, a bulk of empirical studies investigated the magnitude and the extent to which fluctuations in exchange rate pass-through contribute to domestic prices has long piqued the curiosity of economists and policymakers. Thus, several theoretical and empirical studies have been spawned to investigate the exchange rate pass-through to inflation. Literature on the interaction between import and export prices and exchange rate fluctuations has become popular among economic researchers since the 90s of the last century. Krugman (1987) analyzed the price adjustment by exporters in accordance with the current prices of the same goods in the export market. One of the significant findings that the analysis reported is that the exporters have reacted to the appreciation of the USD by increasing their prices in the US market compared to the prices of the same products in other markets. Furthermore, Lattimore (1987) studied the pass-through of the Australian exchange rate fluctuations to manufacture export prices. He concluded that the ratio of the exports to the GDP exported and how much the industry contributes to total exports determine the extent to which the exchange rate pass-through is. Applying the same analysis to import prices within industries, Dornbusch (1987) utilized firm-level models to conclude that relative prices significantly respond to exchange rate fluctuations. This response is based on market concentration, import market penetration (IPR), and the capacity of imported and domestic products to be substituted. This has also been explored in prior studies by Feinberg (1986; 1989) who used German and United States data. He found that exchange fluctuations have more influence in less concentrated but are more exposed to import-penetration sectors.

Although these results were based on micro-level models, the analysis could be extended to explain the exchange rate pass-through to import and export prices within countries. If import share simulates import penetrations, countries with high import share are more sensitive to exchange rate pass-through to domestic prices (McCarthy, 2000). Dellmo (1996) investigated the relationship between import prices and consumer prices using data from Sweden. He found that import weakly explains the variations of consumer goods. Unlike the findings by Clark (1995), the results, these results were surprisingly unexpected as the US is a large open economy and the Swedish economy is relatively small. Dellmo (1996) justified the weak relationship as rising from technical and economic factors. Menon (1995) conducted a survey of 43 industrialized economies in order to examine pass-throughs in different countries. In general, the findings of ERPT on consumer prices were varied and incomplete. Smaller and more open economies tended to have higher ERPT. McCarthy (2000) utilized the distribution chain of prices using data from 6 developed OECD countries. He evaluated the pass-through to import, producer and consumer prices using a recursive VAR estimation. He found a significant but incomplete pass-through to IMP and PPI and a modest pass-through to CPI specifically for relatively larger economies. The results seem to be consistent with the assumption that pass-through to consumer prices appears to be relatively lower than imports and producer prices. Masha and Park (2012). This is also has been documented by Murgasova's (1996) analysis of the pass-through of the lower exchange rate to import and consumer prices. The data covered two years of devaluation in the Spanish pesta proved a complete pass-through to import prices. However, the consumer price index has been impacted only by 10%.

For the sake of investigating the different responses of developing and industrialized economies to exchange rate pass-through, Goldfajn and Werlang (2000) analyzed a panel of 71 developing and developed countries. They suggested that the magnitude of exchange rate pass-through, especially after a substantial devaluation, is determined by the output gap, the initial inflation, the initial overestimation of the real exchange rate and the economic openness.

Economists anticipate high and speed exchange rate levels passing through to inflation for emerging and less developed countries when they heavily depend on imports. The study assumes that the response of prices to the devaluation of the Egyptian pound is consistent with the literature suggested by Goldfajn and Werlang (2000) and others for the developing and least developing countries where the pass-through is relatively high. Another assumption could be held for Egypt, suggested by Krugman and Taylor (2000), that the degree of openness and inflationary environment indicates the magnitude of pass-through of exchange rate variations. Research on the ERPT to domestic prices in Egypt is still rare. Choudhri and Hakura (2001) tested the relationship between exchange rate variations and inflation in 71 developed and developing countries including Egypt. Based on general equilibrium modeling for open economies with imperfect competition and price inertia, the results showed a significant relationship between exchange rates and inflation. Specifically for Egypt, the pass-through was about ranged from 21% in the short run and 25% in the long run.

In contrast, the SVAR model based on the price chain suggested by McCarthy (2000), where exchange rate fluctuations transit to domestic prices through import and then producer prices was widely adopted to investigate the ERPT. For example, Savastano et al. (2005) utilized monthly data from 1995 to 2004 in a VAR model to conclude that the exchange rate pass-through to prices is relatively slow. Although the ERPT to CPI was about 11%, it was statistically insignificant. For WPI, the pass-through barely reached 35% over 24 months. The results were at odds with the literature for similar small open economies which showed. The week relationship between exchange rate shocks and CPI is that the basket of the goods and services included in the index are restricted by administrative prices.

Nafie et al. (2004) investigated the exchange rate pass-through in Egypt using a VAR model. The authors used monthly CPI and exchange rates of the Egyptian pound against the US dollar in the parallel market. The data covered the period of October 2001 to July 2003. The study found an incomplete exchange rate pass-through. The authors explained the incomplete pass-through was due to the composition of the consumer price index representing the price variable. The basket mainly has a set of regulated prices.

Similarly, Abou-Zaid (2011) conducted a comparison study to study exchange rate pass-through between Egypt and Israel during the ten years of the 1st quarter of 1996 and 2006. The study used a recursive VAR following McCarthy (2000) to detect the ERPT in the Middle East. The analysis also examined the implications of Taylor hypothesis in both countries. The author found an incomplete pass-through to WPI and CPI. However, the finding showed that WPI was more sensitive to exchange rate shocks than CPI.

Massoud (2014) extended the analysis of Nafie et al. (2004) to include monthly data from 2003 to 2013 using a recursive VAR method. The SVAR output showed that the pass-through of exchange rate and import prices was also incomplete. Massoud (2014) explained the incompleteness of transitions due to some reasons. First, importers lowered their margin profits instead of raising prices to sustain high demand for a large inventory of imports, as their price elasticity was high. Second, the government subsidized some essential goods and services or imposed administrative prices.

Helmy et al. (2018) used data from the period from 2003 to 2015 to examine the ERPT in Egypt using a structural VAR model. They found that the pass-through to prices was substantial but incomplete. The authors justified the incomplete and slow pass-through by examining the composition of price indices; IMP, PPI, and CPI which heavily include subsidized products or regulated prices.

This study revisits the exchange rate pass-through using a different monetary policy. The study focuses on the money supply M2 role in the context of the ERPT. Before doing so, the estimation of ERPT using an SVAR model is required to determine the magnitude and degree of ERPT to domestic prices. This assessment can help Egypt's authorities to comprehend the impact of exchange rate pass-through and adjust monetary policies.

3. Exchange Rate and Inflation Trends in Egypt

Egypt adopted many exchange rate regimes before switching to a flexible regime in 2000. Consequently, the exchange rate went through a series of substantial depreciations. From 2000 to 2004, the Egyptian pound was evaluated by 68%. Concurrently, a premium of 15% in the parrel market over the official exchange rate, and inflation increased and peaked in the Q4 of 2005 at 12.6%.

The rate gap in official and parallel markets was headed to close in June 2004. Five months later, Egypt's central bank introduced a formal interbank foreign exchange market. As a result, the exchange rate of the Egyptian pound was appreciated, but inflation persisted during the following year. This could result from the delayed pass-through impact of exchange rate fluctuations. Until 2011, the exchange rate remained relatively stable despite the inflation waves during the subsequent six years. The political instability after January 2011 was reflected in economic vulnerability contributing to ongoing inflation, fiscal deficits, and accumulating debt. In late 2012, the foreign reserves reached a historical minimum level. Thus, the Central Bank of Egypt introduced a new foreign exchange auction system, FX auctions, to conserve foreign reserves. The FX auction is an instrument that the central bank intervenes in the foreign exchange on the interbank market.

During the fiscal years 2014-2015 and 2015-2016, the economy of Egypt experienced a massive deficit in the current account; it reached 12.1bn dollars and 18.7bn dollars for both fiscal years respectively CBE (2016). Moreover, the foreign currencies market witnessed heated waves of speculations against the Egyptian pound. As a result, the CBE devaluated the Egyptian pound in March 2016 by 14.3%. Furthermore, another sharp depreciation of 48% in November 2016 occurred. The depreciation was a part of comprehensive economic reforms reliant on a $12 billion loan over three-year from the International Monetary Fund.

By the end of 2017, the inflation rate accumulated to 29.51% with a premium of 15.69% over 2016. The high inflation rate prevailed during the next two years, with 14.40% and 9.15% for 2018 and 2019, respectively. Despite the high inflation accompanied by the devaluation, we cannot conclude that the inflation is due to the depreciation of the Egyptian pound. To follow up with the reforms suggested by the IMF, Egypt proceeded to cut subsidies on energy as well as raise regulated prices. For example, electricity prices were raised to 46 % in 2016, based on consumption brackets. Another increase was applied in 2017, up to 42% for households and 46 for businesses MERE (2016, 2017). In addition, fuel prices rose the day after the devaluation. The government replaced the old subsidy system with a cash-based system.

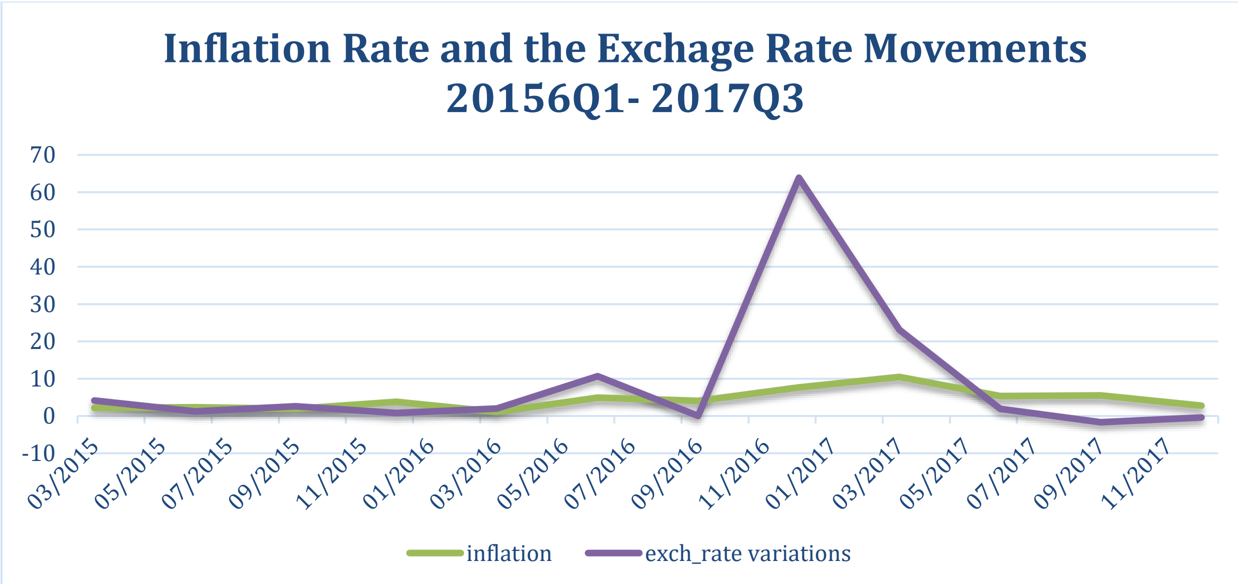

Figure 1

Source: Author's calculations based on CAPMAS data

Since Q1 of 2022, Egypt has devalued the pound by nearly 50% to exceed 30LE/ 1USD. In March 2022, the Central Bank of Egypt weakened Egypt's currency by almost 14% to compensate for withdrawing hot money from the treasury market. The growing tension between Ukraine and Russia shocked the global economy, especially the supply chains. In response, massive waves of capital outflow from emerging markets. In addition, economists anticipated that the US Federal Reserve might hike the rates to unprecedented levels. Although no official statements report the total capital outflow, the Egyptian Exchange statistics show that foreign investors have sold equities worth $196 million during the first quarter of 2022 EX (2022). Thus, the CBE weakened the pound's value in the foreign exchange markets and raised the interest rates, 17.25 % for lending and 16.25 % for the deposit, to mitigate the crucial impact of capital outflow and curb inflation. Given the economic situation, Consumer inflation for urban consumers rate hit 24.4% in December 2022 from 21.5% in November 2022 and 31.9% in February 2023, compared to 25.8% in January of the same year, approaching 50% over the first quarter of 2023. CAPMAS (2023). The latest large-scale depreciation in the exchange rate of the Egyptian pound against foreign currencies coincided with shockwaves of global food shortage caused by the Russia-Ukraine war. By mid-2022, prices of wheat increased internationally by 60%. Egypt gets around 85% of its wheat and 73% of its sunflower oil from Russia and Ukraine USDA (2022). In addition, Egypt suffers from rice shortage as the domestic producers were restrained from supplying the needed amount of rice as the price is lower than the prevailing global prices alongside the increase in supply cost.

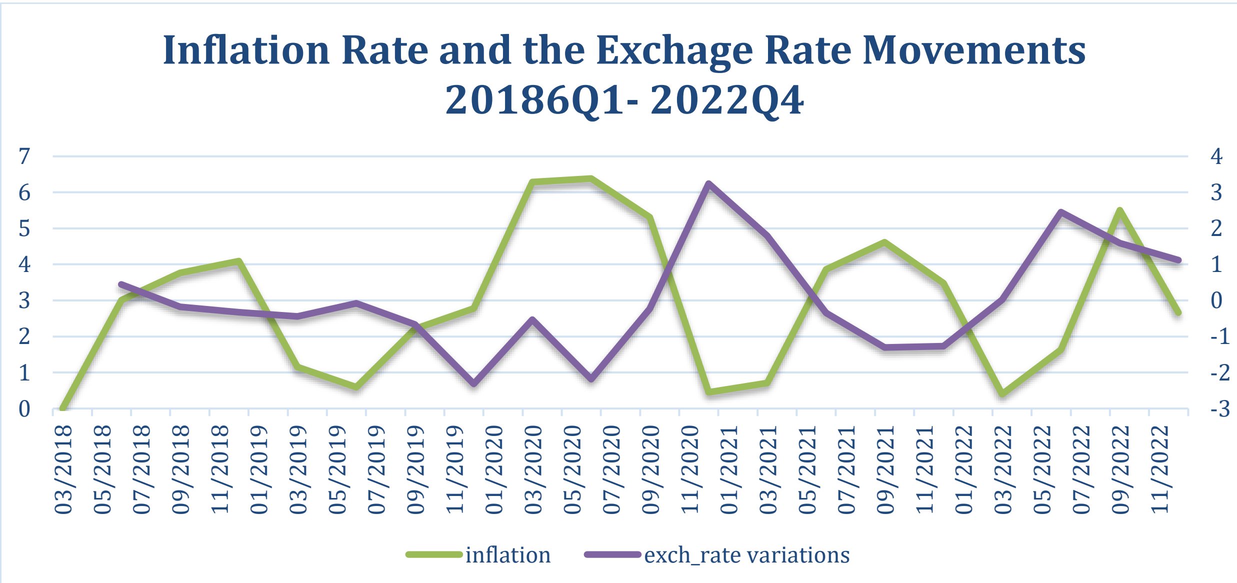

Figure 2

Source: author's calculations based on CAPMAS data

4. The Data and Their Properties

Quarter data covers the 2006Q1: 2022Q4 adopted from CAPMAS, FREED, and IFS to assess the pass-through of the nominal exchange rate to Egypt's consumer and producer prices. The SVAR model implies six exogenous and indigenous variables with a specific order in shocks and price chains. In the two subsections. We explore the exogamous variables as well as the price chain variables. Each variable in the system has an order along with the chain. Empirical analysis may suggest different orders for the same variable, based on the aim of the analysis. Table 1 summarizes by order of the variables used in the study.

Table 1: Data Sources and Description				
Variable, notation	Type	Unit	Description	Source
Oil Price, oil_price, μ_t^{oil}	External variable	USD/b	The global price of Brent Crude in US dollars per barrel	FRED
Output Gap, output_gap, Ý	External variable	expressed in terms of the real GDP	The difference between actual and potential GDP	Author's calculation
Money Supply, M_2	External variable	The growth rate of Money supply in local currency.	Money supply M2 includes the most liquid money.	CBE
Exchange Rate variations, Δe %	External variable	Percent change in exchange rate	The change in the exchange rate of the Egyptian pound against the US dollar	CBE
Import Prices, ΔIMP%	a price chain variable	Percentage change of import price index	The index measures the prices of imported goods weighted by the ratio of imports of a particular commodity to the total imports of all commodities according to 2010 prices.	CAPMAS
Producer Prices, ΔPPI%	a price chain variable	Percentage change of producer price index	The average prices paid by producers the production inputs based on 2010 prices.	CAPMAS
Consumer Prices, ΔCPI%	A price chain variable	Percentage change in consumer price index	The CPI is the index to measure the average prices of consuming goods by the average household.	CAPMAS

a. Exogenous Variables

The first set of variables is used to detect the shocks in Egypt's economy. Crude oil prices in USD variations are expected to impact all other variables as oil prices are the most external variable in the series of shocks. The crude oil prices for West Texas Intermediate (WTI) crude oil accounts for the crude oil prices prevailed in the United States. Intuitively, Egypt has a relatively small and open economy in the global oil market. Thus, oil prices have a one-way impact on macroeconomic variables, not vice versa. Despite the fact that the fuel market in Egypt is regulated by Egypt's Fuel Automatic Pricing Committee (FAPC), the argument for preferring crude oil prices over the fuel prices suggested by the committee is still valid. First, domestic prices are linked to the exchange rate and crude oil prices. Therefore, the model is likely to have endogeneity between oil prices and the nominal exchange rate. Second, global oil prices hit the macroeconomic variables in the medium-long run, even with the government's effort to eliminate the shocks by regulating prices in the short run.

As oil prices represent supply shocks, the output gap is widely accepted as a proxy to capture demand-side shocks. The output gap is generated by the deviation of the real GDP from the potential GDP. Given the limitation of not considering other data for the economy, such as inflation and unemployment, the Hodrick–Prescott filter calculates the potential GDP. The filter uses real GDP data to decompose the series' pattern as it estimates potential real GDP.

The nominal exchange rate comes in the third order of the sequence of the variables. Due to the limitations and incredibility of the parallel exchange rate data, official data from the central bank of Egypt. The gap between the official and parrel prices is substantial for some periods. However, both markets have almost similar patterns. Moreover, documentary credits are the procedure followed in contracts for importing in Egypt.

To account for the monetary policy, the money supply M2 has been used in estimating the ERPT. The shocks of monetary policy have a significant impact on price levels. However, there is no consensus in the literature on what order the money supply should be included in the analysis. The order in the analysis is based on how the money supply affects other factors or is affected by others. For example, Hahn (2003) assumed that monetary policies determine the output gap, not the reverse. Monetary shocks also have a synchronous impact on the exchange rate. Sato's (2008) study on exchange rate pass-through to consumer prices ordered monetary supply between the output gap and exchange rate as money supply targeting inflation which ends up with a depreciation or appreciation in domestic currencies against the foreigners in the currency market. In this study, the money supply is inserted ahead exchange rate as Egypt is an inflation-targeting country.

b. Pricing Chain Variables

The nominal exchange rate determines the prices of goods and services in a country relative to their prices in another country. Empirical studies on ERPT typically use the real effective exchange rate as the main variable of interest. However, Nafie et al. (2004) used the exchange rate in the parallel markets to investigate the exchange rate path-through in Egypt. As data about Egypt's the real effective exchange rates is limited, this study uses the nominal exchange rate of the US dollar against the domestic currency to estimate the ERPT. The exchange rate variable is followed by import prices, production prices, and finally consumer prices.

Import prices are the first in-chain price to be influenced by exchange rate movements. In this study, the import price index produced by Central Agency for Public Mobilization and Statistics, CAPMAS, and obtained from the IFS database proxies the import goods prices. The index includes the average prices of a basket of imported goods based on their ratio of the value of imports to the total value of imports of all commodities. Following the import prices, the impact of exchange rate variations transits to producer prices. When import prices increase, it can cause higher production costs. To account for input price pass-through, McCarthy (2000) suggested that producer prices or whole prices are interchangeably used to determine the intermediate prices. Based on this recommendation and data availability, the study uses the producer price index. Although their limitations, the consumer price index is the most comprehensive variable to measure the level of final consuming prices. CPI potentially weakens the impact of exchange rate fluctuations as the index includes a bulk of administrated goods and services.

c. Preliminary Tests

To estimate an SVAR model for ERPT in Egypt, it's important to run some tests to examine the preliminary statistical properties. These tests are conducted to check the validity of data characteristics to the assumptions of the model run. Accordingly, the researcher takes the decision to do further data transformations or change the model.

i. The Optimal Lag Test

Theoretically, the dynamics of VAR models assume that the set of variables is defined by the actual and historical values of variables in the system. Therefore, determining the optimal lag is a prerequisite step to estimating the structural VAR. The process to decide on the optimal lag is based on minimizing the information criteria. Information criteria estimate the goodness of fit to the selected model by measuring the loss in information. The method compares different specifications with different parameters to filter the best-fit model. Empirically, we have a set of estimated models. These models deviate from the true ones. The selection process estimates the distance of the deviation from the true model to minimize the Kullback-Leibler distance. In econometric theory, we have different information criteria based on the strength of the penalty on the complex. However, the general equation of a criterion can be summarized as follow:

$$IC = - \ln (Lt(k)) + \ln(t)/t.(k)$$

Where: Lt(k) is the likelihood of the model; k is the number of parameters; t is the number of observations in the sample; ρ_t is the decreasing function over time.

In practice, we have different criteria to identify the optimal number of lags such as the Akaike Information Criterion (AIC), the Bayesian information criterion (BIC) and the Hannan-Quinn Information Criterion (HQC).

The Bayesian Information Criterion, also known as Schwarz's Bayesian Information Criterion (SIC), is a common method to estimate the optimal lag with a minimum loss of information. Using the previous equation to estimate the least information criterion to get the Bayesian Information Criterion:

$$BIC = - \ln (Lt(k)) + \ln(t)/t.(k)$$

According to the Bayesian Information Criterion, the maximum lag is 7 which means that the shock continues for 21 months as shown in Table 2.

Lag	SIC
0	15.54993
1	15.87609
2	17.34110
3	17.44158
4	19.17728
5	20.21672
6	20.79002
7	**10.34765***

Table 2: Optimal Number of Lags Based on SIC.

ii. Stationarity Test

Theoretically, to deal with time series data, all observations must be first in a stochastic process. Stochasticity is the main process to ensure that the realizations of the time series are random. Stationarity is one of these important processes while dealing with time series data. A series is stationary if the mean and the variance are constant over all time periods. Stationarity also requires the covariance of the realizations, say Xt and Xt-j, to change over the length of time between these realizations, not over time itself. White noise is a type of stationarity where all frequencies are independent with a zero mean and constant variance. The process is drawn from the fact that all observations in the set must be uncorrelated with the error term. This process implies that all observations in the sample have equal and independent power. Therefore, we conduct a Dickey-Fuller test to ensure that all realizations are stationary at their levels. In order to perform the test, we assume a general model regresses observations to their historical values as follows:

$x_t = \alpha + \delta\, x_{t-1} + \varepsilon_t$ (1)

$x_t - x_{t-1} = \alpha + \delta\, x_{t-1} - x_{t-1} + \varepsilon_t$ call $(\delta - 1) = \beta$ (2)

$\Delta\, x_t = \alpha + \beta\, x_{t-1} + \varepsilon_t$ (3)

Where xt is a matrix of the variables of interest; $(\delta - 1) = \beta$; Δ the operator of $x_t - x_{t-1}$ and ε_t is the vector stochastic error term. In the last equation, the null hypothesis becomes H_0: $\beta=0$ instead of $\delta=1$. To reject the null hypothesis, the coefficient matrix β is significantly different from zero. Then, we use the ordinary least squares, OLS to estimate β. However, Dickey and Fuller (1979) criticized the estimation using the standard t-statistic because it doesn't follow the *t*-distribution, and he suggested using the Dickey-Fuller tables instead. Table 3 shows the results from running the unit root test.

Table (3): Results for the Unit Root Test		
Variables	Augmented Dickey-Fuller test statistic	
	Level	First Difference
Oil Prices	-2.260574	
Output Gap	-3.382729	
Nominal Exchange Rate	0.253035	-4.429981
IMP	-2.801179	-5.739210
PPI	2.066199	-4.217780
CPI inflation	-5.016647	
M2	-2.342683	-3.782817
Critical values for t- statistics are - 3.6, -2.9 and 2.6 at 1%, 5% and 10% respectively.		

The result from the test denotes that oil prices, output gap and CPI inflation are stationary at the level. However, Nominal exchange rate, import price index, production price index and money supply are stationary at the first difference.

5. Methodology

As mentioned above, our system, the nominal exchange rate pass-through to domestic pieces is estimated using an SVAR. The structural model is drawn on the same order suggested by McCarthy (2000). **From the literature overview, we can see that most empirical studies addressed the ERPT used a VAR model to investigate the dynamic relationship between a set of variables within a system. Applying this method is useful because the model considers each actual variable and past values of the variables in the system. This explains the transitional mechanism of the shock in a variable that affects other variables and explains a specific economic problem. However, the SVAR model addresses the main issue of the VAR model, which is the endogeneity problem among these variables. The usefulness of SVAR models is that a researcher can impose restrictions on the model's specification to detect the impact of the exchange rate movements given the behavior and the order of the price chain. These restrictions consider the sophistication of the ERPT, isolate the interaction of shocks, and provide the variance decomposition of each variable into the others within the system.** As mentioned in section 2, the variables order as follows: Oil prices, output gap, nominal exchange rate, import price index, producer price index, consumer price index and money supply (M2). The model tracks the dynamics of exchange rate shocks on domestic prices along the chain throughout the import prices and producer prices to consumer prices at last. The study utilizes the structural VAR to analyze the ERPT to domestic prices in Egypt. "Sims (1980) proposed the structural vector autoregression (SVAR) model as an extension of the vector autoregression (VAR) model. The SVAR model enables the investigation of the relationship between variables in a system, considering their contemporaneous and lagged values. Additionally, model identification is used to impose some restrictions on the actual and past values, underling the impact of structural shocks on variables in the dynamic system of interest. Assume a model of xt variables; θ_0 is an n x n matrix representing the Simultaneous relationships between these factors; $\theta(L)$ is the matrix of parameters; L represents the lag operator; εt is an N x 1 vector representing the economic shocks. The general form of a structural VAR of lags j can be represented as:

$\theta(L)\, x_t = \varepsilon_t$ (4)

$\theta(L) = \theta_0 L^0 - \theta_1 L^1 - \theta_j L^j + \ldots$ (5)

$\theta(L) = \theta_0 - \theta_1 L^1 - \theta_2 L^2 - \theta_j L^j + \ldots$ (6)

$\theta_0\, x_t = \theta_1\, x_{t-1} + \theta_2\, x_{t-2} + \theta_j\, x_{t-j} \ldots + \varepsilon_t$ (7)

$\theta_0\, x_t = \theta_0^{-1}\theta_1\, x_{t-1} + \theta_0^{-1}\theta_2\, x_{t-2} + \theta_0^{-1}\theta_j\, x_{t-j} \ldots + \theta_0^{-1}\varepsilon_t$ (8)

If $A_j = \theta_0^{-1}\theta_j$ (9)

$\theta_0\, x_t = A_1 x_{t-1} + \ldots + A_j x_{t-j} + \ldots + \mu_t$ (10)

Also, can be represented as:

$x_t = \theta^{-1}{}_0\theta\, A\,(L)\, x_{t-1} + \mu_t$ (11)

(j = 1, 2, ... N) and $\mu_t = \theta_0^{-1}\varepsilon_t$ and white noise.

To solve the system of equations, a number of N^N additional restrictions needed to be imposed as we have extra N^N coefficients. For the matrix θ_0 of shocks, we diagonalize the system by 1 to end up with (N^2-N) elements.

5.1 The model Identification

The model identification follows equation 11 where the vector x_t denotes the exogenous factors in the model: OIL_PRICES, OUTPUT_GAP, NEXR, IMP, PPI, CPI and M2 in order.

According to BIC, the optimal number of lags is 7 lags in the time horizon. Therefore, we need to impose number of 21 restrictions such that $\frac{N(N-1)}{2}$, according to Blanchard and Quah (1989).

$$A^{-1}(7) = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a21 & 1 & 0 & 0 & 0 & 0 & 0 \\ a31 & a32 & 1 & 0 & 0 & 0 & 0 \\ a41 & a42 & a43 & 1 & 0 & 0 & 0 \\ a51 & a52 & a53 & a54 & 1 & 0 & 0 \\ a61 & a62 & a63 & a64 & a65 & 1 & 0 \\ a71 & a72 & a73 & a74 & a75 & a76 & 1 \end{bmatrix}$$

Matrix A^{-1} is the inverse of the moving average of parameters with a number of 7 lags. The previous restrictions imply the variables are not correlated and assure their orders. The lower triangular matrix means allows the response of a variable in a specific order to its lags, and the diagonal 1 in the matrix reflects

100% of the responding shock on itself. Given the previous specification as well as the Therefore, we can present the system of functions as follow:

$\mu_t^{oil} = E_{t-1}[\mu_t^{oil}] + \varepsilon_t^{oil}$

$\acute{Y}_t = E_{t-1}[\acute{Y}_t] + \alpha_1\varepsilon^{oil} + \varepsilon_t^{\acute{Y}}$

$\Delta e_t = E_{t-1}[\Delta e_t] + \beta_1\varepsilon^{oil} + \beta_2\varepsilon_t^{\acute{Y}} + \varepsilon_t^{\Delta e}$

$\mu_t^{IMP} = E_{t-1}[\mu_t^{IMP}] + \gamma_1\varepsilon^{oil} + \gamma_2\varepsilon^{\acute{Y}} + \gamma_3\varepsilon_t^{\Delta e} + \varepsilon_t^{IMP}$

$\mu_t^{PPI} = E_{t-1}[\mu_t^{PPI}] + \theta_{1t}\varepsilon^{oil} + \theta_2\varepsilon_t^{\acute{Y}} + \theta_3\varepsilon_t^{\Delta e} + \theta_4\varepsilon_t^{IMP} + \varepsilon_t^{PPI}$

$\mu_t^{CPI} = E_{t-1}[\mu_t^{CPI}] + \delta_{1t}^{oil} + \delta_2\varepsilon_t^{\acute{Y}} + \delta_3\varepsilon_t^{\Delta e} + \delta_{4t}^{IMP} + \delta_5\varepsilon_t^{PPI} + \varepsilon_t^{CPI}$

$\Delta M_2 = E_{t-1}[\Delta M_2] + \lambda_1\varepsilon_t^{oil} + \lambda_2\varepsilon_t^{\acute{Y}} + \lambda_3\varepsilon_t^{\Delta e} + \lambda_4\varepsilon_t^{IMP} + \lambda_5\varepsilon_{tt}^{PPI} + \lambda_6\varepsilon^{CPI} + \varepsilon_t^{M2}$

where the μ_t^{oil} is the oil prices, $\acute{Y}$ is the output gap, Δe is the exchange rate movements, μ_t^{IMP} is the import prices inflation, μ_t^{PPI} is the producer prices inflation, μ_t^{CPI} is the inflation in consumer prices, ΔM_2 is the money growth, t denotes a three-month period.

6. Results

As mentioned in the previous sections, the study utilized a SVAR using seven variables: oil prices, the GDP gap, money supply growth, nominal exchange rate fluctuations, import price index, production price index, and consumer price index. The reduced form of residuals resulting in the SVAR is standardized by a Cholesky decomposition to be orthogonal to trace the structural shocks of the variables of interest.

In the estimated SVAR model, the number of lags is seven over the Sixty-four quarters. A typical VAR model output provides two main statistical methods, impulse responses and variance decomposition. These techniques are commonly used in econometrics to examine the exchange rate pass-through to domestic prices. Impulse responses identify a one-time shock of exchange rate variations to the import price index, producer price index, and consumer price index. Variance decomposition assesses the relative contributions of variables of interest to the variability of the nominal exchange rate over time.

a. Impulse Responses to Exchange Rate and Import Price Shocks

SVAR estimation shows the response of price indices to a one-time shock of the exchange rate. As discussed in the method section, the structural VAR assesses exchange rate shocks based on lagged values of all variables and real-time values of oil prices, the GDP gap, and money supply growth.

The solid line in the graphs 3.a and 3.b represents the response and the dotted lines depict the confidence level within two standard errors. The depreciation in the nominal exchange rate initially has a positive effect on the import price index as expected by theory. However, this positive impact lasts statistically significant for the next half of the coming quarter and then turns to become insignificant and fluctuates over time until diminishing. The impulse response of one standard shock of exchange rate depreciation has an initial positive impact on the producer price index over the first horizon period. This impact starts to be significant in the middle of the first quarter. For the consumer index, the response is lower than other responses of IMP and PPI.

To carry on with the price chain analysis, the responses of producer and consumer price indices to import price index were estimated. The analysis showed import prices has a relatively week but negative impact on price index and insignificant impact on the consumer prices. Finally, responses of the producer price index are statistically significant for less than one month following the shock although a weak transition.

b. Variance Decomposition:

Period	**IMP**	**PPI**		**CPI**			
	REER	**ERER**	**IMP**	**REER**	**IMP**	**PPI**	**CPI**
1	**61.18**	**47.57**	**37.13**	**21.18**	**3.95**	**0.020**	**36.24**
2	34.24	11.90	5.84	63.55	4.42	0.015	7.74
3	21.49	8.50	4.25	59.17	4.65	0.117	6.45
4	**32.26**	**13.47**	**3.42**	**54.78**	**4.31**	**0.224**	**6.023**
5	32.33	13.51	3.31	54.16	4.26	0.240	5.952
6	22.34	15.01	2.10	57.396	4.79	0.193	5.150
7	21.30	14.72	2.52	54.43	6.78	0.195	4.855
8	19.56	14.27	2.64	54.97	6.76	0.310	4.720
9	19.06	14.31	2.57	54.57	7.12	0.467	4.710

10	**17.20**	**11.10**	**2.088**	**53.30**	**7.36**	**0.460**	**4.324**
Table 4: The Impulse Response Function (IRF) for IMP, PPI and CPI.							

The impulse responses demonstrate the degree of pass-through to domestic prices, but the method does not reveal the contribution of each shock to fluctuations in domestic prices. Thus, variance decomposition is essential to have more comprehensive analysis as shown in Table 4.

For import prices, the exchange rate has a substantial role in import price variations. Initially, exchange rate variations explain about 61.18% in the first period and reaches 32.26% in the fourth quarter. This impact is persistent but declines over time to reach about 17.2 in the 10th quarter. Similarly, exchange rate fluctuations account for approximately 47.57% of the producer price variations observed during the initial period then decline in the 4th quarter. While this influence remains present, it gradually decreases over time to around 12 % in the tenth quarter. In addition, IMP contributes 37.13% to the PPI initially and falls below the 5% level in the following quarters till reaches about 2% in the 10th period.

In contrast, exchange rate variations explain 4% of the consumer price inflation in the first period. This impact jumps to 16% in the following five quarters, hitting a peak of 20% over the second half of the time horizon of the analysis. Then coming to the direct impact of the IMP on the CPI, it’s almost 3.95% in the 1st period, 7.12%, and 7.36% in the 4th and 10th periods respectively. However, the influence of PPI on CPI does not exceed 0.5% in the 10th period.

c. Estimating the Exchange Rate Pass-Through in Egypt

According to Goldberg and Knetter, (1997), exchange rate pass-through is defined as the magnitude to which the variations in exchange rate can affect the prices of imported goods valued in domestic currencies. Thus, the change in imported prices leads to changes in the consumer price. When economies are more open, inflation transits within trading economies through the exchange rate. Accordingly, the magnitude of exchange rate pass-through could be estimated as follows:

$$\Delta CPI = \beta_0 + \beta_1\ \Delta CPIt_{-1} + \beta_2\ \Delta(NEXR + FCPI) + \beta_3\ \Delta\ (NEXR\ t_{-1} + FCPI_{t-1}) + \beta_4\ \Delta(NEXR_{-2} + FCPIt_{-2})$$

Where the FCPI is the foreign consumer price index for the top 10 trade partners of Egypt. The resulting coefficients from the model are substituted in the equation: $(\beta_2 + \beta_3 + \beta_4)/ (1- \beta_1)$ ranges between 0 and 1 where 0 is no pass-through and 1 is complete ERPT. The estimation shows an incomplete pass-through where the magnitude is 0.693409. This means that when the Egyptian pound is depreciated by 1% raises the consuming prices by 0.69.34% on average.

The results are consistent with the findings of Nafie et al. (2004), Massoud (2014), and Helmy et al. (2018). In accordance with the response functions, the exchange rate pass-through to the domestic prices is relatively considerable but incomplete. This might be explained since the consumer price index in Egypt is made up of a substantial quantity of subsidized goods and commodities that have prices determined by an administering authority. Additionally, the analysis indicates that the degree of passthrough is significantly higher for the Consumer Price Index (CPI) compared to the Producer Price Index (PPI). This is due to that the producer index does not compose any of the imported goods. Finally, import prices, as expected, are more sensitive to exchange rate shocks. This might be attributed to the fact that importers decrease their profit margins rather than increase prices, given that import price elasticity is relatively high.

d. Robustness Analysis

Taylor (2000) assumed that the extent to which exchange rate movements are transmitted to domestic prices is dependent on the prevailing level of inflation in the economy. The author hypothesizes that the trustworthiness and efficiency of monetary policies is reflected on the exchange rate pass-through. The reasoning behind the author's assumption is that the confidence of firms in the efficiency of monetary policies, and accordingly inflation expectations, influence their decisions about transiting the actual and expected inflations to production costs. Drawing on Taylor's (2000) argument, this study suggests that the Egyptian authorities' excessive money supply has resulted in consequences such as inflation and currency depreciation, which have led to public questioning of the credibility of the monetary policies aimed at addressing these issues. Accordingly, ignoring the role of money supply by last literature conducted on ERPT in Egypt led to inaccurate estimation of the pass-through to prices. Therefore, the study run a robustness check to test the role of money supply growth on exchange rate pass-through to the domestic prices. In general, a robustness check on the benchmark model tests the reliability and validity of results under different specifications. The alternative specification analyzes the consistency of results in in light of the monetary policies. This specification put the money supply ahead of the nominal exchange rate which can be as follows:

$$\mu_t^{oil} = E_{t-1}[\mu_t^{oil}] + \varepsilon_t^{oil}$$

$$\acute{Y}_t = E_{t-1}[\acute{Y}_t] + \alpha_1\varepsilon^{oil} + \varepsilon_t^{\acute{Y}}$$

$$\Delta M_2 = E_{t-1}[\Delta M_2] + \lambda_1\varepsilon^{oil} + \lambda_2\varepsilon^{\acute{Y}} + \varepsilon_t^{M2}$$

$$\Delta e_t = E_{t-1}[\Delta e_t] + \beta_1\varepsilon^{oil} + \beta_2\varepsilon^{\acute{Y}} + \beta_3\varepsilon^{M2} + \varepsilon_t^{\Delta e}$$

$$\mu_t^{IMP} = E_{t-1}[\mu_t^{IMP}] + \gamma_1\varepsilon^{oil} + \gamma_2\varepsilon^{\acute{Y}} + \gamma_3\varepsilon^{\Delta e} + \varepsilon_t^{IMP}$$

$$\mu_t^{PPI} = E_{t-1}[\mu_t^{PPI}] + \theta_1\varepsilon^{oil} + \theta_2\varepsilon^{\acute{Y}} + \theta_3\varepsilon^{\Delta e} + \theta_4\varepsilon^{IMP} + \varepsilon_t^{PPI}$$

$$\mu_t^{CPI} = E_{t-1}[\mu_t^{CPI}] + \delta_1^{oil} + \delta_2\varepsilon^{\acute{Y}} + \delta_3\varepsilon^{\Delta e} + \delta_4^{IMP} + \delta_5\varepsilon^{PPI} + \varepsilon_t^{CPI}$$

Comparing the output from the baseline and extended model. As a result, the estimation is not robust. The findings of the alternative specification investigate that the money supply has a significant impact on the exchange rate variations as well as the inflation prices. The variance decompositions of CPI show that the exchange rate explains only 4.4% of the variations in consumer goods prices in the first period and it increases over time until reaching 19.75% in the 10th period. Another interesting result from the model is the money supply explains almost 31% - 41% of the variations of CPI while the CPI inflation is only 12% of the variations of the CPI itself. These results shed light on the influence of the money supply on the nominal exchange rate. Although the Contractionary Policies by the CBE curb inflation after the devaluations, these results need further analysis to investigate the increase in the money supply either by expansionary policies or seigniorage. This questions the validity that the inflationary environment assumption by Krugman and Taylor (2000), at which the extent of openness and inflation levels play an important role in the degree of pass-through of exchange rate variations, at least the CPI.

Table 5: Variance Decomposition for the Robustness Check								
Period	S.E.	Oil Prices	Output Gap	M2	REER	IMP	PPI	CPI
1	**0.0114**	**10.446**	**28.164**	**31.110**	**4.444**	**5.167**	**8.278**	**12.39**
2	0.0246	18.250	6.006	52.3110	16.863	2.119	1.775	2.676
3	0.0272	20.085	9.496	47.5699	17.422	1.761	1.464	2.202
4	**0.0283**	**21.671**	**12.937**	**44.051**	**16.115**	**1.656**	**1.467**	**2.103**
5	0.0285	21.420	13.919	43.564	15.916	1.634	1.477	2.075
6	0.0329	21.746	10.680	44.554	18.614	1.2889	1.337	1.778
7	0.0343	21.546	12.151	41.555	20.353	1.495	1.236	1.664
8	0.0348	21.249	11.906	42.727	19.780	1.457	1.246	1.634
9	0.0350	21.180	11.835	42.910	19.785	1.435	1.248	1.608
10	**0.0366**	**23.479**	**10.966**	**41.529**	**19.743**	**1.625**	**1.168**	**1.489**

7. Conclusion

The study analyzed the ERPT to the import prices, producer prices, and consumer prices in Egypt during 2006Q1: 2022Q2. Despite the number of observations which is limited to 68, the results show that the exchange rate pass-through in Egypt is incomplete. Even though the pass-through channel, import and producer prices, transit the variations in the exchange rate to the consumer goods, the impact is weak and substantially low. These findings are consistent with the literature that studied the phenomenon in Egypt. This may be due to the composition of the CPI index, which consists of a large amount of subsidized and regulated goods and services. In addition, the producing prices do not include the imported goods. However, the extended analysis considered monetary policy finds that money supply plays a crucial role in the attribution of exchange rate movements. In the presence of money supply, the exchange rate explains less than 20% of the variations in consumer prices during the 10th period of the analysis horizon time. In addition, the inflationary environment assumption is not applicable to understanding the inflation behavior in consumer prices. Alternatively, the money supply heavily impacts CPI inflation. CPI inflation responds by more than 40% of the shocks in the money supply. These results have important implications for policymakers while targeting inflation and managing the appropriate exchange rate regime. Controlling the money supply can effectively eliminate the shocks of currency devaluations. In addition, it's recommended that the government should consider fiscal policies besides monetary policies. Excessive government expenditure should be decreased to curb the high rate of inflation. Given the Egyptian context, the government runs a huge budget deficit addressed by expansionary policies via borrowing or seigniorage. These expansionary policies and government expenditure motivate high rates of inflation. However, the interaction between monetary and fiscal policies, exchange rates, and domestic prices needs more attention and further research**.**

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9. Index

Period	IMP	PPI	CPI
1	-0.005057	0.000129	0.003652
	(0.00647)	(0.00213)	(0.00139)
2	0.017672	0.023078	0.016774
	(0.01768)	(0.00621)	(0.00426)
3	0.003545	-0.010531	-0.000510
	(0.02388)	(0.01524)	(0.00725)
4	-0.001912	0.005596	-0.004404
	(0.02910)	(0.01661)	(0.00707)
5	-0.013829	-0.003637	-0.006464
	(0.03073)	(0.01720)	(0.00744)
6	0.004167	-0.006258	-0.013786
	(0.03088)	(0.01771)	(0.00777)
7	0.017277	0.010462	-0.000186
	(0.03565)	(0.02080)	(0.00960)
8	-0.018967	0.002435	0.008268
	(0.03596)	(0.02195)	(0.01015)
9	0.004521	0.004837	0.007481
	(0.03597)	(0.02228)	(0.01095)
10	-0.007313	-0.008895	-0.005788
	(0.03625)	(0.02312)	(0.01214)

Cholesky Ordering: OIL_PRICE GDP_GAP REER IMP PPI CPI I
Standard Errors: Analytic

Period	IMP	PPI	CPI
1	-0.027103	-0.010799	-0.002396

	(0.00344)	(0.00164)	(0.00079)
2	0.010867	0.008361	0.009834
	(0.00997)	(0.00453)	(0.00336)
3	-0.004941	-0.000253	0.005141
	(0.01307)	(0.01092)	(0.00673)
4	0.027637	0.015011	6.90E-05
	(0.01542)	(0.01157)	(0.00662)
5	0.013537	0.004032	-0.000289
	(0.01714)	(0.01219)	(0.00649)
6	-0.012275	-0.017917	-0.008513
	(0.01788)	(0.01229)	(0.00638)
7	-0.002620	-0.002843	-0.006120
	(0.02362)	(0.01802)	(0.00833)
8	-0.009799	0.002162	-0.000105
	(0.02290)	(0.01672)	(0.00854)
9	-0.003089	-0.004686	-0.001987
	(0.02612)	(0.01751)	(0.00833)
10	0.003987	-0.006623	-0.004645
	(0.02518)	(0.01811)	(0.00853)

Cholesky Ordering: OIL_PRICE GDP_GAP M2 REER IMP PPI CPI
Standard Errors: Analytic

Variance Decomposition of IPI: Period	S.E.	OIL_PRICE	GDP_GAP	M2	REER	IPI	PPI	CPI
1	0.034652	6.238693	0.237911	5.627840	61.17715	26.71841	0.000000	0.000000
2	0.049899	24.96472	6.970735	15.53829	34.24520	13.36041	1.379529	3.541111
3	0.063891	41.15928	9.434895	15.89207	21.48680	8.217098	1.198597	2.611260
4	0.071323	33.03023	7.743438	13.73629	32.25665	9.973137	0.961935	2.298315
5	0.075120	32.51399	8.782483	12.76898	32.32577	10.14007	0.894937	2.573773
6	0.094012	37.36741	18.19005	12.54381	22.34411	6.490532	1.170930	1.893156
7	0.096446	39.19562	17.54607	12.21081	21.30438	6.507977	1.400292	1.834852
8	0.103056	34.33068	15.40067	21.98224	19.56295	5.856748	1.259199	1.607518
9	0.104645	34.71568	14.93754	22.57027	19.06051	5.702834	1.361327	1.651840
10	0.110577	33.03948	14.04239	27.78758	17.20048	5.230611	1.220085	1.479377

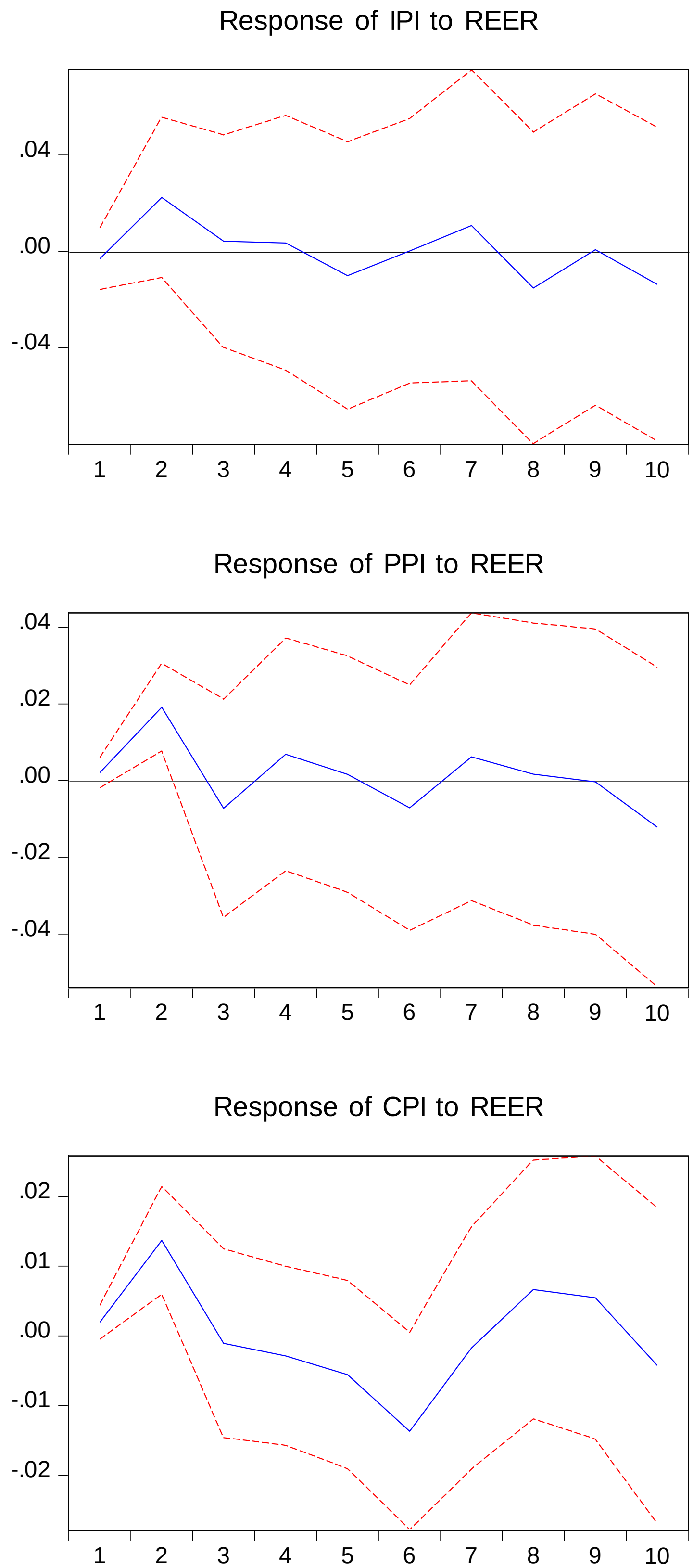
Variance Decomposition of PPI: Period	S.E.	OIL_PRICE	GDP_GAP	M2	REER	IPI	PPI	CPI
1	0.015657	0.227659	2.803754	9.571257	47.56729	37.13424	2.695804	0.000000
2	0.039597	30.56784	7.595617	42.57632	11.89635	5.835703	1.024085	0.504083
3	0.046866	48.22413	7.017673	30.84829	8.495165	4.249041	0.805630	0.360075
4	0.055296	36.66885	13.94327	31.54269	13.47232	3.424211	0.689560	0.259102
5	0.056287	35.39308	13.62903	33.04941	13.51523	3.307801	0.790316	0.315129
6	0.070647	41.67155	17.25322	22.37874	15.01092	2.099726	0.923415	0.662429
7	0.071734	42.18164	16.82823	22.01109	14.71672	2.522597	1.034710	0.705005
8	0.073065	40.82626	16.40759	24.13900	14.27267	2.641356	1.010433	0.702691
9	0.074006	39.88878	16.03183	25.35678	14.31313	2.574950	1.098222	0.736302

10	0.083063	37.83084	15.37353	31.22013	11.99770	2.087782	0.885686	0.604323

Variance Decomposition of CPI: Period	S.E.	OIL_PRICE	GDP_GAP	M2	REER	IPI	PPI	CPI
1	0.011368	10.44640	28.16407	31.10991	4.444041	5.167073	8.278137	12.39036
2	0.024648	18.24973	6.006403	52.31104	16.86262	2.118696	1.775617	2.675897
3	0.027197	20.08458	9.495939	47.56988	17.42202	1.761431	1.463873	2.202266
4	0.028279	21.67100	12.93732	44.05065	16.11541	1.655571	1.467428	2.102629
5	0.028465	21.41528	13.91863	43.56434	15.91563	1.633998	1.476770	2.075357
6	0.032895	21.74607	10.68047	44.55400	18.61435	1.288826	1.336550	1.779735
7	0.034259	21.54609	12.15098	41.55510	20.35282	1.495439	1.235667	1.663903
8	0.034752	21.24873	11.90637	42.72773	19.77986	1.456549	1.246523	1.634242
9	0.035034	21.18014	11.83524	42.90950	19.78451	1.434477	1.248039	1.608096
10	0.036596	23.47891	10.96627	41.52894	19.74294	1.625457	1.168313	1.489176

Cholesky Ordering: OIL_PRICE GDP_GAP M2 REER IPI PPI CPI

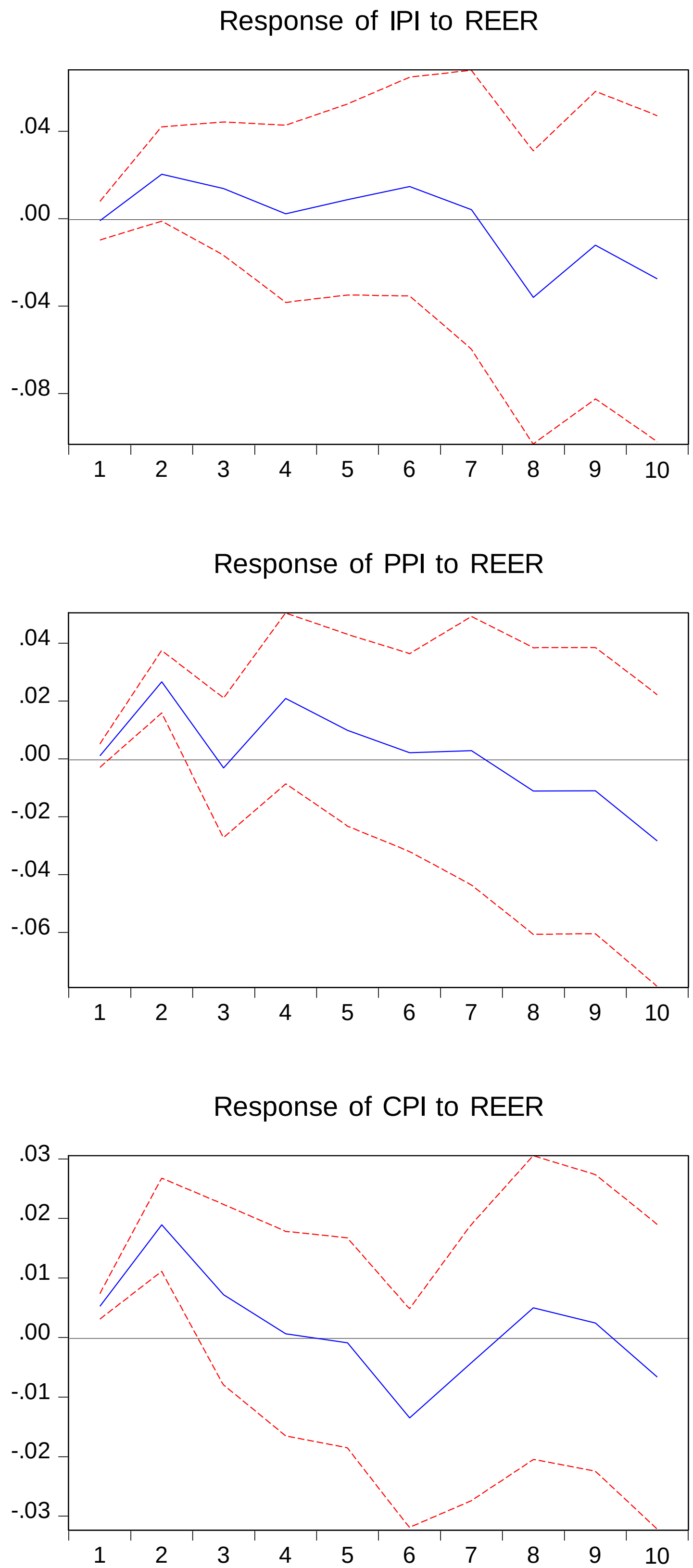
Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



Period	IMP	PPI	CPI
1	-0.003008	0.002092	0.001971
	(0.00642)	(0.00198)	(0.00121)
2	0.022433	0.019127	0.013702
	(0.01662)	(0.00571)	(0.00386)
3	0.004230	-0.007227	-0.001051
	(0.02206)	(0.01422)	(0.00678)
4	0.003537	0.006838	-0.002884
	(0.02648)	(0.01518)	(0.00643)
5	-0.010096	0.001638	-0.005572
	(0.02776)	(0.01542)	(0.00676)
6	0.000214	-0.007084	-0.013686
	(0.02748)	(0.01600)	(0.00709)
7	0.010757	0.006168	-0.001742
	(0.03229)	(0.01875)	(0.00870)
8	-0.015160	0.001670	0.006655
	(0.03236)	(0.01970)	(0.00929)
9	0.000764	-0.000303	0.005486
	(0.03233)	(0.01991)	(0.01016)
10	-0.013682	-0.012119	-0.004258
	(0.03259)	(0.02085)	(0.01131)

Cholesky Ordering: OIL_PRICE GDP_GAP I REER IMP PPI CPI
Standard Errors: Analytic

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



Period	IMP	PPI	CPI
1	-0.000943	0.001109	0.005231
	(0.00440)	(0.00202)	(0.00106)
2	0.020417	0.026720	0.018940
	(0.01078)	(0.00538)	(0.00391)
3	0.013729	-0.003075	0.007182
	(0.01525)	(0.01205)	(0.00758)
4	0.002201	0.020869	0.000621
	(0.02028)	(0.01475)	(0.00859)
5	0.008778	0.009904	-0.000892
	(0.02187)	(0.01657)	(0.00882)
6	0.014699	0.002145	-0.013499
	(0.02501)	(0.01712)	(0.00919)
7	0.004092	0.002836	-0.004212
	(0.03192)	(0.02322)	(0.01160)
8	-0.035935	-0.011131	0.005004
	(0.03351)	(0.02479)	(0.01275)
9	-0.012074	-0.010980	0.002448
	(0.03518)	(0.02474)	(0.01247)
10	-0.027527	-0.028323	-0.006639
	(0.03730)	(0.02524)	(0.01281)

Cholesky Ordering: OIL_PRICE GDP_GAP REER IMP PPI CPI M2
Standard Errors: Analytic

Null Hypothesis: CPI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.685177	1.0000
Test critical values:	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI)
Method: Least Squares
Date: 04/02/23 Time: 19:42
Sample (adjusted): 9/01/2006 12/01/2022
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI(-1)	0.016778	0.006248	2.685177	0.0093
D(CPI(-1))	0.426265	0.128666	3.312961	0.0015
C	0.061869	1.086010	0.056969	0.9548

R-squared	0.356299	Mean dependent var	4.993774
Adjusted R-squared	0.335864	S.D. dependent var	5.021456
S.E. of regression	4.092214	Akaike info criterion	5.700438
Sum squared resid	1055.012	Schwarz criterion	5.799968
Log likelihood	-185.1145	Hannan-Quinn criter.	5.739767
F-statistic	17.43573	Durbin-Watson stat	1.966272
Prob(F-statistic)	0.000001		

Null Hypothesis: I has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.429397	0.1378
Test critical values:	1% level	-3.534868	
	5% level	-2.906923	
	10% level	-2.591006	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(I)
Method: Least Squares
Date: 04/02/23 Time: 19:44
Sample (adjusted): 12/01/2006 12/01/2022
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I(-1)	-0.071232	0.029321	-2.429397	0.0181
D(I(-1))	0.492972	0.123817	3.981450	0.0002
D(I(-2))	0.205702	0.128390	1.602166	0.1143
C	0.813424	0.328492	2.476236	0.0161

R-squared	0.383003	Mean dependent var	0.071259
Adjusted R-squared	0.352659	S.D. dependent var	0.850976
S.E. of regression	0.684674	Akaike info criterion	2.139816
Sum squared resid	28.59548	Schwarz criterion	2.273624
Log likelihood	-65.54401	Hannan-Quinn criter.	2.192612
F-statistic	12.62200	Durbin-Watson stat	1.913646
Prob(F-statistic)	0.000002		

Null Hypothesis: IMP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.801179	0.0636
Test critical values:	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IMP)
Method: Least Squares
Date: 04/02/23 Time: 19:45
Sample (adjusted): 9/01/2006 12/01/2022
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMP(-1)	-0.154175	0.055039	-2.801179	0.0068
D(IMP(-1))	0.398902	0.118078	3.378299	0.0013
C	44.28388	15.69377	2.821748	0.0064

R-squared	0.195888	Mean dependent var	1.489645
Adjusted R-squared	0.170360	S.D. dependent var	21.45396
S.E. of regression	19.54124	Akaike info criterion	8.827321
Sum squared resid	24057.19	Schwarz criterion	8.926851
Log likelihood	-288.3016	Hannan-Quinn criter.	8.866650
F-statistic	7.673640	Durbin-Watson stat	1.946996
Prob(F-statistic)	0.001041		