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THE MONETARY TRANSMISSION MECHANISM IN A SMALL OPEN ECONOMY: THE CASE OF EGYPT

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ABSTRACT: By treating the Egyptian economy as a small open economy, the current study attempts to fill a gap in studies about MTMs in the Egyptian economy. The results of the study are as follows: (i) The CBE is factually applying the sterilized intervention policy. (ii) The CBE does not apply an independent monetary policy. (iii) The federal funds rate and the FX rate, respectively, play the most important role among the foreign and domestic variables that influence the reaction of the CBE. (iv) Foreign economic shocks play a dominant role in explaining the behavior of real domestic growth, whereas domestic economic shocks play a dominant role in explaining the behavior of domestic inflation, especially in the short run. (v) The interest rate channel explains the MTMs in the Egypt.

KEYWORDS: Monetary Policy in Egypt, VAR Model, Monetary Transmission Mechanism in Egypt

JEL Classification: E40, E50, E52

Introduction

Monetary transmission mechanisms (MTMs) are the channels through which monetary policy actions are transmitted to changes in real output and the price level. In his article about the role of monetary policy, Friedman (1968) avers that monetary policy cannot peg either interest rates or the unemployment rate at their equilibrium rates, through cheap money policy, for more than very limited periods. Unemployment cannot be maintained away from its natural rate without accepting a positive and finite rate of inflation. Thus, monetary policy can affect the real economy only in the short run. In the long run, inflation is a monetary phenomenon, and real output is driven by real factors.

Although the vast majority of economists agree with Friedman's view about the role of monetary policy, economists are divided regarding the question of how monetary policy actions can affect the real economy in the short run. Generally speaking, four MTM channels have been highlighted in the literature[1]. They are; the interest rate channel, the exchange rate channel, the asset price channel, and the credit channel (Taylor, 1995; Mishkin, 1995, 2004; Bernanke and Gertler, 1995; Mohanty and Turner, 2008)[2].

A review of previous studies about MTMs in the Egyptian economy indicates that these studies are very limited and do not give much attention to foreign shocks that may control the behavior of macroeconomic variables in the Egyptian economy, especially when the Egyptian economy is assessed on the basis of being a small open economy.

In his study about MTMs in the Egyptian economy, Hassan (2003) used a structural VAR model to address the following two questions: How significant is the effect of the interest rate on domestic credit to the private sector (construction sector)? Does a reduction in the nominal interest rate cause international reserves to deteriorate? The study uses monthly data covering the period 1992–2002. The short-term interest rate is used as a measure of the monetary policy stance, whereas international reserves, real domestic credit to the private sector, and the real effective exchange rate are the other variables in the model. The study concludes that investors seem to have been operating under a soft budget constraint, which has made changes in the interest rate less important for investment decisions. Thus, the nominal interest rate does not have a significant impact on the level of real

[1] There is also an expectation channel, which has considerable effect on the effectiveness of the other channels mentioned in the text. See Mohanty and Turner (2008).
[2] For details about a description of MTMs, see Awad (2010).

domestic credit to the private sector. In addition, it is real domestic credit, rather than the interest rate, that affects the international reserves.

Emphasizing the role of the credit channel in MTMs, Noureldin (2005) used a five-variable structural VAR model to analyze MTMs in the Egyptian economy during the period 1980:4–2002:4. The rate of growth of M0 or M2 is used as a proxy for the monetary policy stance, whereas real GDP, the CPI, the real effective exchange rate, and commercial bank credit are the other variables of the model. The results of his study indicated that the credit channel has a greater impact on both real output and inflation during the period of study.

Moursi et al. (2007) examined the features and development of monetary policy structure in the Egyptian economy during the period 1990–2005. Their study uses analytical models introduced by Bernanke and Mihov (1998) and Uhlig (2005) to measure the monetary stance and to identify the effects of policy shocks on the economy. The results of their study show that monetary policy shocks have recently had virtually no real effect on output, thereby providing evidence in support of the long-run neutrality of money. They concluded that the effect of monetary policy on the level and the growth rate of real output in the long run is limited by its capacity to achieve long-run price stability. Employing an estimated interest rate targeting rule, historical and counterfactual policy simulations indicated that during 2001–2006, the central bank of Egypt (CBE) gave precedence to reducing interest rate variances rather than to the stabilization of inflation.

Al-Mashat and Billmeier (2007) examined MTMs in the Egyptian economy from January 1996 to June 2005, when an overnight corridor was introduced in the CBE. Their baseline VAR model includes exogenous and endogenous variables with monthly frequency data. The exogenous variables include oil prices and the federal funds rate. The endogenous variables include real GDP, the WPI, the 3-month deposit rate, and different measures of the exchange rate. One of the results of this study is that the exchange rate channel plays a strong role in propagating monetary shocks to output and prices in the Egyptian economy.

By treating the Egyptian economy as a small open economy, the current study attempts to fill a gap in studies about MTMs in the Egyptian economy. The purpose of this study is to answer the following questions: Does the CBE maintain an implicit target for the FX rate? Does the CBE follow an independent monetary policy? which variables have priority in the reaction function of the CBE? How far can foreign economic shocks explain the behavior of real GDP and price level in the Egyptian economy compared with domestic economic shocks? And which monetary transmission mechanism channels play a dominant role in the Egyptian economy?

The paper is organized as follows. Section 2 specifies a structural VAR model in a small open economy. Section 3 analyzes the estimation results of the study. Section 4 concludes.

VAR Model Specifications in a Small Open Economy

In the case of a small open economy, the focus falls on the effect of a big foreign economy on the domestic economy. Using a structural VAR model, Cushman and Zha (1995) specified and estimated a monetary reaction function for the Canadian economy as a small open economy relative to the USA economy. In their opinion, the imposition of 'block exogeneity' seems a reasonable way to help identify foreign shocks.

As for the Egyptian economy, it is quite open regarding the ratios of both exports and imports to GDP. The ratios of exports and imports to GDP (on average for the period 1990–2006) are 22.4% and 27.7%, respectively, and the degree of openness (trade, % of GDP) equals 50% during the same period.[3] The EU and the USA are the main traders with Egypt. During the period 1990/91–2006/07, 66.5% of Egyptian exports went to the USA and the EU (32.5% and 34%, respectively) and 60% of Egyptian imports came from the USA and the EU (22.4% and 37.5%, respectively).[4] In this study, we will focus on the Egyptian economy as a small open economy relative to the US economy. The EU case will be left to another separate study.

Following Zellner and Palm (1974), Cushman and Zha (1995), and Zha (1998), a structural linear, stochastic dynamic VAR model can take the following representation:

$$A(L)\,Z(t) = \varepsilon(t), \tag{1}$$

where $Z(t)$ is an (m x 1) vector of variables, $A(L)$ is an (m x m) matrix polynomial in the lag operator (L) with non-negative power, and $\varepsilon(t)$ is an (m x 1) vector of structural disturbances.
Equation (1) can be divided into two blocks of variables: endogenous variables, $Y(t)$, and exogenous variables, $X(t)$, as follows:

[3] Calculated from WDI, CD-R, 2009.
[4] Calculated from data available on the CBE website: http://www.cbe.org.eg/.

$$\begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \begin{bmatrix} Y(t) \\ X(t) \end{bmatrix} = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}, \tag{2}$$

Where, A_{11} *(L)* is (m_1 x m_1), A_{12} *(L)* is (m_1 x m_2), A_{21} *(L)* is (m_2 x m_1), A_{22} *(L)* is (m_2 x m_2), *Y (t)* is (m_1 x 1), *X (t)* is (m_2 x 1), ε_1 *(t)* is (m_1 x 1), and ε_2 *(t)* is (m_2 x 1), where $m_1 + m_2 = m$. The assumptions of system 2 are that the coefficient matrix of L^0, A_0, is non-singular and that ε *(t)* is uncorrelated with the past y (t-s) for s > 0, and

E[ε(t) ε(t)' | y(t-s), s > 0] = I, E[ε(t) | y (t-s), s > 0] = 0.

Under the prior information that the elements of *X (t)* are exogenous, the matrix A_{21} *(L)* elements have to be restricted, i.e., A_{21} *(L)* = 0. Therefore, system (2) will yield:

$$A_{11}(L)\,Y(t) + A_{12}(L)\,X(t) = \varepsilon_1(t) \tag{3}$$

$$A_{22}(L)\,X(t) = \varepsilon_2(t) \tag{4}$$

Accordingly, the elements of ε_1 *(t)* do not affect the elements of *X (t)*, whereas the elements of ε_2 *(t)* affect the elements of *Y (t)* only through the elements of *X(t)*.

A reduced form of (1), which expresses the current values of endogenous variables as a function of lagged endogenous and current and lagged exogenous variables can be derived from (3) as follows;

Define $A_{11}(L) = A_{10} + A_1(L)$, where A_{10} is the contemporaneous coefficient matrix on L^0 in $A_{11}(L)$, and $A_1(L)$ is the coefficient matrix in $A_{11}(L)$ without contemporaneous coefficient A_{10}. We can rewrite (3) as follows:

$$A_{10}\,Y(t) + A_1(L)\,Y(t) + A_{12}(L)\,X(t) = \varepsilon_1(t) \tag{5}$$

Rearranging and pre-multiplying (5) by A_{10}^{-1} we get:

$$Y(t) = -A_{10}^{-1}A_1(L)\,Y(t) - A_{10}^{-1}A_{12}(L)\,X(t) + A_{10}^{-1}\,\varepsilon_1(t), \tag{6}$$

or, equivalently:

$$Y(t) = -a(L)\,Y(t) - b(L)\,X(t) + V_1(t), \tag{7}$$

Where, $a = A_{10}^{-1}A_1$, $b = A_{10}^{-1}A_{12}$, and $V_1(t) = A_{10}^{-1}\,\varepsilon_1(t)$.

In general, a reduced form of $Z(t)$ can be derived directly from the structural model, (1), as follows:

$$\text{Define } A(L) = A_0 + A^0(L) \tag{8}$$

Where, A_0 is the contemporaneous coefficient matrix on L^0 in $A(L)$, and $A^0(L)$ is the coefficient matrix in $A(L)$ without contemporaneous coefficient A_0. By substituting (8) in (1) and rearranging, we get:

$$Z(t) = - B(L)\, Z(t) + V(t), \tag{9}$$

Where, $B = A_0^{-1} A^0$ and $V(t) = A_0^{-1} \varepsilon(t)$.

To identify structural shocks $\varepsilon(t)$ from reduced form residuals $V(t)$, a problem of identification has to be solved. That is, unless we appropriately restrict the structural model it will not be possible to identify structural shocks from the estimated reduced form (9). Restrictions equal to $(n^2 - n)/2$ have to be imposed on A_0 to make the system identifiable (Enders and Walter, 2004, pp. 291–293).[5] Christiano et al. (1999) and Enders and Walter (2004) reported different strategies for identifying monetary policy shocks. One of these strategies is to make identifying assumptions about the parameters included in the feedback rule besides the functional form of the feedback rule itself. The assumption that a policy shock is orthogonal to variables in the feedback rule along with the linearity assumption of the feedback rule justify estimating the dynamic response of variables to a monetary policy shock by regressing current and lagged values of the variables on the fitted residuals.

The recursiveness assumption based on the Choleski decomposition is used to identify the structural shocks $\varepsilon(t)$ from a vector of residuals $V(t)$, where $\varepsilon(t) = A_0 V(t)$. A straightforward way to impose such restrictions is to impose A_0 as a lower triangular matrix. The order of the variables reflects our prior assumptions about the variables that the CB looks at when setting its operating instrument and the interaction of a monetary policy shock with the variables in the feedback rule.

In the course of assessing whether the monetary policy stance is expansionary or contractionary, empirical studies use different specifications of monetary policy

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[5] Given that the diagonal elements of A_0 are all unity, A_0 contains $n^2 - n$ unknowns. In addition, there are n unknown values var. (ε_t), thus the total unknown values equal n^2. To identify n^2 unknowns from the estimated variance/covariance matrix with $(n^2 + n)/2$ known independent elements, it is necessary to impose an additional $n^2 - [(n^2 + n)/2] = (n^2 - n)/2$ restrictions on the system.

instruments. These specifications abandon the traditional approach of measuring the stance of monetary policy using the rate of growth of monetary aggregates. The reasons for that are as follows:

(i) The use of monetary aggregates to measure the monetary policy stance delivers anomalous results, especially when the nominal interest rate is included in the model.

(ii) Disturbances in monetary aggregates do not completely reflect the policy stance, as it can be affected by other non-policy factors such as money demand disturbances. For instance, higher demand for money will cause the reserves of commercial banks to fall. If the operating procedures of the CB involve smoothing the short-term interest rate, the CB will react by allowing the money supply to increase in order to accommodate the money demand. In reality, growth in the money supply reflects both growth in money demand and changes in policy. Therefore, we cannot use change in the money supply as a pure measure of the monetary policy stance. Besides, if we decided to use innovations in the total reserves of commercial banks as a measure of the monetary policy stance we would have to separate changes in reserves that pertain to money demand innovations from those that pertain to money supply innovations, as the latter can be used to reflect the monetary policy stance (Bernanke and Mihov, 1998; Strongin and Steven, 1995).

(iii) Strongin and Steven (1995) argue that the demand for total reserves is inelastic with respect to the nominal interest rate in the short run, so that a monetary policy shock will initially rearrange the structure of total reserves between non-borrowed and borrowed reserves. As a result, the monetary policy shock should be measured as an innovation to the ratio of non-borrowed reserves to total reserves.

Following Christiano et al. (1999, p. 83), three measures can be used for the monetary policy stance (S_t). These measures, as indicated by (10), are the short-term nominal interest rate (DR_t), non-borrowed reserves (NBR_t), and the ratio of non-borrowed reserves to total reserves (*NBR/TR*).

$$S_t \equiv \left(DR_t, \quad NBR_t, \quad NBR/TR_t\right) \tag{10}$$

One interesting result of the study by Christiano et al. (1999, p. 89) is that although all three measures of the monetary policy shock, S_t, lead to similar inferences about the qualitative effects of a disturbance to monetary policy, the bivariate correlations between them is less than one. That is, at least two of them must be confounded by limited non-policy shocks.

In this study, three identification schemes will be tested with each element of S_t. In the first benchmark, (11), we assume that the CBE does not anchor monetary policy, changes in the monetary policy instrument (S_t), either to the money supply or to the FX rate.

$$Y(t)' = \begin{bmatrix} y_t & P_t & S_t & M2_t & E_t \end{bmatrix} \quad (11)$$

Where, $Y(t)$ represents a vector of endogenous variables including real GDP (y_t), a measure of the price level (P_t), the monetary policy instrument (S_t), the nominal money supply ($M2_t$), and the nominal FX rate (E_t).

In the second benchmark scheme, (12), we assume that the CBE anchor monetary policy to changes in the money supply, M2, i.e. the money supply represents the intermediate target of monetary policy. In other words, the CBE applies the monetary targeting regime.

$$Y(t)' = \begin{bmatrix} y_t & P_t & M2_t & S_t & E_t \end{bmatrix} \quad (12)$$

In the third benchmark, (13), we assume that the CBE anchor monetary policy to changes in the FX rate, i.e. the FX rate represents the intermediate target of monetary policy under the FX rate targeting regime[6].

$$Y(t)' = \begin{bmatrix} y_t & P_t & E_t & S_t & M2_t \end{bmatrix} \quad (13)$$

As the USA economy is one of the main traders with Egypt, the above three schemes of domestic variables will be augmented by foreign variables for the USA economy. As mentioned above, domestic variables are assumed to be affected by foreign variables without feedback. Variables that represent the USA economy include real GDP, y_t^{USA}, the general price level measured by CPI_t^{USA}, and the short-term nominal interest rate measured by the federal funds rate (FFR_t^{USA}).

[6] Notice that, the final goal of monetary policy in the three schemes is to achieve price stability thereby growth rate will be higher.

Following Christiano et al. (1999), Peersman and Smets (2001), and Mojon and Peersman (2001), the exogenous variables (USA economy variables) and endogenous variables (domestic variables) take the following order:
First scheme:

$$Z_t' = \left[y_t^{USA} \quad CPI_t^{USA} \quad FFR_t^{USA} \quad y_t^{EG} \quad P_t^{EG} \quad S_t^{EG} \quad M2_t^{EG} \quad E_t^{EG} \right] \tag{14}$$

Second scheme:

$$Z_t' = \left[y_t^{USA} \quad CPI_t^{USA} \quad FFR_t^{USA} \quad y_t^{EG} \quad P_t^{EG} \quad M2_t^{EG} \quad S_t^{EG} \quad E_t^{EG} \right] \tag{15}$$

Third scheme:

$$Z_t' = \left[y_t^{USA} \quad CPI_t^{USA} \quad FFR_t^{USA} \quad y_t^{EG} \quad P_t^{EG} \quad E_t^{EG} \quad S_t^{EG} \quad M2_t^{EG} \right] \tag{16}$$

In the light of this, the three recursive schemes will be as follows:

$$\begin{bmatrix} \varepsilon_t^{y_t^{USA}} \\ \varepsilon_t^{CPI_t^{USA}} \\ \varepsilon_t^{FFR_t^{USA}} \\ \varepsilon_t^{y_t^{EG}} \\ \varepsilon_t^{P_t^{EG}} \\ \varepsilon_t^{S_t^{EG}} \\ \varepsilon_t^{M2_t^{EG}} \\ \varepsilon_t^{E_t^{EG}} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} \end{bmatrix} \begin{bmatrix} V_t^{y_t^{USA}} \\ V_t^{CPI_t^{USA}} \\ V_t^{FFR_t^{USA}} \\ V_t^{y_t^{EG}} \\ V_t^{P_t^{EG}} \\ V_t^{S_t^{EG}} \\ V_t^{M2_t^{EG}} \\ V_t^{E_t^{EG}} \end{bmatrix} \tag{17}$$

$$\begin{bmatrix} \varepsilon_t^{y_t^{USA}} \\ \varepsilon_t^{CPI_t^{USA}} \\ \varepsilon_t^{FFR_t^{USA}} \\ \varepsilon_t^{y_t^{EG}} \\ \varepsilon_t^{P_t^{EG}} \\ \varepsilon_t^{M2_t^{EG}} \\ \varepsilon_t^{S_t^{EG}} \\ \varepsilon_t^{E_t^{EG}} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} \end{bmatrix} \begin{bmatrix} V_t^{y_t^{USA}} \\ V_t^{CPI_t^{USA}} \\ V_t^{FFR_t^{USA}} \\ V_t^{y_t^{EG}} \\ V_t^{P_t^{EG}} \\ V_t^{M2_t^{EG}} \\ V_t^{S_t^{EG}} \\ V_t^{E_t^{EG}} \end{bmatrix} \tag{18}$$

$$\begin{bmatrix} \varepsilon_t^{y_t^{USA}} \\ \varepsilon_t^{CPI_t^{USA}} \\ \varepsilon_t^{FFR_t^{USA}} \\ \varepsilon_t^{y_t^{EG}} \\ \varepsilon_t^{P_t^{EG}} \\ \varepsilon_t^{E_t^{EG}} \\ \varepsilon_t^{S_t^{EG}} \\ \varepsilon_t^{M2_t^{EG}} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} \end{bmatrix} \begin{bmatrix} V_t^{y_t^{USA}} \\ V_t^{CPI_t^{USA}} \\ V_t^{FFR_t^{USA}} \\ V_t^{y_t^{EG}} \\ V_t^{P_t^{EG}} \\ V_t^{E_t^{EG}} \\ V_t^{S_t^{EG}} \\ V_t^{M2_t^{EG}} \end{bmatrix} \tag{19}$$

Schemes (17)–(19), summarize our assumptions about the variables included in (9), the operating instrument, the variables that the CBE looks at when setting its operating instrument and the interaction of a monetary policy shock with the variables in the feedback rule. A monetary policy shock is identified through a standard Choleski decomposition with the variables ordered as in (17)–(19). The zero block(s) corresponding to a monetary policy shock (ε_t^{St}) in the instruments' rows indicates that the CBE does not see the subsequent variables E_t or/and $M2_t$ when setting its monetary policy instruments. The other zero blocks reflect the recursiveness assumption. In other words, while the CBE contemporaneously reacts to changes in the foreign and domestic variables preceding a monetary policy instrument, the change in the monetary policy instrument S_t, does not affect the preceding variables of S_t but instead it has a contemporaneous effect on the following variables of S_t.

Estimation Results

Results of measurement of the price index and the monetary policy stance in Egypt

The three-benchmark VAR model is estimated on the period 1995Q1–2007Q4. The source of the data is the IFS (CD-R 2009). As quarterly data on real GDP is not available for Egypt either in the IFS or in any other source during the period of the study, I used statistical methods included in E-views 5 to extrapolate quarterly data on real GDP from the annual data. Because the data are quarterly, the variables are seasonally adjusted using seasonal dummies. All variables are expressed in logs, except for nominal interest rates, i.e., FFR_t^{USA} and DR_t^{EG}.[7]

Using unit root tests (the Augmented Dickey-Fuller unit root test and the Phillips-Perron unit root test), all variables are found to be non-stationary, I ~ (1), except for FFR_t^{USA} and DR_t^{USA}, I ~ (0). Thus, nonstationary variables are introduced using first differences after taking logs. By estimating the model, all roots are found to be inside the unit root circle. The Akaike information criterion (AIC) and the likelihood ratio test (LR) are used to determine the appropriate lag length, which turns out to be one lag.

As the measure of the price level in Egypt, the study experimented with both the CPI and the wholesale price index (WPI). Although the directions of causality, as indicated by block exogeneity Wald tests, were similar using both the CPI and the WPI, the CPI is excluded from the analysis because it does not reflect changes in the money supply, M2. According to Granger causality tests, the rate of growth of M2 does not Granger cause CPI inflation. Indeed, this result agrees with the results of a study by Awad (2008), which found no relationship between the money supply and CPI-inflation in Egypt either in the short run or in the long run. In addition, by estimating the exchange rate pass-through effect in Egypt to both the WPI and CPI during the period 2000–2004, Rabanal (2005) found that while the pass-through effect to the WPI was higher (from 30% to 60%) and statistically significant, it was lower and insignificant if measured by the CPI. The weak relationship between exchange rate shocks or money supply shocks and changes in the CPI can be

[7] The correlation coefficient between the three-month deposit rate and the discount rate during the period of the study is 93%. As an alternative to the three-month deposit rates, discount rates were used in the three schemes. The results, however, did not change substantially.

attributed to the relatively large share of goods with administered prices included in the CPI series that was used until July 2003 (roughly one third to one half of the CPI items).

As for the measure of the monetary policy stance in Egypt, S_t, both NBR^{EG} and NBR/TR^{EG} are excluded from the analysis, thus DR_t^{EG} is used to estimate the three-benchmark VAR model. The reasons for excluding both NBR^{EG} and NBR/TR^{EG} are as follows:

(i) In the light of the aforementioned description of the three-benchmark VAR model, the relationship between a small open economy and a large open economy is unidirectional, i.e., the large open economy affects the small open economy and not the opposite. Taking into account that the causality relationships among the macroeconomic variables should come outside econometrics, block exogeneity tests delivered results that conflict with our prior descriptions. For instance, when we estimated the model using either NBR^{EG} or NBR/TR^{EG}, block exogeneity Wald tests indicated that the Federal Reserve Bank set its FFR to react to both the rate of change in real GDP^{EG} and the rate of change in NBR^{EG}. Rather, when we used DR_t^{EG} as a measure of the monetary policy stance, the Granger causality directions were in accordance with our prior descriptive of the relationship between a small open economy and a large open economy.

(ii) Both NBR^{EG} and NBR/TR^{EG} do not reflect the stance of the CBE on changes in the FX rate, as neither *NBR* or *NBR/TR* nor the FX rate Granger cause each other. One reason for this is that the CBE adopted inconsistent objectives for monetary policy after the introduction of the economic reform and structural adjustment program (ERSAP) at the start of the 1990s (Moursi et al., 2007, Kamar and Bakardzhieva, 2005, and Panizza, 2001). After the introduction of the ERSAP in 1990, the ultimate objective of monetary policy was determined to be achieving both internal and external stability of the domestic currency in line with the national objectives of spurring economic growth and creating more job opportunities. During this period, the intermediate target of monetary policy was determined to be net domestic credit and later the rate of growth of the money supply (M2). The daily operational target of monetary policy was determined to be banks' excess reserves, which had to be set in such a way as to achieve the intermediate target (Abu-Elayoun, 2003). During the period from 1990 until the start of 2003 the CBE was targeting the FX rate. Taking into account that the CBE liberalized domestic interest rates on both loans and deposits in 1991,[8] one may

[8] By January 1991, the CBE liberalized interest rates on loans and deposits. Accordingly, banks were given the freedom to set their loan and deposit interest rates subject to the restriction that the 3-month

thus ask how the CBE can maintain the FX rate target and, at the same time, achieve the goal of price stability through maintaining an implicit M2 target. A sterilized intervention policy may give the answer. Under the sterilized intervention policy, the CB will accommodate capital flows by sterilizing their effect on the money supply. Thus, the CBE has to satisfy the net demand for foreign exchange at the prevailing FX rate using sterilized foreign exchange intervention. For instance, if the CB is faced by capital outflows that negatively affect the supply of money, it can maintain its money supply target by purchasing securities with the same amount of capital outflows (Goodfriend, 2008). In such a case, changes in either NBR^{EG} or NBR/TR^{EG} will be isolated from changes in the FX rate. As a result, Granger causality tests will not detect any causality relationship between these variables.

Estimation results using WPI and DR

a. Results of the intermediate target of monetary policy in Egypt

Figure 1 highlights the response of domestic monetary policy, DR^{EG}, to structural one standard deviation innovation in the rate of change in WPI^{EG}, the rate of change in $M2^{EG}$ and the rate of change in FX^{EG}. The only significant response of monetary policy (at 5 % level) is the response to the FX rate shock as shown in Scheme 3. It tells us that the CBE cuts domestic interest rate when domestic currency depreciates (USD appreciate). This result seems anomalous based on the FX rate targeting regime, where the CB should react to a depreciation of domestic currency by increasing domestic interest rate. Indeed, this result is quite normal if it will be assessed on the basis of the sterilized intervention policy. Where the CBE has to take a compensatory action to offset a change in the monetary base resulted by an intervention policy in the FX market. In addition, this result comes in line with the aforementioned study by Al-Mashat and Billmeier (2007), which asserts the dominant role of the FX rate despite the fact that the CBE (formally) no longer uses the nominal exchange rate as a nominal anchor for its monetary policy. In the light of this, the significant and positive response of monetary policy to the FX rate shocks as shown in Scheme 3 indicates that the CBE is factually applying the sterilized intervention policy.

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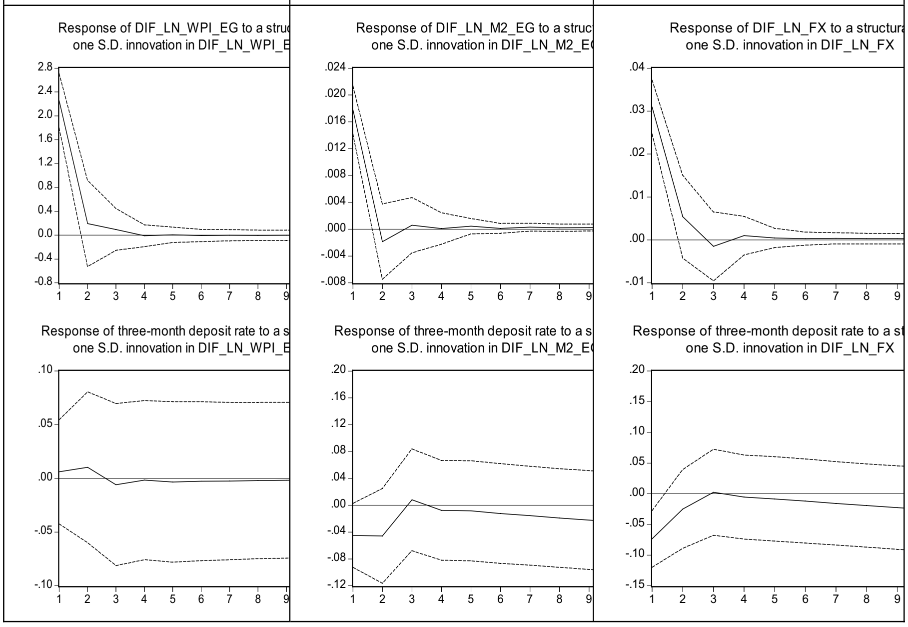
interest rate on deposits should not fall below 12% per annum. This restriction was cancelled in 1993/1994 (Moursi et al., 2007, pp. 6–7).

Figure 1: The response of domestic monetary policy to a structural shock in domestic prices, money supply, and FX rate.

Scheme 1	Scheme 2	Scheme 3



b. The impact of foreign economic shocks on real GDP and inflation

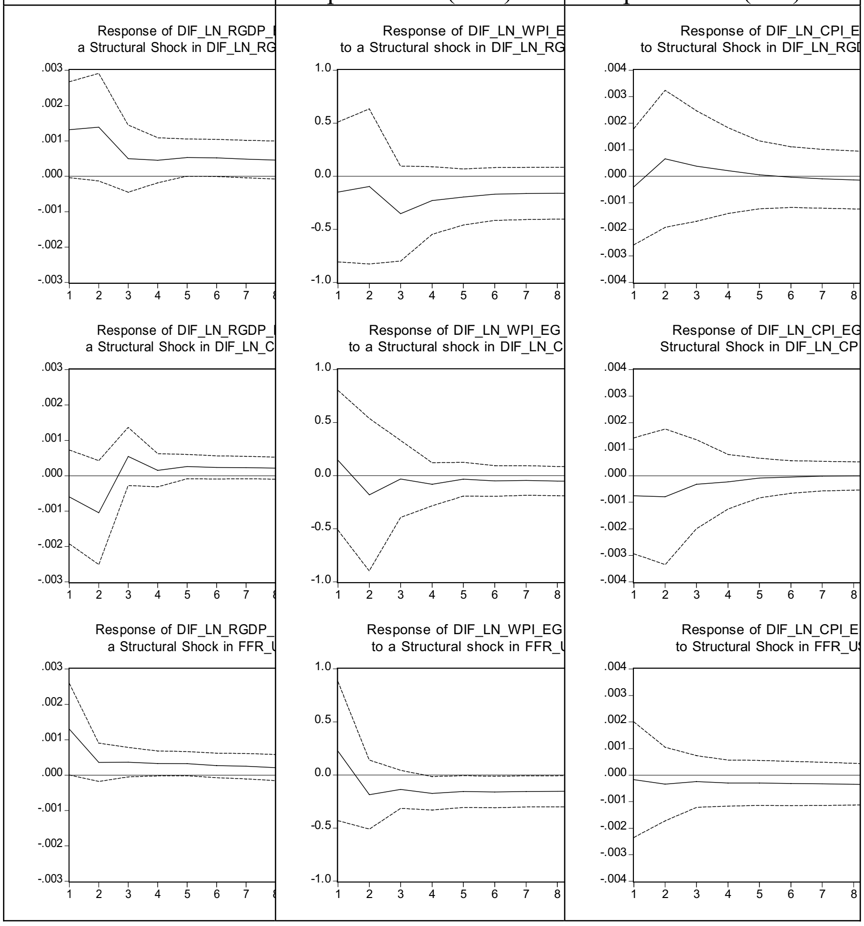
Figure 2 reports the impact of foreign economic shocks on the rate of growth of real GDP^{EG} and the rate of inflation in Egypt. Panel 1 depicts the response of the rate of growth of real GDP^{EG} to structural one standard deviation innovation in the rate of growth of real GDP^{USA}, the rate of change in the CPI^{USA}, and the FFR^{USA}. It indicates that a shock in the rate of growth of real GDP^{USA} has significant impact (at 10 % level) on the rate of growth of real GDP^{EG} for two quarters. In addition, a shock in the FFR^{USA} has significant impact on the rate of growth of real GDP^{EG} (at 10 % level) for one quarter. A shock in the rate of change in the CPI^{USA}, however, does not have significant impact on the rate of growth of real GDP^{EG}.

While the expansion of real GDP^{EG} induced by a positive shock in real GDP^{USA} can be attributed to the demand effect, the expansion of real GDP^{EG} induced by a positive shock in FFR^{USA} can be attributed to a depreciation of the domestic currency vis-à-vis the US dollar, which stimulates domestic exports.

Panels 2 and 3, Figure 2, mirror the impact of foreign economic shocks on domestic inflation measured by the rate of change in WPI^{EG} and, for robustness, the rate of change in CPI^{EG}. While CPI-inflation does not indicate any significant impact of foreign shocks, WPI-inflation detects significant impact of FFR^{USA}, at 5 % level, beginning of quarter 4.

Figure 2: The impact of foreign economic shocks on domestic variables (real GDP and prices)

Panel 1: The impact on real GDP	Panel 2: The impact on price level (WPI)	Panel 3: The impact on price level (CPI)



c. The impact of domestic economic shocks on real GDP and inflation

Figure 3 reports the responses of both the rate of growth of real GDP^{EG} and inflation to shocks in other domestic variables (a structural shock in the rate of change in FX^{EG}, DR^{EG}, and the rate of growth of $M2^{EG}$).

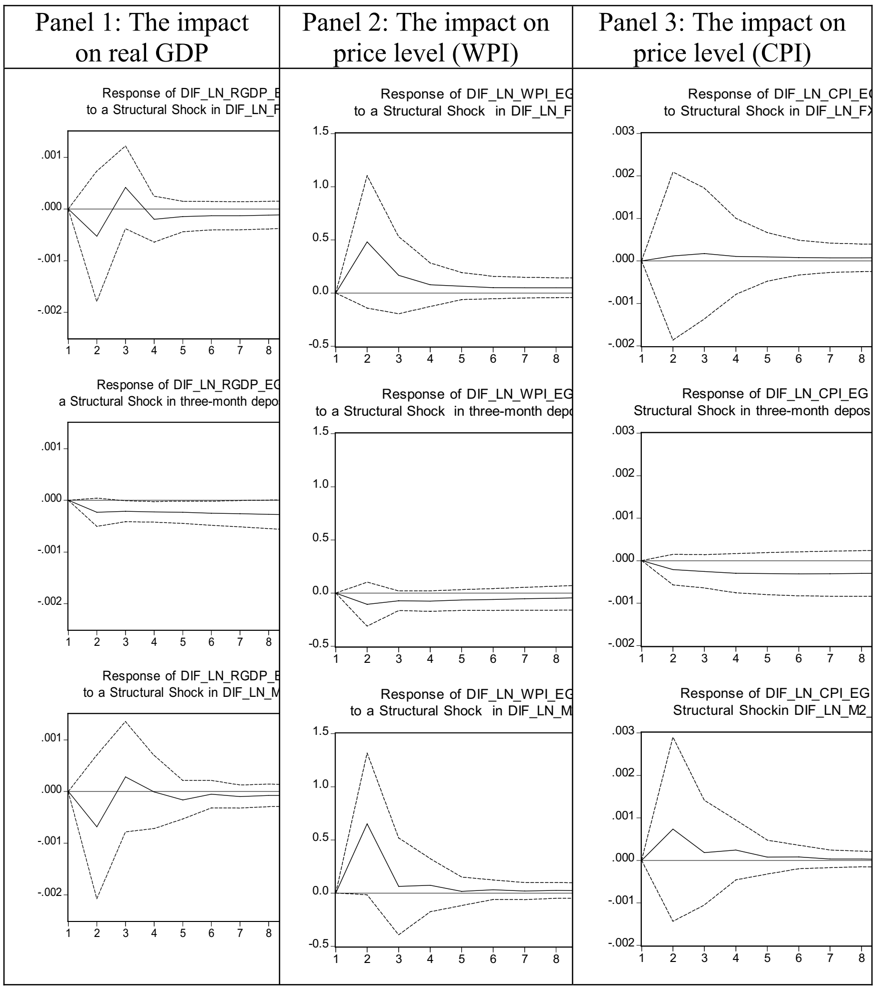
As shown in panel 1, DR^{EG} is the domestic variable that has significant impact on the rate of growth of real GDP^{EG}. As DR^{EG} comes after real GDP^{EG}, a shock in DR^{EG} does not have a contemporaneous effect on the rate of growth of real GDP^{EG}. The significant impact of a shock in DR^{EG} on the rate of growth of real GDP^{EG} (at 5 % level) begins from the third quarter. In the light of a descriptive analysis of MTMs in section 2, the negative impact of a positive shock of short-term interest rate on real GDP can be explained by the interest rate channel[9].

Panels 2 and 3 depict the response of domestic inflation, measured by the rate of change of both WPI and (for robustness) CPI, to domestic shocks. Panel 2 tells us that the rate of change in M2 has significant influence at 5 % (or 10 %) level, in the second quarter, on the inflation rate measured by the rate of change in WPI (see appendix 1). The influence of the rate of change in M2 on domestic inflation is not significant when the rate of inflation is measured by the change in CPI as shown in panel 3. Indeed, this result agrees with the aforementioned studies by Awad (2008) and Rabanal (2005). In addition, it justifies the use of WPI rather than CPI in analyzing the MTMs in Egypt[10].

Other domestic variables, in Panel 2, seem to have significant influence, at 10 % level, on domestic inflation measured by a change in WPI^{EG}. As both FX^{EG} and DR^{EG} come after the rate of change in WPI^{EG} they do not have a contemporaneous effect on WPI^{EG}. While the rate of change in FX^{EG} has significant impact on domestic inflation in quarter 2, DR^{EG} has significant impact on domestic inflation beginning from quarter 3.

[9] We focus on the direct effect of changes in short-term interest rate on real GDP, i.e. changes in short-term interest rate affect the marginal cost of borrowing thereby real investment and real GDP change.
[10] Notice also that the CPI-inflation did not detect any significant impact of foreign economic shocks, as mentioned above.

Figure 3: The impact of domestic economic shocks on domestic variables (real GDP and prices)



d. Variance decomposition of domestic variables to foreign and domestic shocks

Table 1 summarizes the forecasting variance decomposition of the domestic variables as follows: (i) External shocks explain roughly 25% of the variances in real GDP^{EG} in the short run and 32% in the long run. A shock in the rate of growth of real GDP^{USA} takes priority among the foreign shocks that affect the variances of real GDP^{EG} either in the short run or in the long run.

(ii) Domestic inflation is controlled by domestic shocks in the short run. The rate of growth of M2 takes priority among the domestic and foreign variables that influence domestic inflation in the short run. In the long run, the rate of growth of $M2^{EG}$ and the rate of growth in real GDP^{USA}, respectively, play an important role among the domestic and foreign variables that affect domestic inflation.

(iii) The variance decomposition of the three-month deposit rate shows that the FFR^{USA}, among foreign variables, explains 36% of variances in DR^{EG} in the long run. In the short run, domestic variables, especially FX^{EG} play a role in explaining variances of DR^{EG}.

(iv) The rate of growth of $M2^{EG}$ is driven by domestic and foreign shocks. While the rate of growth of real GDP^{USA} takes priority among the foreign shocks that affect the rate of growth of $M2^{EG}$,the DR^{EG} takes priority among the domestic variables that affect the rate of growth of $M2^{EG}$.

(v) As for the rate of change in the FX^{EG}, domestic shocks take higher priority than foreign shocks either in the short run or in the long run. The rate of growth of M2 and changes in short-term interest rates, respectively, are the two domestic factors that represent the main source of variances in the FX rate, whereas the rate of growth of real GDP^{USA} represents the main source of foreign shocks that influence variances in the FX rate.

Table 1: Forecasting variance decomposition of domestic variables (%)

	External Shocks				Domestic shocks					
Variance decomposition of the rate of growth of real GDP										
period	$RGDP^{USA}$	CPI^{USA}	FFR^{USA}	**Sum.**	RGDP	WPI	DR	M2	FX rate	**Sum.**
6 months	13.2	5	5.2	**23.4**	-	0.02	0.001	2.6	0.2	**2.82**
1 year	14.3	6	5.6	**25.9**	-	0.02	0.5	3	0.44	**3.96**
4 years	19.2	7.3	6	**32.2**	-	0.03	2.06	3.4	1.22	**6.71**
Variance decomposition of the rate of inflation (WPI)										
6 months	0.51	0.9	1.4	**2**	2.4	-	1.5	9.3	0.1	**11**
1 year	3.2	0.95	2	**6.25**	2.3	-	1.9	9.2	0.2	**11.3**
4 years	7.6	1.4	5.4	**14.4**	2.2	-	2.2	8.5	0.25	**12**
Variance decomposition of the three-month deposit rate										
6 months	1.1	9.1	9.5	**19.7**	2	0.2	-	0.08	3.72	**6**
1 year	2.4	9.45	12.5	**24.35**	2.2	0.1	-	2.2	6	**10.5**
4 years	7.93	3.48	35.9	**47.31**	1.1	0.04	-	0.94	3.5	**5.6**

Variance decomposition of the rate of growth of M2										
6 months	7.2	1.4	2.8	**11.4**	2	2	5.8	-	0.19	**10**
1 year	7.49	1.9	3.11	**12.5**	2.35	2	5.79	-	0.31	**10.45**
4 years	9.2	2.12	4.38	**15.7**	2.3	1.9	5.68	-	0.34	**10.22**
Variance decomposition of the rate of change in the FX rate										
6 months	21.78	1.16	1.1	**24.04**	0.06	4	10.7	23.7	-	**38.46**
1 year	23.84	1.24	1.15	**26.23**	0.29	4.12	10.08	24.45	-	**38.94**
4 years	24.49	1.54	1.2	**27.23**	0.36	4.03	10.24	23.97	-	**38.6**

To summarize:

(i) The CBE is factually applying the sterilized intervention policy. This result is corroborated through positive and significant response of monetary policy to structural shock in the rate of change in FX^{EG} (Figure 1). Taking into account that the CBE is (formally) applying the monetary targeting regime, thus the CBE is (implicitly) maintaining a target for the FX rate.

(ii) The high variance of DR^{EG} caused by either FFR^{USA}, among foreign variables, or FX^{EG}, among domestic variables, indicates that the CBE does not apply an independent monetary policy, given the result that the CBE is factually applying the sterilized intervention policy.

(iii) The FFR^{USA} and FX^{EG}, respectively, play the most important role among the foreign and domestic variables that influence the reaction of the CBE.

(iv) Foreign economic shocks, particularly shocks in both the rate of growth in real GDP^{USA} and FFR^{USA}, play a dominant role in explaining the behavior of the rate of growth of real GDP^{EG}. Domestic interest rate, DR^{EG}, is the domestic variable that has significant impact on the rate of growth of real GDP^{EG}. This result is corroborated through impulse responses (Figures 2 and 3) and variance decomposition analysis (Table 1).

(v) Foreign economic shocks do not have significant impact on the rate of inflation in Egypt during the short run. That is the rate of inflation in Egypt in the short run is controlled by domestic variables. The rate of growth of $M2^{EG}$ takes priority among domestic and foreign variables that influence domestic inflation either in the short run or in the long run. Changes in DR^{EG} take the second priority among domestic variables that affect the rate of inflation in Egypt. The rate of change in FX^{EG} affects domestic inflation in the short run. This result is derived from impulse responses (Figures 2 and 3) and variance decomposition analysis (Table 1).

(vi) Given results (iv) and (v), the interest rate channel explains the MTMs in the Egyptian economy, where changes in DR^{EG} have significant impact on both the rate of growth of real GDP^{EG} and domestic inflation (Figure3).

Conclusions

Empirical studies about the MTMs in the Egyptian economy are limited and do not give much attention to foreign shocks that may control the behavior of macroeconomic variables. Thus, this study does attempt to fill a gap in studies by estimating MTMs in the Egyptian economy using a structural VAR model in which the Egyptian economy is treated as a small-open economy.

The purpose of this study is to answer the following questions: Does the CBE maintain an implicit target for the FX rate? Does the CBE follow an independent monetary policy? Which variables have priority in the reaction function of the CBE? How far can foreign economic shocks explain the behavior of real GDP and price level in the Egyptian economy compared with domestic economic shocks? And which monetary transmission mechanism channels play a dominant role in the Egyptian economy?

The results of the study are as follows: (i) The CBE is factually applying the sterilized intervention policy. Taking into account that the CBE is (formally) applying the monetary targeting regime, thus the CBE is (implicitly) maintaining a target for the FX rate. (ii) The high variance of domestic interest rate caused by either the federal funds rate or the FX rate, indicates that the CBE does not apply an independent monetary policy. (iii) The federal funds rate and the FX rate, respectively, play the most important role among the foreign and domestic variables that influence the reaction of the CBE. (iv) Foreign economic shocks play a dominant role in explaining the behavior of real domestic growth, whereas domestic economic shocks play a dominant role in explaining the behavior of domestic inflation, especially in the short run. (v) The interest rate channel explains the MTMs in the Egyptian economy, where changes in domestic interest rate have significant impact on both the rate of growth of real GDP and inflation.

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