RedFame

Applied Economics and Finance
Vol. 2, No. 3; August 2015
ISSN 2332-7294 E-ISSN 2332-7308
Published by Redfame Publishing
URL: http://aef.redfame.com

An Assessment of the Real Exchange Rate Misalignment in Egypt: A Structural VAR Approach

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Received: April 14, 2015 Accepted: April 29, 2015 Available online: May 19, 2015

doi:10.11114/aef.v2i3.831 URL: http://dx.doi.org/10.11114/aef.v2i3.831

Abstract

This paper calculates the equilibrium real effective exchange rate for the Egyptian economy during the period (1974-2012). The paper reviews the evolution of Egypt's exchange rate policy and the most significant developments of its real effective exchange rate during the same period. Using a structural vector auto-regression model identified with long-run restrictions, it evaluates the relative importance of real supply, demand and nominal shocks to the disturbances of Egypt's real effective exchange rate. The identified shocks and their impulse responses are consistent with the theoretical priors stemming from the Mundell-Fleming model. The main contribution to the fluctuations of the real effective exchange rate, roughly 80 percent, comes from both real demand and supply shocks. The model is used to check if the real exchange rate in Egypt is misaligned during the period under investigation. It shows that the actual real effective exchange rate has deviated from the equilibrium real effective rate with various degrees during the estimation period.

Keywords: Egypt, real effective exchange rate, structural VAR, exchange rate misalignment.

JEL Classification: C32, F31, F41, O55.

1. Introduction

The increasing pace of international financial integration, brought by de-regulation of domestic capital accounts and cross-border capital flows, may have its positive effects on an economy through boosting domestic investment and economic growth. However, these benefits come with some risks to the exchange rate stability. This global economic environment has elicited the need for periodical assessment of real exchange rate misalignment for better management of domestic financial and overall macroeconomic systems. Assessing the extent of real exchange rate misalignment has been a long standing tradition and ac common practice in policy oriented research work.

Real exchange rate misalignments, perceived as a key economic indicator has a critical interest for policymakers. Such misalignments cause growth slowdowns and terms of trade deterioration among other things. This raises concerns about any potential departures of the actual exchange rate from its equilibrium level, especially if such departures are significant and/or persistent. As such, a frequent evaluation of both the actual and equilibrium exchange rates is considered essential so that policymakers can maintain a sustainable external position of their economies (Borowski and Couharde, 2003; Ajevskis et al., 2012).

Wherefore, appropriate models should be used to estimate the equilibrium exchange rate and assess the deviation of the actual rate from its fair value. Many empirical papers have focused on examining real exchange rate misalignments especially on the scale of developed countries. Only recently, there has been a prominent interest such topic for developing and emerging countries. Several studies have tried to estimate the equilibrium real exchange rate and identify its link to the real economy (Hosni, 2015).

Studies that include Egypt and country specific studies on Egypt are indeed scarce. These include (Mongardini, 1998) and (Mohieldin and Kouchouk, 2003). Mongardini (1998) uses monthly data from February 1987 to December 1996 to estimate the equilibrium exchange rate for Egypt. His model is in line with Edwards' model described above and include terms of trade, government consumption, technological innovation, Gulf war dummy, fiscal deficit and debt service ratio. The findings indicate that while the Egyptian pound was overvalued before 1993, it has converged to the equilibrium rate at the end of 1996. A model based on Edwards (1989) is developed and employed by Mohieldin and

Kouchouk (2003) to be applied to the bilateral exchange rate. Their estimation covers the period between 1970 and 2001 and suggest terms of trade, gross capital formation, government consumption, real GDP growth, capital flows, economic openness and environmental stance as the main fundamental variables to be incorporated into the model. The study underscored the presence of high degrees of misalignment during the period under investigation.

The present study constructs a structural vector auto-regression (SVAR) model to check if real exchange rate in Egypt is misaligned during the period (1974-2012). The paper is organized in eight sections. The next section provides an overview of the exchange rate policy in Egypt with particular attention to the most significant developments of the real effective exchange rate during the estimation period. Section III presents a discussion of the theoretical background and empirical literature. Section IV describes the methodology used. Section V and VI provides some preliminary data analysis and the estimation results, respectively. Section VII shows an empirical estimate of the equilibrium exchange rate in Egypt between 1974 and 2012 based on the SVAR methodology and section VIII concludes.

2. Exchange Rate Regime and Developments – A Historical Overview

The implementation of monetary policy has witnessed many shifts in Egypt since the launch of the Economic Reform and Structural Adjustment Program (ERSAP) in the early 1990s. Remarkable changes included abolishing interest rate ceilings and other policies, which hindered an efficient allocation of resources, financial restructuring for the banking sector, and minimizing the role of the Central Bank of Egypt (CBE) in financing the treasury deficits.

Egypt maintained a multiple exchange rate regime with a relatively appreciated or subsidized exchange rate for food imports before the official launch of the ERSAP[1]. The regime consisted of three main pools; an official Central Bank rate, a commercial bank rate, and an illegal yet tolerated parallel foreign exchange market; each had its own sources and uses of foreign exchange and with separate rates (Abdel-Khalek, 2001).

Due to an increasing pace of economic difficulties during the early 1990s, Egypt started the ERSAP in 1991. The program was mainly designed to achieve macroeconomic stability and create a decentralized open market oriented economy. At the heart of the program was the exchange rate liberalization and unification (Mohieldin and Kouchouk, 2003; El-Shazly, 2011). In February 1991, a significant step was undertaken when the three-tier exchange rate regime was temporarily replaced by a dual exchange rate system consisting of a primary market and a secondary market. The two rates were finally merged and unified under ERSAP in October 1991. Since then, the Central Bank of Egypt intervened to maintain a stable foreign exchange rate against the US dollar using the pound/dollar exchange rate as a nominal anchor for monetary policy. This represented a new phase in the exchange rate management in Egypt.

The development of the real effective exchange rate during the period (1988-1991) was affected by the several administrative adjustments (i.e. nominal devaluations) that occurred since 1987, which resulted in a sharp depreciation of the real trade-weighted index of exchange rate. The trend had completely been reversed after the stabilization effort took place; between 1991 and 1996, the real effective exchange rate has appreciated by almost 27 (figure 1).

A series of devaluations started in 2000 and 2001 due to the persistent pressures on the Egyptian pound and in an attempt to prevent extra drainage of the foreign reserves[2]. The government has gradually moved to a more flexible exchange rate in late 2000. It is worth mentioning that from 2002 onwards, the economy experienced high inflation rates (reflected in the trends of both the Wholesale Price Index (WPI) and the Consumer Price Index (CPI) following the successive devaluations of the exchange rate during 2000 and 2001. In 2003, the objective of price stability was formally declared to be the main objective of the monetary policy (Hosni, 2015; Mabrouk and Hassan, 2012).

[1] In 1981 for instance, the official exchange rate for food imports was set at L.E. 1.43 per USD and L.E. 1.19 per USD for non-food imports (Huizinga, 1995).

[2] Toward the late 1990s, the Egyptian economy has started to show many signals of serious economic troubles. The Egyptian economy was hit by a succession of both internal and external shocks in 1997. The East Asian crisis, the Luxor tragedy and the decline in oil international price led to a deterioration in Egypt's external position triggered mainly by an outflow of capital and a decline in tourism receipts in addition to a widening current account deficit (Handy, 2001; Panizza, 2001).

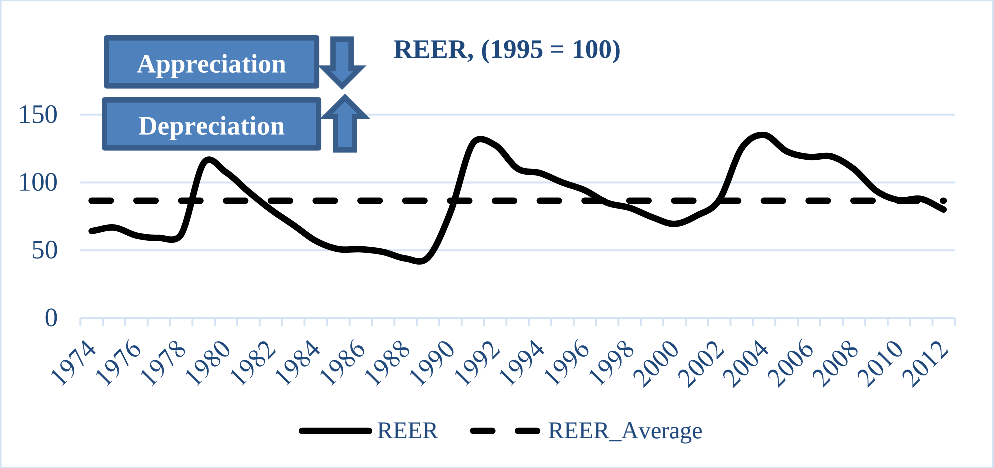

Figure 1. Real Effective Exchange Rate for Egypt during the Period (1974-2012)

Source: Author's Calculations using data from DOTS, IMF and IFS, IMF.

In 2003, a free float of the Egyptian pound was announced as an attempt to resolve the policy inconsistency, originating from a combination of exchange rate rigidity, a reluctance to run down international reserves to support the peg to the dollar, and to reduce interest rates to activate the economy (Galal, 2003; Hassan, 2003). This caused the real effective exchange rate to lose nearly 69 percent of its value between 1999 and 2003.

A remarkable progress has occurred in 2005 when the CBE announced its intension to adopt the inflation targeting policy. On June 2, 2005, the CBE developed a new framework for the monetary policy, which replaced the overnight interest rate on interbank transactions as an operational target instead of the excess reserve balances of banks (Al-Mashat, 2008; Mabrouk and Hassan, 2012).

The Egyptian economy experienced positive external factors during 2006 and 2007 such as favorable terms of trade, high external demand and an increase in foreign capital inflows. This had an appreciating effect on the real exchange rate during the same period (figure 1). The Egyptian Pound exchange rate has depreciated by roughly 4.7 percent against the US dollar during the FY 2008/2009 as a result of the global financial crisis and a parallel current account deficit (CBE, External Position of the Egyptian Economy, FY 2008/2009). The period between 2005 and 2008 witnessed an appreciation of the real effective exchange rate of around 11 percent.

The Egyptian economy has suffered from unstable political and economic conditions since the outbreak of the January 25th revolution in 2011. Some unfavorable conditions included a rise in capital outflows, a decline in tourism receipts, an increase in the dollarization process and a downgrade in Egypt's credit rating. The CBE reacted by withdrawing from the net international reserves, which dropped by about USD 11 billion or nearly 42 percent between June 2011 and June 2012 (Central Bank of Egypt, 2011/2012). In an attempt to avoid further declines in the net international reserves, the CBE introduced a new system of dollar auctions through which domestic banks can buy or sell US dollars, which should help in saving the remaining reserves for the purposes of covering the import bill and servicing the external debt (Brixiova, Égert and Essid, 2013, Hosni, 2015).

Nevertheless, confidence in the Egyptian currency has been regained with the improvement on the political spectrum in 2012. This led to a light deceleration in the dollarization process3 and hence, affected the pattern of exchange rate evolution slightly (ALEXBANK, 2011; MoF Financial Monthly 2012; Central Bank of Egypt, Monthly Bulletin, 2012). The real exchange rate has appreciated by almost 27 percent between 2008 and 2012 in effective terms (figure 1).

3. Theoretical Background and Empirical Literature

The SVAR approach is an alternative line of research for the determination of equilibrium exchange rates. It takes the irrelevance of the PPP hypothesis – which implies that the real exchange rate should fluctuate around a constant mean – as a starting point. The failure of the hypothesis as an empirical approximation of the equilibrium real exchange rate in

[3] The dollarization ratio declined from roughly 21 percent in June 2011 to around 20.6 percent in June 2012. This was attributed to a decline in the proportion of foreign currency deposits in total deposits between the two time points. While local deposits comprised L.E.664.6 billion of a total of L.E.841.5 billion in June 2011, they went up to L.E.714.3 billion of 900.4 billion in June 2012 (Central Bank of Egypt, Monthly Bulletin, 2012).

some applications implies that there might be a permanent effect of shocks on the real exchange rate and that the equilibrium exchange rate can be more accurately modelled as time-varying (Gauthier and Tessier, 2002).

The VAR model is a beneficial approach, which can be used to decompose the variation in the actual real exchange rate into components attributable to different economic shocks. These shocks should be identified through a number of assumptions about their long-run impact on the variables incorporated in the model employed (Bjørnland, 2004; Mehrara, 2006). Blanchard and Quah (1989) represents a pioneering work that is based on a bivariate SVAR model for output and unemployment. They interpret the fluctuations in output and unemployment to two different types of disturbances; supply disturbances and demand disturbances. Their results show that while supply disturbances have a permanent effect on output, demand disturbances have only a transitory effect on both output and unemployment.

Following the influential work of Blanchard and Quah (1989), several studies have explored the sources of real exchange rate fluctuations. Lastrapes (1992) investigated the relative importance of real and nominal shocks in explaining the variation of real exchange rates of the USA, the UK, Germany, Japan, Italy and Canada over the period (1979-1989) based on monthly data. The findings indicated the dominance of real shocks over nominal shocks both over short and long-run frequencies for nominal and real exchange rate series.

Clarida and Gali (1994) provide the seminal work to investigate the effects of real and nominal shocks on the real exchange rate. Their identification of such shocks is achieved with long-run restrictions in an open macro-economy model context, which is a version of the model developed by Obstfeld (1985). Their representation illustrates how the Mundell-Fleming-Dornbusch (MFD) model can be used as a baseline framework for the identification of different types of shocks in the economy.

The shocks in the open macro-economy model can be classified into three types; supply shocks (such as changes in relative productivity of home to foreign countries), demand shocks (such as changes in government spending), and nominal shocks (such as monetary policy shocks). The model includes two basic assumptions; (1) prices are sluggish, and (2) foreign and domestic goods are imperfect substitutes. Under these assumptions, the three shocks have an impact on the levels of prices, output and real exchange rate only in the short-run then they converge to their long-run trends when the price adjust fully to the shocks. A positive supply shock in the home country increases the aggregate supply of domestic goods and the rate of return to capital. In the context of the MFD model in which capital is mobile, this will lead to an inflow of capital and an appreciation of the exchange rate. In the long-run, domestic output increases to its potential level, domestic price decreases and real exchange rate depreciates (assuming that the nominal exchange rate does not change) to generate surplus in the trade balance. This surplus is used to cover the net foreign liabilities of the home country. A positive demand shock raises the demand for domestic goods and their prices increase consequently. This leads to an appreciation of the real exchange rate (assuming that the nominal exchange rate does not change) along with higher levels of output in the short-run. In the long-run, however, output level returns to its long-run trend while the price stays at its high level and real exchange rate above its long-run trend. Finally, a positive nominal shock lowers the interest rate in home country. This causes a depreciation of the real exchange rate, an increase in both the price level and domestic output. In the long-run, output and the real exchange rate return to their long-run trends (Wang, 2005; Daly, 2006).

Accordingly, nominal shocks are assumed not to affect the real exchange rate and output levels in the long-run in spite of affecting the price level. Supply shocks, however, are deemed to influence all the three variables in the long-run. Demand shocks cannot affect the output level in the long-run. Thus, only supply shocks can have a long-run influence on output, prices are affected by the three shocks, and the real exchange rate is influenced by only supply shock and demand shocks in the long-run (Ajevskis et al., 2012).

Identification Methodology

Our empirical model draws from Clarida and Gali (1994) by estimating the following reduced-form VAR model:

$$Z_t = \sum_{l=1}^{L} \varphi_l Z_{t-l} + u_t = \varphi(L) Z_t + u_t \tag{1}$$

where Z_t is a vector containing the first differences of the real exchange rate, relative output and relative price level. The variables are constructed relative to an economy's trading partners. u_t is a vector of reduced–form disturbances that are serially uncorrelated but can be contemporaneously correlated with each other. It has an estimated variance covariance matrix Ω.

Deriving the moving average representation of this VAR gives:

$$Z_t = u_t + R_1 u_{t-1} + R_2 u_{t-2} + \cdots \tag{2}$$

The model can be represented by the following structural vector moving average representation:

$$Z_t = C_0 \varepsilon_t + C_1 \varepsilon_{t-1} + C_3 \varepsilon_{t-2} + \cdots \tag{3}$$

where ε_t represents structural disturbances or shocks, which have certain effects on the level endogenous variables and are assumed to be uncorrelated. C_0 is the 3×3 matrix that defines the structural relationship among the three variables (Claida and Gali, 1994; Pfaff, 2008).

Assuming that there exists a nonsingular matrix S such that $u_t = S\,\varepsilon_t$ and comparing equations (2) and (3), gives the following:

$$C_0 = S\,,\ C_1 = R_1 S,\ C_2 = R_2 S \ldots\ldots$$

Accordingly,

$$u_t = C_0 \varepsilon_t \tag{4}$$

such that ε_t is the vector of (relative) demand shocks, (relative) real supply shocks, and (relative) nominal shocks so that the effect of a shock on the real effective exchange rate is obtained in relative terms to other shocks/variables in the model and can be determined by the sum of structural coefficients.

Taking into consideration that the structural disturbances are orthogonal and each has unit variance, and using equation (4) implies that:

$$C_0 C_0^T = \Omega \tag{5}$$

As such, in addition to the estimates of the reduced-form disturbances, it is not possible to recover the series of structural shocks without obtaining the estimates of the parameters that define C_0. Since C_0 is a 3×3 matrix, which includes nine parameters with only 6 parameters given by the matrix Ω (three estimated variances and three co-variances of the reduced-form disturbances), three additional restrictions are required to identify the system (Clarida and Gali, 1994). For instance, the restriction that shock j has zero long–run effect on the level of endogenous variable i means that Cij (1) = 0 is imposed (Mehrara, 2006).

Following the approach of Blanchard and Quah (1989), which is based on using long-run theory-based restrictions to the effects of certain shocks on the levels of certain endogenous variables, the below restrictions are imposed.

Nominal shocks have no long-run effect on the real exchange rate. In particular, a nominal shock leads to an increase in the price level, depreciates the exchange rate proportionally and thus, leaves the real exchange rate unchanged. This result is predicted by the "exchange rate overshooting model" (Krugman, Obstfeld and Melitz, 2012). This implies that:

$$C_{23}(1) = 0 \tag{6}$$

In other words, real demand shocks can have a long-run impact on itself and can be influenced only by supply shocks.

There is no long-run effect of nominal or real demand shocks on output. Output is solely determined by supply driven shocks. Hence,

$$C_{12}(1) = C_{13}(1) = 0 \tag{7}$$

Nominal shocks are affected both by long run real demand and supply shocks.

This makes C_0 a lower triangular matric, which can be written as follows:

$$\begin{bmatrix} C_{11}(1) & 0 & 0 \\ C_{21}(1) & C_{22}(1) & 0 \\ C_{31}(1) & C_{32}(1) & C_{33}(1) \end{bmatrix}$$

The model thus, identifies the permanent impact of three structural shocks; real demand, supply and nominal shocks, and evaluates their relative contribution to the forecast error variance in the real exchange rate.

A number of recent studies have applied the above methodology to explore the sources of exchange rate fluctuations in various countries. Thomas (1997) constructed a structural vector auto-regression model to examine the movements of the real effective exchange rate in Sweden between 1979 and 1995 using quarterly data. Based on a Mundell-Flemming Framework, the results suggest that real demand and supply shocks play a significant role in the real exchange rate since they account for over 60 percent of the movements of the Swedish Krona. Weber (1997) carried out the methodology of Clarida and Gali (1994) using monthly data between 1971 and 1994 for the United States, German and Japan real bilateral exchange rates. His study included a larger number of shocks such as labor supply and productivity shocks, money supply and money demand shocks, and aggregate demand shocks. Based on the long-run restrictions of Blanchard and Quah (1989), their findings confirm that demand shocks are the driving force of real exchange rate movements. However, for the two bilateral rates of the Japanese Yen, supply shocks do contribute with a much more significant fraction than do demand shocks.

Applying a bivariate structural VAR analysis on seven industrialized countries (the USA, Canada, the UK, Japan, Germany, France and Italy), Lee and Chinn (1998) explored the effects of both real and nominal shocks on the real exchange rates of these countries. It was found that only real productivity shocks have an effect on real exchange rates in the long-run. Rogers (1999) examined the contribution of various shocks (real government spending shocks, real income shocks, money multiplier and real money base shocks) to the movements of the Sterling Pound-US dollar rate based on annual data ranging between 1889 and 1992. Employing a structural VAR model, he found evidence that monetary shocks are essential in explaining the real exchange rate since they typically account for roughly 50 percent of the variation of the real exchange rate over short horizons.

Dibooglu and Kutan (2001) examined the specific cases of Hungary and Poland using monthly data from 1990 and 1999. Their structural VAR analysis concluded that while real shocks are the main determinant of real exchange rate in Hungary, nominal shocks has the major influence in affecting real exchange rate in Poland. Detken et al. (2002) estimated the real effective equilibrium rate of the synthetic euro during the period (1970:Q1-2000:Q4). They concluded that real demand shocks explain the bulk of fluctuations in the real exchange rate followed by supply shocks (labor supply and productivity shocks).

Soto (2003) carried out a structural VAR model using long-run restrictions to examine the forces behind the movements of the real exchange rate in Chile between 1990 and 1999 on a monthly based data. The structural VAR model included both nominal shocks and real supply and demand shocks as well. It was found that the Chilean Peso was mainly driven by nominal shocks in the short-run and real shocks in the long-run. However, the response of the currency to real shocks differ based on their type. Supply shocks lead to an appreciation of the real exchange rate while demand shocks cause a depreciation of the real rate. Additionally, the historical composition of the real exchange rate did not reflect periods of large misalignments of the real exchange rate.

Wang (2005) employed a structural vector auto-regression model to study the sources of fluctuations in the real exchange rate of China during the period (198-2002). Three types of shocks were identified in the system; the aggregate supply shocks, the aggregate demand shocks, and the nominal demand shocks. The results indicated that for China, relative real demand shocks have been the most important sources of renminbi real rate fluctuations over the estimation period. Stazka (2006) has employed a structural VAR model on the lines of Clarida and Gali (1994) to empirically investigate the sources of real exchange rate movements in eight Central and East European (CEE) new European Union (EU) member states: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. Among the eight countries; the Czech Republic, Hungary and Poland, were not participating in the Exchange Rate Mechanism II (ERM II) at the time of writing Stazka's paper. As such, the author aimed at testing whether the decisions by countries which have already joined the ERM II were driven by the fact that their real exchange rates were mainly driven by nominal disturbances[4]. The empirical analysis was based on monthly data during the period (1995-2005). The findings came in contrast to the theoretical considerations since it was found that the real exchange rates in non ERM II countries and Latvia are mainly driven by nominal shocks while real demand shocks are the main forces behind the fluctuations of real exchange rates in the ERM II countries. Kontolemis and Ross (2005) found a evidence that real demand shocks explain most of the variance of the real exchange rate in new member states of the EU (Hungary, Poland, Latvia, Slovakia, Slovenia, the Czech Republic, Cyprus, Estonia and Lithuania) based on monthly data that spans from 1986 to 2003.

Joshi (2006) attempted to estimate the equilibrium real effective exchange rate in India using long-run restrictions in a structural VAR framework during the period (1996:Q1-2005:Q4). The analysis indicated the relative importance of real demand shocks followed by nominal and real supply shocks, respectively. Mehrara (2006) calculated the equilibrium exchange rate in Iran based on a structural VAR approach using annual data from 1338 to 1381. His model specified four main shocks; real demand, real supply, nominal and oil price shocks. The analysis showed that the movements of the real exchange rate were mainly driven by fiscal shocks and nominal shocks.

Khan, Mohammad and Alamgir (2010) applied the structural vector auto-regression technique to investigate the effect of various economic shocks on the real exchange rate of Pakistan during the period (1982-2007) based on quarterly data. Their found that nominal shocks explain a significant amount of the variance in dollar-rupee real exchange rates.

Ajevskis et al. (2012) constructed a structural VAR on the lines of Clarida and Gali (1994) using the long restrictions of Blanchard and Quah (1989) to explore time path of equilibrium exchange rate in Latvia between 2001 and 2009 based on quarterly data. They found that the actual real effective exchange rate follows closely the equilibrium rate during the estimation period and that nominal and demand shocks dominate supply shocks in explaining the variance of the real

[4] The countries whose real exchange rates are mainly driven by nominal shocks reflect the disequilibrium view of exchange rates while those whose real exchange rates are mainly driven by real shocks reflect the real economy view of exchange rates (Stazka, 2006).

effective exchange rate in Latvia. Based on the structural VAR methodology, Rimgailaite (2012) estimates the equilibrium real exchange rates for both Lithuania and Switzerland using quarterly data during the periods (1995-2010)

Unit Root Tests at:	Augmented Dicky-Fuller Test Results	Phillips-Perron Test Results
Levels	Model Form: Intercept	Model Form: Intercept
LREER	-3.489972	-2.447663
LGDP	-2.300871	-2.378501
LCPI	-1.700165	-1.688451

and (2000-2010), respectively. The results indicated the significant role of real demand shocks in explaining the movements of the real exchange rate for both countries.

4. The Econometric Framework of the SVAR Methodology

The SVAR approach is particularly useful because it decomposes the variation in the real exchange rate into components attributable to different economic shocks.

The estimate of an equilibrium exchange rate can be defined as the historical component of the real effective exchange rate that is driven by the identified real supply and real demand shocks, since the latter are deemed to impact the exchange rate in the long-run.

To justify the suitability of estimating a structural VAR model, it is essential to show that each of the individual series used are not integrated of order zero (i.e. I(0)) and that they are not co-integrated. Otherwise, a structural VAR model should be replaced by a vector error correction model. Estimation of the VAR model requires that each of the variables that enter the model is stationary. Series that are non-stationary should be appropriately transformed prior to estimation (Jacobs, Kuper and Sterken, 2003; Khan, Mohammad and Alamgir 2010).

The VAR model incorporates three main variables; the log of the real effective exchange rate (reer), the log of the relative output (y) and the log of the relative consumer price index (p). The three variables are constituted relative to a trade-weighted measure of Egypt's trading partner countries. As such, three structural shocks can be identified; real demand shocks (attributed to reer), real supply shocks (attributed to y) and nominal shocks (attributed to p). By accumulating the contribution of the permanent real demand and supply shocks to the real effective exchange rate, one can get a measurement for the long-run equilibrium real effective exchange rate. The choice of the variables incorporated in the VAR model and the restrictions imposed on them builds on a standard open macro-economy model as in Clarida and Gali (1994).

5. Preliminary Data Analysis

First, we need to examine the properties of the time series employed in the estimation process. The data used spans from 1974 to 2012 and are obtained from the IMF, IFS database and World Bank, WDI database. The sample used under this approach reflects both the availability of data and the appropriate number of lags based on the VAR estimation.

In order to properly specify the VAR model, the first step is to determine the order of integration of each of the variables incorporated using the formal stationarity tests; the augmented ADF test and the PP test.

The results in table (1) imply that the null hypothesis of a unit root cannot be rejected for the logarithm of the real effective exchange rate, relative output and relative CPI against the hypothesis of stationarity. The statistics of both the ADF and PP tests are smaller (in absolute value) than the 5 percent critical values for the three variables. To confirm that the three variables are first difference stationary, unit root tests were conducted for the first differences of the variables and it was found that the test statistics for the latter are larger (in absolute value) than the respective 5 percent critical values. Consequently, it can be concluded that the system variables are all integrated of order one (i.e. I(1)).

Table 1. Unit Root Test Results

First Differences	Model Form: Intercept	Model Form: Intercept
LREER	-4.235938*	-3.785989*
LGDP	-4.987436*	-4.933166*
LCPI	-3.779147*	-5.629606*

* Denotes significance at the 5 percent level and the rejection of the null hypothesis of non-stationarity.

Mackinnon (1991) critical values for rejection of hypothesis of unit root are applied. The critical values at 5 percent significance level are -3.5348 and -3.5312 for ADF and PP tests, respectively.

Having concluded that the individual time series are first difference stationary, the second step of the empirical work is to check for the co-integration among the three variables. The suitability of the implementation of the SVAR method is based on the variables being not co-integrated. Otherwise, a vector error correction model should be employed for the estimation process. To proceed with the Johansen's co-integration procedure, it is a necessity to decide on the appropriate number of lags in the VAR system. The optimal lag length was chosen according to the AIC test. The lag length of the chosen VAR was found to be three and the co-integration test showed no evidence for a co-integration relationship among the variables used (table 2).

Table 2. Johansen's Co-integration Likelihood Ratio Test for Multiple Co-integrating Vectors

Trace Statistic					Maximum Eigenvalue Statistic				
H_o	H_A	λ_{trace}	$CV_{5\%}$	$CV_{1\%}$	H_o	H_A	λ_{max}	$CV_{5\%}$	$CV_{1\%}$
$r_0 = 0$	$r_1 > 0$	14.66	15.41	20.04	$r_0 = 0$	$r_1 = 1$	8.35	14.07	18.63
$r_0 \leq 1$	$r_1 > 1$	6.30*	3.76	6.65	$r_0 = 1$	$r_1 = 2$	6.30*	3.76	6.65

Notes: i. r refers to number of co-integrating equations.

ii. $CV_{5\%}$ and $CV_{1\%}$ refers to the critical value at the 5 percent significance level.

iii. * Denotes rejection of the hypothesis at the 5 percent and 1 percent level.

6. Estimation Results

The unrestricted reduced-form VAR model was estimated using annual data from 1977 to 2012 with three lags of each variable in each of the three equations. This section presents the impulse responses of each of the variables to one standard deviation in each of the structural shocks and then computes the variance decompositions of the forecast errors based on the SVAR analysis.

Figure (2) plots the impulse responses for up to ten years of the three shocks on the relative output, real effective exchange rate and relative prices. The figure gives the accumulated response in each endogenous variable to one standard deviation structural shocks. Impulse responses are useful in gauging the signs and magnitudes of responses of the endogenous variables to specific shocks in the VAR system.

The results are broadly in line with the predictions given by a standard open economy model. A supply shock increases real output permanently, appreciates real effective exchange rate only temporarily before it depreciates in the long-run. Moreover, the supply shock reduces relative prices permanently. A positive real demand shock causes an immediate temporary increase in relative output, which thereafter returns to its long-run level. Real effective exchange rate appreciates permanently and prices increase gradually after the demand shock. Regarding the nominal shock, it leads to a depreciation in the real exchange rate only temporarily before it returns to its long-run trend as predicted by Dornbusch's overshooting model (Krugman, Obstfeld and Melitz, 2012). While the same occurs to relative output after a nominal shock, relative prices increase slowly to a new permanent higher level.

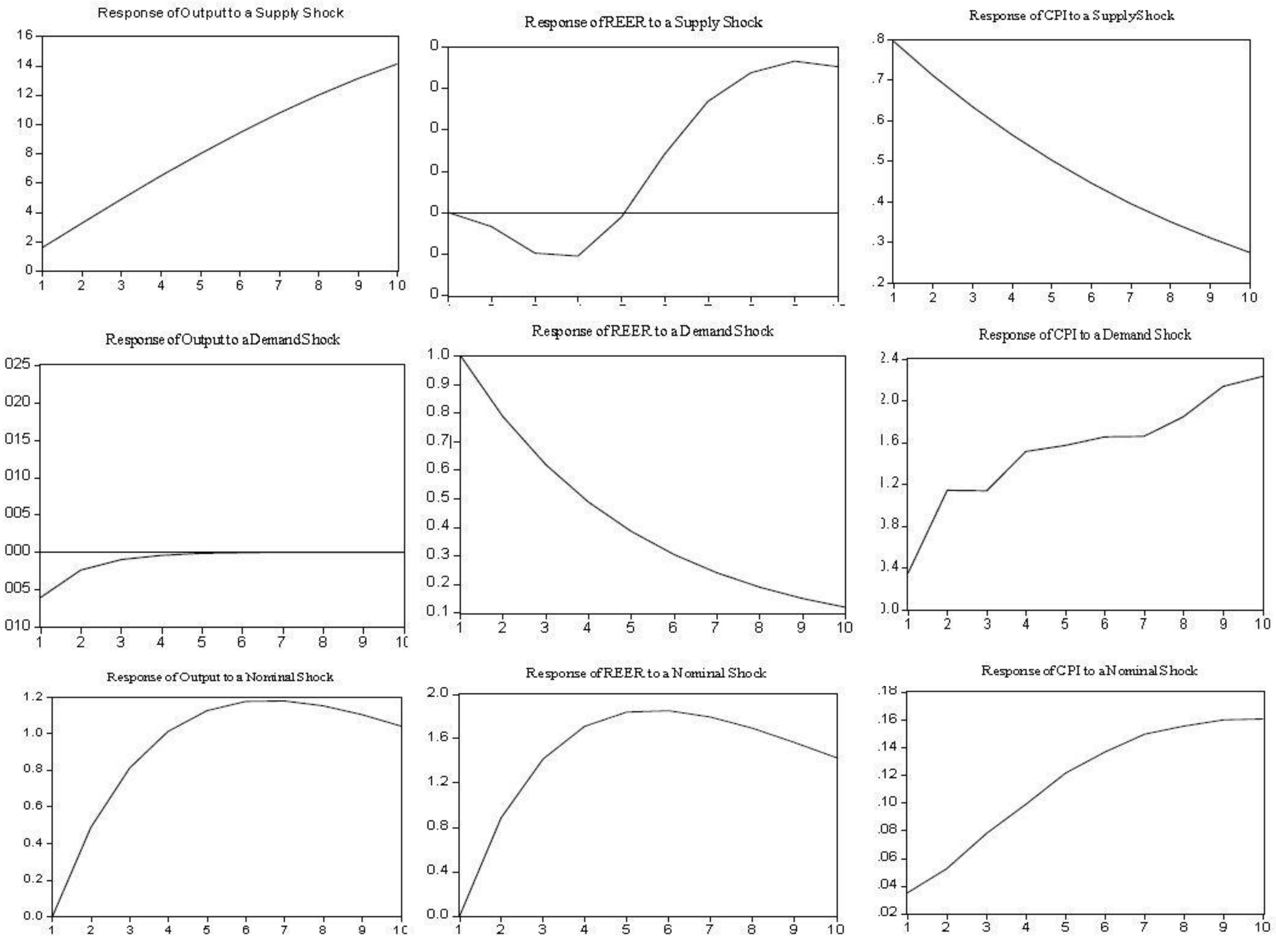

Figure (2). Accumulated Impulse Response Function of Relative Output, REER and Relative Prices Post Real Supply, Real Demand and Nominal Shocks

Table (3). Decomposition of Forecast Error of the Real Effective Exchange Rate

Horizon	Supply Shock	Demand Shock	Nominal Shock
1	38.08	39.66	22.24
2	40.69	43.02	16.27
3	39.03	44.06	16.90
4	39.80	41.40	18.78
5	48.03	35.41	16.54
6	48.20	34.68	17.11
7	45.13	34.82	20.04
8	44.70	35.50	19.78
9	44.48	35.91	19.59
10	45.20	35.43	19.36

Table (4). Decomposition of Forecast Error of the Relative Output

Horizon	Supply Shock	Demand Shock	Nominal Shock
1	61.44	15.93	22.61
2	57.34	17.83	24.82
3	54.25	21.76	23.98
4	55.19	22.49	22.30
5	53.24	24.18	22.57
6	52.96	23.94	23.09
7	52.79	23.88	23.31
8	52.61	23.82	23.55
9	52.52	23.80	23.66
10	52.44	23.76	23.79

Table (5). Decomposition of Forecast Error of the Relative Prices

Horizon	Supply Shock	Demand Shock	Nominal Shock
1	39.83	0.49	59.66
2	38.55	2.86	58.58
3	38.53	2.89	58.56
4	39.98	3.27	56.73
5	40.05	3.46	56.48
6	39.79	3.48	56.71
7	39.66	3.84	56.49
8	39.91	3.82	56.26
9	40.12	4.84	55.02
10	40.30	4.85	54.84

Table (3) reflects the relative importance of different shocks in explaining the fluctuations of the real effective exchange rate in the SVAR system. The main contribution to the fluctuations of the real effective exchange rate, roughly 80 percent, comes from both real demand and supply shocks. The relative importance of the supply shocks increases in the long-run. Nominal shocks play a weaker role in explaining the variation to the real effective exchange rate during the estimation period. The contribution of nominal shocks to changes in the real effective exchange rate amounts approximately to only a range of 16 percent to 22 percent.

Table (4) suggests that supply shocks play significant role in explaining the variance in relative output throughout the estimation horizon and represent a significant factor to the variation of the forecast error of this variable. The rest of the variance can be attributed to both real demand and nominal shocks on roughly an equal basis (around an average of 20 percent).

Finally, table (5) shows that nominal shocks account for most of the variation in relative prices. More than half of the total forecast error of relative prices can be attributed to nominal shocks during the different time horizons. A considerable variation of almost 40 percent seems to come from supply shocks as well. This evidence is consistent with the findings of Agénor, McDermott and Prasad (2000) and Wang (2005), who conclude that supply shocks are a key determinant for inflation changes in developing countries.

7. The Empirical Estimate of the Equilibrium Real Equilibrium Exchange Rate

Having captured the contributions of different economic shocks to the variance of the real effective exchange rate, the real equilibrium exchange rate can be computed using both real demand and real supply shocks added to the drift from the MA representation of the VAR model. Figure (3) plots the SVAR-empirical estimate of the equilibrium real effective exchange rate against the actual real effective exchange rate. The figure reflects the time path of the real effective exchange rate that is due to the permanent effect of real demand and supply shocks, which is used as a measure of the long-run equilibrium rate. The results are broadly similar to those obtained by the PPP, BEER and MB approaches.

Any deviation of the actual real effective exchange rate (representing the misalignments in the actual rate) below the trend signifies an overvaluation and vice versa. The misalignments in the real effective exchange rate based on the SVAR model is shown in figure (4).

The two figures show that the Egyptian pound has been overvalued during most of the years before the implementation of the ERSAP according to the SVAR model. Through 1974 up till 1990, before the implementation of the ERSAP, the Egyptian trade-weighted exchange rate was always overvalued with the exception of the period (1979-1981). Starting from 1991, Egypt witnessed an undervaluation of the exchange rate that continued till 1996. This means that the unification of the multiple exchange rates that existed before the ERSAP brought a temporary end to the currency overvaluation.

The pound began to be overvalued afterwards till the beginning of the 2000s, particularly 2002. As regards the floatation of the pound in 2003, the SVAR model shows that the Egyptian pound witnessed an undervaluation, which continued till end of the sample period[5].

[5] The findings indicate an overvaluation of the real effective exchange rate in 2012.

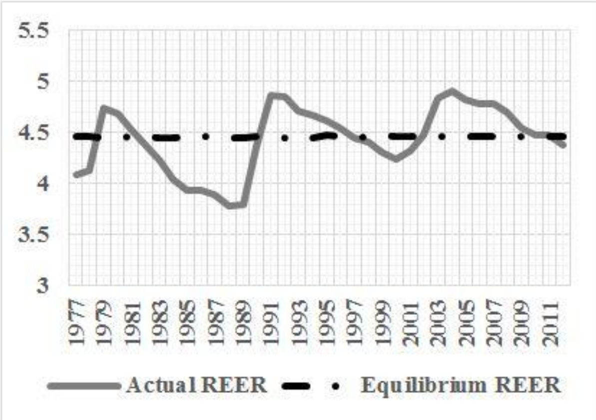

Figure (3). Actual and Equilibrium Real Effective Exchange Rate in Egypt (1977-2012)

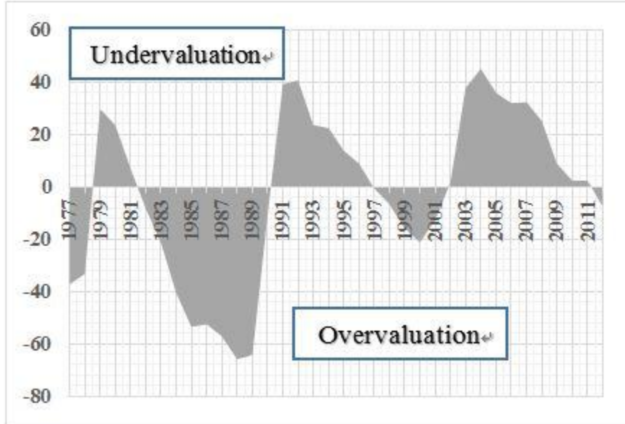

Figure (4). Misalignments of the Actual Real Effective Exchange Rate in Egypt (1977-2012) in

8. Concluding Remarks

This paper estimates the equilibrium real effective exchange rate for Egypt between 1974 and 2012. In particular, the relative ability of demand, supply and nominal shocks in explaining the fluctuations of the real effective exchange rate is examined. To do so, a structural vector auto-regression model is specified with main three main variables being included; real effective exchange rate, relative output and relative prices. The model is identified using long-run restrictions on the multipliers of the model in line with Clarida and Gali (1994). It shows that the behaviour of the real effective exchange rate is dominated by both real supply and demand shocks followed by nominal shocks.

Moreover, if one takes the contribution of permanent shocks to the real exchange rate as a measure of the equilibrium exchange rate, there seems to be an overwhelming evidence that the actual real effective exchange rate does not follow the equilibrium rate during the estimation period.

With regard to the policy advice concluded from the paper, the SVAR estimation provides several implications to decision making and exchange rate management. First, the dominance of real shocks in interpreting the behaviour of actual effective exchange rate in Egypt implies that the Egyptian authorities may need to improve some aspects related to the real side of the economy (productivity, technology and efficiency) to enhance the level of the pound's competitiveness. Second, the SVAR model gives an evidence of the over- and undervaluation phases of the real effective exchange rate in Egypt. Thus, it provides a reference to the decision making process if any corrections to the misaligned rate perceived as essential to the real economy. This, in turn, requires further investigation into the implications of the misalignments (their types and extent) on the Egyptian economy, which is not the core of the present paper.

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APPENDIX

Real Effective Exchange Rates for the Egyptian Economy

(1974-2012)

To compute the REER index for the Egyptian economy, a number of factors had to be identified; the range of foreign countries to be covered as trading partners, their trade weihgts and the price indices to be compared.

The source of the trade data are the exports and imports with the top ten trading partners for the period (1974-2012) as reported in the Direction of Trade Statistics (DOTS) of the IMF. The source of data for consumer prices is the International Financial Statistics (IFS) of the IMF for the same period. Nominal exchange rates in national currency per base curency (US dollar) were obtained from the IFS, IMF as well.

The calcuation of REER for Egypt for the period between 1974 and 2012 required dealing with three successive tasks; the first represents the calculation of the trade shares of the top 10 trading partners, which involved working on 39 columns each representing a year in the sample period (1974-2012), 10 rows each representing a trade partner chosen, the second represents calculating the price differential between Egypt and each trading partner, which involved working on 10 columns each representing the currencies of the top trading partners, 39 rows representing the price indices over the sample period, and the third represents calculating the overall REER for Egypt with 10 columns each representing the currencies of the top trading partners, 39 rows representing the sample period.