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Exchange rate pass-through to inflation in Egypt: a structural VAR approach

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Abstract

Purpose – The theoretical and empirical literature stipulated that exchange rate shocks do influence the domestic price of imports. Hence, this paper aims to investigate the underlying relationship between the exchange rate and prices known as the exchange rate pass-through.

Design/methodology/approach – The paper uses a structural vector auto-regression (SVAR) model, drawing on Bernanke (1986) and Sims (1986), to empirically examine and analyze the pass-through of exchange rate fluctuations to domestic prices in Egypt.

Findings – The empirical results of the monthly data between 2003 and 2015 revealed that the exchange rate pass-through in Egypt is fairly substantial but incomplete and slow in the three price indices [IMP, producer price index and consumer price index (CPI)]. However, the impact is more prominent for consumer prices than for any other price index. This finding could be attributed to the fact that the CPI in Egypt is composed of a relatively large number of subsidized commodities and goods with administered prices as well as the authorities' behavior in manipulating prices (i.e. export ban). This is expected to weaken the transmission of exchange rate shocks.

Practical implications – The result has interesting implications for Egypt's ability to attain an effective inflation targeting regime.

Originality/value – The study contributes to the literature by assessing the effect of changes in the exchange rate (the Egyptian £ *vis-à-vis* the US$) on prices using an updated time series from 2003 to 2015. It addresses the limitations of the study of Nafie *et al.* (2004), which found no strong relationship between the exchange rate and inflation rate in the Egyptian context. One of these limitations was using the CPI, as the only price index.

Keywords Monetary policy, Inflation rate, Exchange rate pass-through, Structural vector auto-regression

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1. Introduction

Egypt's macroeconomic policies have significantly evolved since the 1990s. Its exchange rate regime varied over the past decades. In 2003, Egypt adopted a flexible exchange rate regime mainly because of the unavailability of dollars at official prices which led to the growth of black market transactions. This liberalization of the Egyptian £, led to a cumulative depreciation of 68 per cent against the US$ from 2000 to 2004. Meanwhile, Egypt witnessed high inflation rates according to the consumer price index. As exchange rate is one determinant of inflation, changes in exchange rates are considered important in the design of monetary policy, especially when a country has a flexible exchange rate policy as well as an open trade policy. It has thus been an ongoing challenge for economists to examine the exchange rate pass-through to domestic prices.

Exchange rate has been considered an important macroeconomic instrument that could help in ensuring low levels of inflation rate and a stable financial system. The literature has stipulated that exchange rate shock does influence domestic price of imports. This shock is transmitted to producer and then consumer prices. McCarthy (2000), Soto and Selaive (2003) and Takhtamanova (2008) identified the degree of openness as an influential factor in the exchange rate pass-through. They argued that the greater the degree of openness, the larger is the pass-through. Furthermore, Krugman (1989); Darvas (2001); Steel and King (2004); Beirne and Bijsterbosch (2009); and Razafimahefa (2012) argued that the exchange rate regime is another determinant that could affect the pass-through of exchange rate to the domestic prices. In fixed regimes, economic agents consider that a change in the exchange rate is permanent and will have a permanent impact on their production costs. Therefore, they adjust selling prices rapidly. In contrast, in flexible regimes, economic agents consider changes in the exchange rate as temporary. Hence, they do not adjust their selling prices immediately. Moreover, Taylor (2000) developed a theoretical model to examine the role of lower and more stable inflation in reducing the degree to which firms "pass-through", to their domestic prices, the impact of the exchange rate movements. According to Taylor's model, the pass-through and persistence of price changes are directly related. When firms decide how much to adjust their prices, they take into account expectations of future costs and price movements. Taylor's study also presented econometric evidence of a reduction in the persistence of aggregate inflation as the inflation rate was reduced. Therefore, lower inflation is associated with lower persistence of cost changes (shocks) in the economy. Consequently, Taylor's model demonstrated that experiencing a lower inflation environment (e.g. because of an inflation-targeting policy) may lead to a lower degree of persistence of price shocks, hence decreasing the degree of the exchange rate pass-through.

Two channels of exchange rate pass-through to domestic prices are distinguished in the literature: a direct and/or an indirect channel. Both become more important with an increase in the openness of an economy. The direct channel of transmission has two alternatives; the first is when the changes in exchange rate affect the import prices (IMPs) of production inputs (semi-finished goods and raw materials), which affect the producer price level, and finally, influence the consumer price level. The other alternative is when the changes in the exchange rate affect the IMPs of finished goods, and thus impact the level of domestic consumer prices. The indirect channel of exchange rate pass-through refers to the competitiveness of goods in international markets. Similarly, the indirect transmission channel has two alternatives; one alternative occurs if the locally produced goods are primarily inputs of production. In this case, producer price levels are expected to rise and consequently consumer price levels. The other alternative occurs if the locally produced goods are finished products. Accordingly, local producers and retailers may increase their selling prices in response to foreign competitor price increases to maintain their profit

margins. Hence, the shock is transmitted to consumer prices (Hyder and Shah, 2004). The degree of pass-through, however, falls within a wide range, starting from zero to complete pass-through. The degree of pass-through is determined according to the firms' behavior regarding the changes in exchange rate. Firms usually choose between keeping the markups unchanged and preserving the level of the sales price, otherwise balancing both alternatives (yang).

Many empirical studies, including Mwase (2006), Nafie *et al.* (2004) and Bwire *et al.* (2013), showed that incomplete pass-through is a common phenomenon. The findings of Goldfajn and Werlang (2000), McCarthy (2000) and Ca' Zorzi *et al.* (2007) concluded that the exchange rate pass-through effect estimates across countries were significantly different. Moreover, other studies, like McCarthy (2000), Bhundia (2002) and Ca' Zorzi *et al.* (2007), concluded that the exchange rate affects the prices, and that this impact declines along different stages of the distribution process. Belaisch (2003) indicated that shocks to exchange rate had little effect on the Brazilian consumer price index (CPI). However, prices of tradable goods were the most sensitive to these exchange rate shocks. Both Hyder and Shah (2004) and Rowland (2004) found that exchange rate pass-through is limited for consumer prices, compared to the producer prices in Pakistan and Colombia, respectively. Contrarily, Tandrayen-ragoobur and Chicooree (2013) and Uddin *et al.* (2014) found that the exchange rate pass-through to consumer prices is highest in Mauritius and Bangladesh, respectively.

The purpose of the study at hand is to estimate the impact of changes in exchange rate on domestic prices, in Egypt during the period 2003-2015. The study contributes to the literature by assessing the effect of changes in the exchange rate (the Egyptian £ *vis-à-vis* the US$) on prices using an updated time series from 2003 to 2015, right after the transition to a flexible exchange rate regime. The study also includes the period when the intention of adopting an inflation-targeting policy was formally announced by the CBE in June 2005. It addresses the limitations of the study of Nafie *et al.* (2004), which found no strong relationship between the exchange rate and inflation rate in the Egyptian context. One of these limitations was using the CPI, as the only price index.

Unlike most of the empirical studies that tackled the pass-through effect in Egypt using a VAR model, this study applies a structural vector auto-regression model (SVAR). Recent empirical studies preferred to use SVAR models as VAR models were criticized of being devoid of any economic content. The SVAR models are used to study the average response of the model variables to a given one-time structural shock. They provide historical decompositions that measure the cumulative contribution of each structural shock to the evolution of each variable over time. The data used are mainly obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF), the Ministry of Planning and the Food and Agricultural Organization (FAO).

The rest of the study is arranged as follows: Section 2 presents an overview of the Egyptian macroeconomic environment, focusing specifically on the exchange rate, as well as the inflation rate developments, together with a preliminary correlation analysis of the variables of interest. Data and methodology of the baseline model are discussed in Section 3, besides the proposed extended experiments. These extended experiments are expected to test the robustness of the results and their sensitivity to different specifications. Finally, in Section 4, the study provides a discussion of the main results and highlights some policy implications.

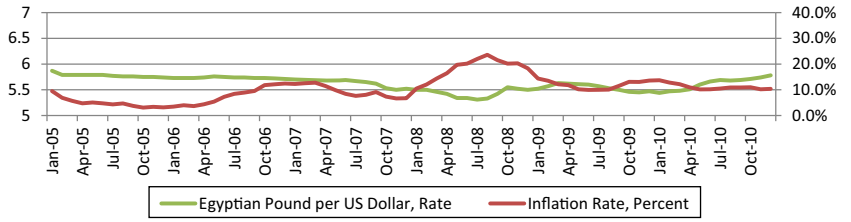
2. An overview of the Egyptian context

Before estimating and analyzing the degree of exchange rate pass-through to domestic prices in Egypt, it is quite essential to understand and relate the country's exchange rate

policies and its inflation rate trends. Accordingly, this section presents an overview of the Egyptian macroeconomic environment, to provide an adequate background for the investigation of exchange rate pass-through in Egypt.

Egypt began a transition to a flexible exchange rate regime in 2000, a first attempt to a floating regime in January 2003 and the successful transition to a unified flexible exchange rate regime in late-2004. From 2000 to 2004, the Egyptian £ experienced a cumulative depreciation of 68 per cent against the US$. The turbulence in the foreign exchange market, during this phase, was reflected in highly volatile domestic prices. The inflation rates accelerated to double digit levels to reach a peak of 12.6 per cent in October 2004. The persistently high price levels, prevailed during 2004, can be attributed to the lagged pass-through effects of the exchange rate changes. In December 2004, the Central Bank of Egypt (CBE) launched the interbank foreign exchange market and the pound appreciated by about 4 per cent within one quarter of this launch. During this period the preference of saving in local currency increased, which was attributed to the stability of the foreign exchange and the remarkable increase in the key CBE interest rates. The excess liquidity in the banking system prompted the CBE to recurrently intervene through open market operations to sterilize the effect of the increase in international reserves at the CBE. In doing so, the CBE either used its traditional instruments, such as the treasury bills, or created new instruments, like the CB notes with maturities over one to two years and the CBE certificates of deposits (CDs) with maturities spanning up to one year, which the CBE sells to banks through outright sales. The final two instruments were introduced to the market during 2005 and 2006. The monetary transmission mechanism, especially that related to the interest rate, improved as market interest rates on deposits and loans became more responsive to the CBE's key policy rates. Furthermore, during this period, the monetary policy committee (MPC) announced the adoption of a new monetary policy framework, namely, inflation-targeting, as of June 2005, upon the fulfillment of certain prerequisites. As a result, the inflation rate eased and reached a single digit rate from the beginning of 2005 to October 2006 (Figure 1).

Inflation started to rise and spiked from October 2006 to April 2007 reaching 11.47 per cent. This shooting of inflation rate was driven largely by the impact of an Avian Flu outbreak and adjustments in administered prices in conjunction with some domestic demand pressures emanating from high economic growth. Once again, the inflation rate gradually increased reaching a peak of 23.62 per cent in August 2008, as depicted in Figure 1. This increase could be attributed to the rise in the international food prices and some oil products. The CBE cut policy rates six times between February and September 2009. Consistent with lower commodity prices and weaker demand, inflation declined rapidly from peaks in August 2008 to around 10.07 per cent by August 2009. Moreover, the CBE launched its core inflation index in October 2009 to supplement the CPI



Source: Authors' calculations based on IFS data

Figure 1. Inflation rate and exchange rate movements, 2005-2010

published by the statistical authorities. In the few months following the Lehman Brothers' collapse in September 2008, the pound depreciated by about 6 per cent. However, in December 2009, the exchange rate appreciated almost to its precrisis level with resumed capital inflows and official reserves reaching their precrisis levels of US $34bn as well.

The year 2011, however, was considered a turning point at the level of political transition. It was characterized by political uncertainty and social unrest, which kept growth rates low, impacted policy performance and clouded the economic outlook. Financial fragilities have continued to build up with rising fiscal deficits, inflation and debt. In December 2012, the CBE introduced a new mechanism, namely, the Foreign Exchange Auctions (FX auctions), to run alongside the dollar interbank system. Following the introduction of the FX auctions, the pound depreciated by 13 per cent, the exchange rate increased from LE 5.80 in January 2011 to LE 7.26 in the corresponding months of 2015 as depicted in Figure 2. The significant decrease in foreign reserve during this period urged the reemergence of the parallel market. Nonetheless, the CBE announced a number of decisions and restrictions to combat the emergence of the parallel market. Inflation rates were highly volatile during the period 2011-2015. The high inflation rate during 2011 (11.4 per cent) to March 2012 (9.04 per cent) could be attributed to the appreciation of the US$ *vis-à-vis* the Egyptian £. Moreover, the political and security unrest in Egypt negatively affected commodity supply in local markets, especially fuel and butane gas cylinders that witnessed several supply bottlenecks. In November 2013, the inflation rate registered its highest level (12.94 per cent) in about three years (since January 2010). This was attributed to government's decision of revising the prices of several regulated items within the CPI basket, which led to a pickup in the monthly share of most of the CPI subgroups, especially restaurants and hotels; healthcare; and food and nonalcoholic beverages.

At the beginning of 2014, inflation rate eased down and reached a single digit rate, mainly because of the lower contributions of some main commodity groups in the CPI. However, inflation rate picked up in the third quarter of 2014 because of fuel and tobacco price hikes in July 2014, reaching 10.13 per cent in December, while core inflation was 7.6 per cent. To control the inflationary pressure, the MPC decided to raise the key policy rate by 100 basis points in July 2014. However, the MPC decided in its meeting in January 2015 to cut the overnight deposit and lending rates, as well as the rate of the CBE's main operation by 50 basis points. This decision came in response to the revisions in inflation rate and the MPC's assessment of inflationary pressures. The headline inflation, as shown in Figure 2, reached 11.3 per cent in June 2015 and eased up afterward to reach 9.7 per cent in October 2015. In December 2015, the inflation rate increased again which led the MPC to raise the policy rates once again by 50 basis points[1].

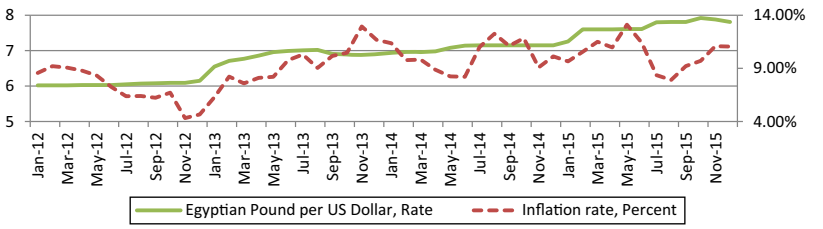


Figure 2.
Inflation rate and exchange rate movements, 2012-2015

Source: Authors' calculations based on IFS data

3. The empirical analysis

3.1 Methodology

The analysis is conducted by using a Structural VAR model, drawing on Bernanke (1986) and Sims (1986) to analyze the interrelationships between economic activity, exchange rate and prices in Egypt during the period of 2003-2015. The structural VAR model depends on economic theory rather than Cholesky decomposition to recover structural innovations from residuals of a reduced-form VAR. Such VAR model has been criticized as devoid of any economic content.

The SVAR model is represented as follows:

$$A_o X_t = A(L)X_{t-1} + \varepsilon_t \tag{1}$$

where X_t is a vector of n endogenous variables; the matrix A_o is of order n *x* n and describes the contemporaneous relationships between the variables; A(L) is a nonsingular matrix of coefficients; L denotes the lag operator; and ε_t is the (unobserved) vector of structural shocks of order N *x 1*. By multiplying equation (1) by an inverse matrix, A_o^{-1}, we obtain the reduced form of the VAR model as in (2). It must be noted that this adjustment is necessary because the model given in equation (1) is not directly observable and structural shocks cannot be correctly identified.

$$X_t = A_o^{-1}A(L)X_{t-1} + e_t \tag{2}$$

where e_t is a nx1 vector of serially uncorrelated structural disturbances of the model and is obtained as follows:

$$A_o e_t = \varepsilon_t \, or \, e_t = A_o^{-1}\varepsilon_t \tag{3}$$

To estimate a SVAR model and obtain the impulse response functions (IRFs) and variance decompositions (VDs), it is necessary to use the structural shocks, ε_t and not the forecast errors, e_t. These innovations are a linear combination of serially independent structural shocks, ε_t. So, the idea of structural decomposition is to take the observed values of e_t from an empirical VAR and restrict the system so as to recover ε_t Nonetheless, additional identifying assumptions are required. Blanchard and Quah (1989) introduced an identification method based on restrictions on the long-run properties of the IRFs. This identification requires imposing $\left(\frac{n^2-n}{2}\right)$ elements of the long-run moving average coefficient matrix. Without additional identifying restrictions, the resulting IRFs and VDs of the SVAR model are economically meaningless.

3.2 The baseline model

3.2.1 Data description. The data used in the SVAR model consist of monthly observations, covering the period from August 2003 to October 2015[2]. The SVAR model includes six variables. The price indices and nominal exchange rate constitute the main variables of interest to estimate and analyze the responsiveness of Egypt prices to exchange rate shocks. The baseline model uses the nominal exchange rate (NEXR) following Sanusi (2010) and Bwire *et al.* (2013). The IMP is included to determine the main channel of exchange rate pass-through in Egypt[3]. Furthermore, inflation rate is proxied by two price indices, namely, the producer price index (PPI) and CPI. Other control variables are used, including the International Food Price Index (FPI) which is used as a proxy for supply shocks[4]. Industrial Production Index (IPI) is used as an indicator of economic activity that proxies demand shocks, as in Nafie *et al.* (2004) and Belaisch

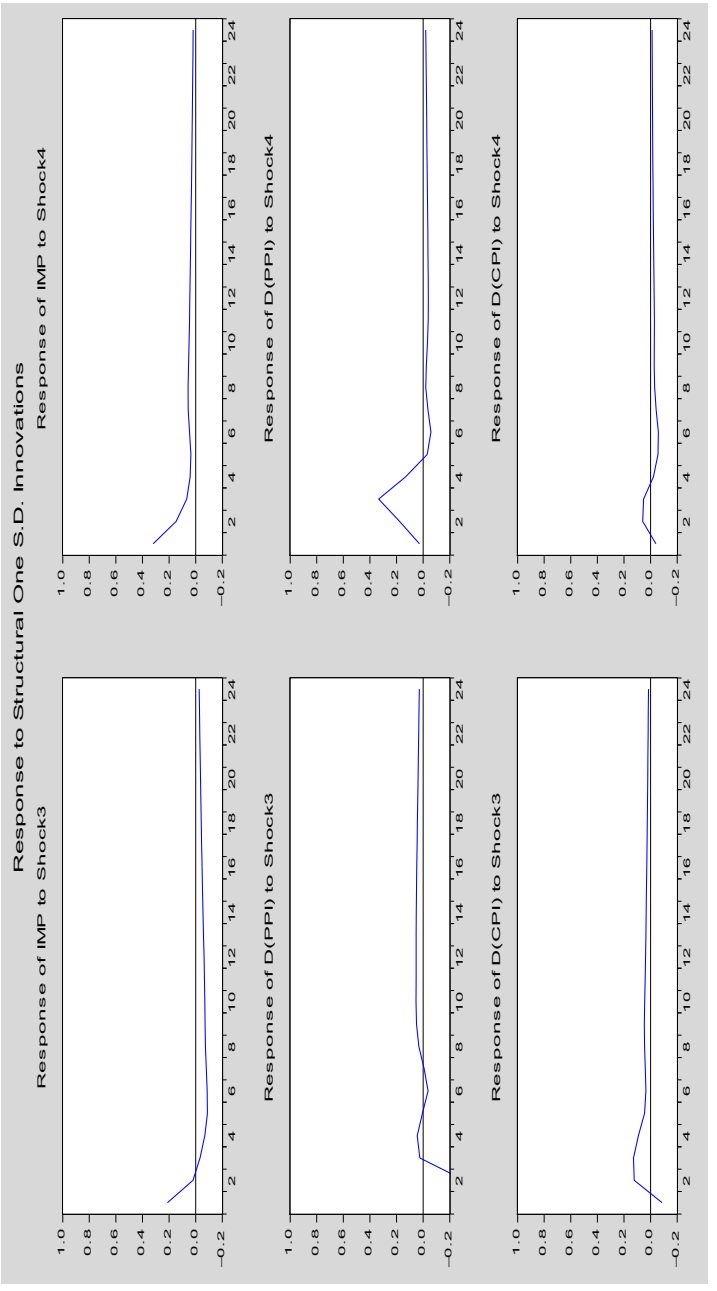
(2003)[5]. The FPI is obtained from the FAO database; the IPI from the Egyptian Ministry of Planning, and the IMP is obtained from the CBE. The rest of the variables are obtained from the IFS database accessed from the IMF e-Library. To estimate the SVAR model, all-time series are used in their stationary state. The order of integration of the variables is investigated using the Augmented Dickey–Fuller unit root test (Dickey and Fuller, 1979). All variables were found first-order homogeneous except for IMP which was found stationary at level.

3.2.2 Identification procedures. The SVAR model is represented as in equation (1), where X_t is a vector of six endogenous variables (FPI, IPI, NEXR, IMP, PPI, CPI). The appropriate lag structure is found to be two according to Schwarz information criterion. To exactly identify the structural model, based on Blanchard and Quah (1989) identification method, it is necessary to impose 15 $\left(\frac{n^2-n}{2}\right)$ elements of the long-run moving average coefficient matrix, A(2), as the lag operator was determined to be two.

$$A^{-1}(2) = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{bmatrix} \tag{4}$$

Identification requires normalizing the shocks and assuming that the structural disturbances are mutually uncorrelated. According to Kilian (2011), normalizing the variance of the SVAR shocks means imposing identifying restrictions on A_0^{-1} in $e_t = A_0^{-1}\ \varepsilon_t$. Hence, structural impulse responses, based on A_0^{-1}, are responses to one standard deviation (SD) shocks. In other words, the impulse response of x generated by setting ε to unity is the effect of a structural shock on x of the size of one SD. The latter normalization does not involve a loss of generality, as long as the diagonal elements of A_0^{-1} remain unrestricted. The zero restrictions expressed in equation (4) correspond to a lower triangular matrix in which the first variable reacts to its own lags and the first shock, the second variable to its own lags and the first two shocks and so on. This identification pattern means that this is a recursive simultaneous equations model, so the ordering of the variables is important in interpreting the results. The order used in this model is {FPI, IPI, NEXR, IMP, PPI, CPI}, where the contemporaneously exogenous variables are ordered first. Following McCarthy (2000), Bhundia (2002) and Belaisch (2003), the variables that account for supply and demand shocks, as well as the exchange rate, are always found to be the most exogenous variables and thus ordered before the price variables. Moreover, Sek and Kapsalyamova (2008) supported the assumption that the exchange rate is contemporaneously affected by supply and demand shocks but unlikely to be affected by domestic prices. Following Ca' Zorzi *et al.* (2007), the price variables are contemporaneously affected by all of the above variables in the model. Following the pricing chain, IMPs precede producer prices, then comes consumer prices allowing for a contemporaneous impact of IMP shocks on producer prices and a contemporaneous impact of producer price shocks on consumer prices but not vice versa (McCarthy, 2000, Ca' Zorzi *et al.*,2007; Bhundia, 2002). The SVAR is now exactly identified and hence can be estimated. IRFs and VDs of the model are used to assess the pass-through from exchange rate to inflation.

3.2.3 Empirical findings. Figure 3 illustrates the IRFs for the baseline model. The exchange rate pass-through to price indices is noticeable in the corresponding IRFs. The one SD shock in the exchange rate (depreciation) is immediately transferred to IMPs. The pass-through is



Note: Shock 3, 4 correspond to a one SD shock in NEXR and IMP

Figure 3.
Impulse Responses of IMP, PPI and CPI

evident and positive over the first three months. For the PPI and CPI, the Figure shows that the effect of an exchange rate shock on PPI and CPI is positive, fairly significant and persistent. Moreover, an IMP shock has a positive impact on both PPI and CPI that lasts for four months. For the CPI, its positive response to shocks in exchange rate is quite larger than its response to shocks in IMPs, implying that the indirect transmission channel of pass-through is stronger than the direct channel in Egypt. In light of the response functions, it can be concluded that the impact of the movements of exchange rate and IMPs on PPI and CPI are fairly substantial but incomplete. This could be attributed to the fact that the CPI in Egypt is composed of a relatively large number of subsidized commodities and goods with administered prices[6]. This is expected to weaken the transmission of exchange rate shocks. Moreover, it is shown that the pass-through is quite larger for the CPI than for the PPI, especially during the first six months. This is expected as PPI excludes imported goods. This result goes along the finding of Tandrayen-ragoobur and Chicooree (2013) and Uddin *et al.* (2014).

The pass-through can be calculated in a way close to the elasticity calculation[7]. For ease of interpretation, the dynamic elasticity of the pass-through is calculated based on the numerical values of the IRF, where the pass-through elasticity at time t is given by:

$$\text{Passthrough}_t = \frac{\%\Delta P_t}{\%\Delta EX_0} \tag{5}$$

The numerator, per cent ΔP_t, is the percentage change in the price level between time 0, when the initial exchange rate shock hits, and time t. The denominator, per cent ΔEX_0, is the percentage change in the exchange rate at time 0. Table I shows the accumulated response of CPI and PPI to a structural one SD shock to exchange rate and their respective dynamic pass-through elasticities. Drawing on equation (5), the dynamic elasticities are obtained by dividing the numerical values of the IRF of prices by the coefficient of the structural shocks (i.e. ε_{REXR}) derived from the SVAR estimates.

From Table I and Figure 4 above, it is clear that the impact of one SD shock (i.e. 0.108819) of exchange rate is incomplete in the three price indices. However, the behavior of the indices differs. In case of the IMPs, the initial pass-through elasticity is positive. However, the exchange rate pass-through elasticity falls to reach 0.15 over eight months till it reaches a negative value over two years, implying that there is no impact of an exchange rate change on IMPs in the long term. In case of the producer and consumer prices, the exchange rate pass-through to producer and consumer prices is positive, though not immediate, and reaches 0.34 and 0.72, respectively by the end of 24 months. Moreover, it is clear that the impact is more prominent for consumer prices than for any other price index. These results

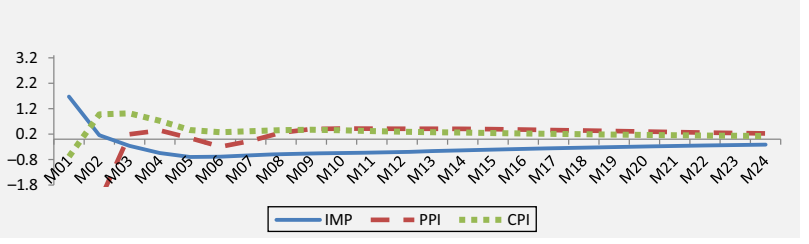
Table I.
Dynamics pass-through elasticity of exchange rate

Period	% ΔIMP (C2)	% ΔPPI (C3)	% ΔCPI (C4)	the coefficient of ε_{REXR} (C5)	Pass-through to IMP C2/C5	Pass-through to PPI C3/C5	Pass-through to CPI C4/C5
M01	0.21171	−0.5487	−0.08619	0.126304	1.67617	−4.34388	−0.68237
M08	0.01995	−0.3103	0.12310	0.126304	0.157913	−2.457	0.974609
M016	−0.03293	0.02479	0.12858	0.126304	−0.2607	0.196241	1.018028
M24	−0.06865	0.04371	0.09145	0.126304	−0.54355	0.346101	0.724063

Source: Authors' calculations based on the outcomes of the SVAR model

suggest that exchange rate pass-through in Egypt is fairly substantial but incomplete and slow. These results appear to be consistent with the findings of the IRFs.

The VD results of the SVAR model are shown in Table II to further analyze the transmission channels of exchange rate pass-through in Egypt. Panel 1 reports the VD of IMPs. By the 24th month, exchange rate shocks explain 34.7 per cent of the variation in IMPs. However, 47.03 per cent of the variation in IMPs is explained by its own shock. Panel 2 and panel 3 demonstrate the VD of PPI and CPI. Exchange rate shocks account for 8.03 per cent of the variation in PPI. IMPs explain little of the variance of producer prices, only 3.37 per cent by the 24th month. These results support the findings of the IRFs that suggest that the indirect exchange rate pass-through channel (i.e. exchange rate changes to producer prices), is stronger than direct channel (i.e. IMP changes to producer prices) in Egypt. Moreover, the PPI shocks explains 64.9 per cent of its variation which indicates that the own price (PPI) shocks are the most important in explaining its variation. Regarding the variance of CPI, exchange rate shocks appear to be more prominent than IMP shocks in explaining the variation in CPI. The exchange rate shock accounts for 5.9 per cent of the variation in CPI against 2.08 per cent explained by IMPs by the 24th month. Furthermore, the PPI shock is the most important determinant in explaining the variation in CPI. By the 24th month, PPI explains 31.9 per cent of the variation in CPI. Hence, the results suggest that the indirect exchange rate pass-through channel of exchange rate changes to producer prices and then to consumer prices is more pronounced than other indirect channel of exchange rate changes to consumer prices in Egypt. This means that the changes in exchange rate affects the locally produced semi-finished goods, hence, the producer price levels are expected to rise and consequently consumer price levels. This is shown by the proportion of movements in consumer prices because of innovations in producer prices (31.9 per cent), IMPs (2.08 per cent) and the exchange rate (5.9 per cent) by the 24th month, respectively.



Source: Authors (based on the outcomes of the SVAR model)

Figure 4.
Dynamics of pass-through elasticity

Panel	Period	NEXR	IMP	PPI	CPI
1	M24	34.68934	47.03317	3.331865	0.26489
2	M24	8.034723	3.37848	64.92517	0.53957
3	M24	5.904162	2.088064	31.92626	49.342

Notes: Panel 1: VD of IMP; Panel 2: VD of PPI; Panel 3: VD of CPI
Source: Adapted by the authors from the VDs of the SVAR model

Table II.
VD results

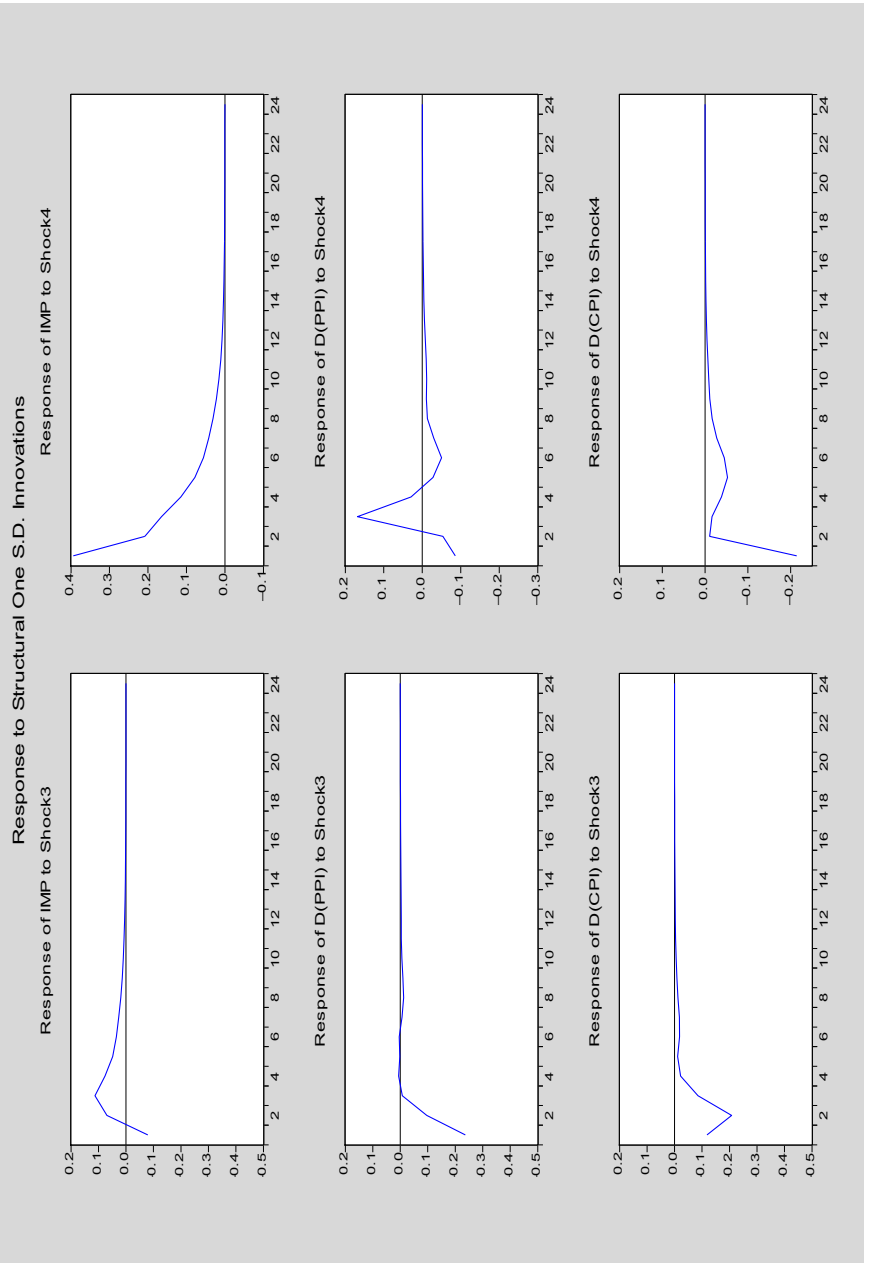


Figure 5.
Impulse responses for IMP, PPI and CPI; extended experiment: NEER

Note: Shocks 3 and 4 correspond to a one SD shock in NEER and IMP

3.3 Extended experiments

3.3.1 Nominal Effective Exchange Rate Shock. The nominal exchange rate is replaced by the nominal effective exchange rate (NEER), obtained from Bruegel Centre database, as its movements provide an indication of the evolution of a country's aggregate external price competitiveness. This is to provide a better interpretation when determining the main transmission channel of exchange rate pass-through in Egypt. Furthermore, this approach goes along with a number of studies, namely, Sek and Kapsalyamova (2008), Sanusi (2010) and Tandrayen-Ragoobur and Chicooree (2013). The NEER measures the value of a currency against a basket of other currencies, which is trade-weighted (Durand, 1986). An increase in NEER implies that exports become more expensive and imports become cheaper. It is thus expected that a positive shock to NEER will lead to a fall in domestic prices. The same identification method of the baseline model is used. The order of the variables is the same, just replacing NEXR by NEER in its stationary form, i.e. first differenced, I (1).

The IRFs, reported in Figure 5, support the findings of the baseline model which is the existence of an incomplete exchange rate pass-through in Egypt. The figure shows that the initial impact of a positive shock to NEER on domestic prices is negative, as expected. The response of PPI and CPI appears to be immediate and fairly significant. However, the impact lasts for 10 months before it fades away. The VD results, as shown in Table III, confirm the expected indirect transmission channel of pass-through conveyed in the baseline model. The degree of variability explained by exchange rate and IMP is modest for both PPI and CPI. It is rather larger for CPI than for PPI. This is an expected result because PPI excludes imported goods. It is worth noting that Sek and Kapsalyamova (2008), Massoud (2014) and Uddin *et al.* (2014) reached the same conclusion in Singapore, Egypt and Bangladesh, respectively.

3.3.2 Monetary policy shock. A further proposed experiment is to examine the effect of a monetary policy shock on domestic prices. This is argued to eventually capture monetary policy effects on the price level[8]. This is done by adding the discount rate (DR), obtained from the CBE in its stationary form, i.e. level, I (0), to the model with the NEER. The corridor rate, which is the main policy instrument used by the CBE, was launched in 2005. Hence, no data are available prior to this year. The discount rate is thus considered appropriate to account for monetary policy in Egypt, as it is one of the instruments that the CBE relied on. Mwase (2006) and Tandrayen-Ragoobur and Chicooree (2013) assumed that prices have a contemporaneous effect on the variable accounting for monetary policy. Thus, this variable is ordered last, according to Ca' Zorzi *et al.* (2007), to allow the money market, particularly monetary policy, to react contemporaneously to all variables in the model and, hence, influence the pass-through relationship. In line with the findings of the extended SVAR model, a positive exchange rate shock leads to a reduction in domestic prices only in the short-term. The impact of a positive shock to exchange rate on domestic prices mirrors that of the extended model in fading away after 10 months as shown in Figure 6. The findings of the VDs in Table IV were also found

Panel	Period	NEER	IMP	PPI	CPI
1	M24	10.2500	74.5388	1.44907	1.94955
2	M24	1.21624	0.81757	62.83471	1.05189
3	M24	5.63064	4.59903	30.06045	44.4773

Notes: Panel 1: VD of IMP; Panel 2: VD of PPI; Panel 3: VD of CPI
Source: Adapted by the authors from the VDs of the SVAR model

Table III.
VD results; extended experiment

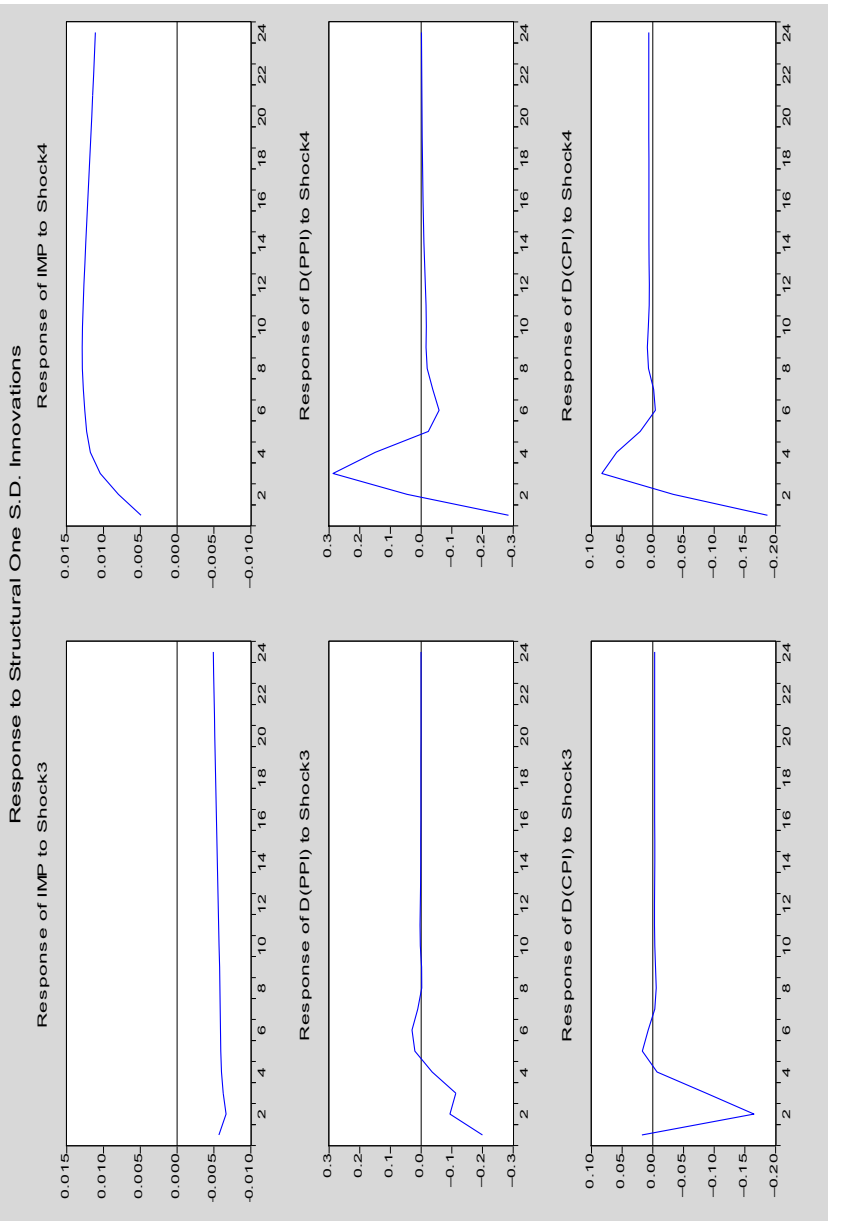


Figure 6.
Impulse responses for IMP, PPI and CPI; extended experiment: monetary policy shock

Note: Shocks 3 and 4 correspond to a one SD shock in NEER and IMP

consistent with that of the extended model. The consistency of the results implies the stability and robustness of the reported empirical results.

4. Conclusion and policy implications

Using an SVAR, this paper estimated the exchange rate pass-through to domestic prices for Egypt during 2003-2015. The IRFs for the baseline model show that the exchange rate pass-through to IMP is evident and positive over the first three months. The impact of the movements of exchange rate and IMPs on PPI and CPI are fairly substantial but incomplete and slow. This could be attributed to the fact that the CPI in Egypt is composed of a relatively large number of subsidized commodities and goods with administered prices. This is expected to weaken the transmission of exchange rate shocks. For the CPI, its positive response to shocks in exchange rate is quite larger than its response to shocks in IMPs, implying that the indirect transmission channel of pass-through (i.e. exchange rate changes to producer prices), is stronger than the direct channel (i.e. IMP changes to producer prices) in Egypt. The pass-through is quite larger for the CPI than for the PPI, especially during the first six months. This is expected as PPI excludes imported goods. The results of the dynamic elasticity of the pass-through appear to be consistent with the findings of the IRFs. The VD results of the SVAR baseline model suggest that the changes in exchange rate affect the locally produced semi-finished goods, hence, the producer price levels are expected to rise and consequently consumer price levels. These results support the findings of the IRFs.

To test the robustness of the results and their sensitivity to different specifications, our analysis was extended by using the NEER and the discount rate (DR) in the baseline model. A positive shock to NEER, implying that exports become more expensive and imports become cheaper, leads to a fall in domestic prices as expected. The response of PPI and CPI appears to be immediate and fairly significant. However, the impact lasts for 10 months before it fades away. These results support the finding of the baseline model. The VD results show that the degree of variability explained by exchange rate and IMP is modest for both PPI and CPI. It is rather larger for CPI than for PPI. These results confirm the expected indirect transmission channel of pass-through conveyed in the baseline model. Examining the effect of a monetary policy shock on domestic prices reveals that a positive change in the exchange rate shock leads to a reduction in domestic prices only in the short-term. The impact of a positive shock to exchange rate on domestic prices fades away after 10 months. The findings of the IRFs and VDs were found consistent with those of the baseline and NEER extended models. The consistency of the results implies the stability and robustness of the reported empirical results.

The result that the exchange rate pass-through in Egypt is fairly substantial but incomplete and slow in the three price indices (IMP, PPI and CPI), and it has an interesting implication for Egypt's economic ability to attain an effective inflation targeting regime. Effective implementation of this regime would limit the exchange rate pass-through phenomenon, but

Panel	Period	NEER	IMP	PPI	CPI
1	M24	9.414937	41.80774	0.037760	0.032903
2	M24	1.170263	3.548244	49.36128	0.725063
3	M24	3.253333	4.334161	19.78859	52.66881

Notes: Panel 1: VD of IMP; Panel 2: VD of PPI; Panel 3: VD of CPI
Source: Adapted by the authors from the VDs of the SVAR model

Table IV.
VD results; extended experiment: monetary policy shock

some of the challenges remain. First, the CBE not only has to deal with high levels of inflation but also with a surge in inflation expectations. Second, more frequent interventions in the foreign exchange market to decrease its fluctuations may be needed. Third, the exchange rate may become the main focus of the CBE, distorting expectations. Accordingly, transparent interventions in the foreign exchange market would allow the Egyptian £ to adjust to a new long-run equilibrium following a shock while attaining the inflation target.

Notes

1. On November 3, 2016, the CBE announced its decision to move, with immediate effect, to a liberalized exchange rate regime to quell any distortions in the domestic foreign currency market. Moreover, the CBE key policy rates have been raised by 300 basis points.
2. The announcement of the adoption of a new exchange rate policy under which the exchange rate was allowed to float was in January 2003. However, data availability was the reason behind starting from August 2003.
3. The model uses imports' value as a proxy for the IMP because there are no available data on the imports' prices for Egypt. The annual figures are obtained from the CBE and converted to monthly data using liner match list method by Eviews 8.1. The imports' value is converted to Egyptian £ using the exchange rate of the Egyptian £ per US$. The percentage change of the natural logarithm import's value is then used in the model.
4. International oil prices were usually used to account for supply shocks in many empirical studies, like Nafie *et al.* (2004), Belaisch (2003) in Brazil and Bhundia (2002) in South Africa. However, this proxy is most likely to be relevant for countries that are purely oil importers and none of their citizens' work in purely exporting oil countries which is not the case for Egypt. In 2003/2004, the exported proceeds of crude oil and its products reached US$4.0bn accounting for 38.4 per cent of the total exports in Egypt. However, the exported proceeds of food (raw material) reached 6.4 per cent with a value of US$0.67bn. In 2012 and 2013, these percentages reached 46.8 per cent for oil and 5.2 per cent for food. On the other hand, the imports of oil amounted only US$1.5bn, constituting 8.3 per cent of the total imports of Egypt in 2003/2004, while the imports of food (non-durable consumer goods) reached 11.3 per cent with a value of US$2.0bn in the same year. In 2012 and 2013, the imports of oil and food increased and reached 16.5 and 16.9 per cent, respectively. Accordingly, FPI is a good proxy to account for supply shocks in Egypt.
5. In Egypt, industrial production measures the output of businesses integrated in the industrial sector of the economy, such as manufacturing, transportation, utilities, construction and tourism.
6. Roughly 70.8 per cent of the items in the CPI series that was used until December 2003 consist of goods with administered prices, including food items, utilities, transportation and rent. According to Central Agency for Public Mobilization and Statistics and the CBE calculations, this figure reached 63.9 per cent in 2013.
7. See Nafie *et al.* (2004), Sanusi (2010), Bangura *et al.* (2012) and Tandrayen-Ragoobur and Chicooree (2013).
8. See McCarthy (2000), Bhundia (2002), Mwase (2006) and Sanusi (2010).

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