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An Assessment of the Real Exchange Rate Misalignments in Egypt: An Application of the Behavioral Equilibrium Approach

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Keywords: egypt, real effective exchange rate, beer, exchange rate misalignment.

I. INTRODUCTION

Exchange rate stability is a major monetary policy goal in emerging countries. Particularly, the question of real exchange rate misalignments, perceived as a key economic indicator has a critical interest for policymakers. It represents an important link between the domestic economy and the rest of the world and reflects movements in relative prices of currencies. Real exchange rate misalignments – defined as the deviation of the actual real exchange rate from the equilibrium real exchange rate – are harmful for the economic performance of an economy.

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 (Montiel, 1998). The theoretical and empirical research suggest that misalignments in the real exchange rate can potentially lead to serious economic repercussions on trade, competitiveness, inflation, investment and hence, economic growth and stability (see for instance, Willet (1986), Edwards (1987) and Rajan and Siregar (2002).

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Fears about such misalignments call for frequent evaluation of both the actual and equilibrium exchange rates so that policymakers can maintain a sustainable external position of their economies. However, the equilibrium exchange rate is not directly observable and appropriate models should be used to estimate it (Borowski and Couharde, 2003; Ajevskis et al., 2012).

Many empirical papers that focus on examining this concept of equilibrium exchange rate have been produced on the scale of developed countries. Only recently, there has been a prominent interest on exchange rate topics for developing and emerging countries. Several studies have tried to estimate the equilibrium real exchange rate and identify its link to the real economy.

The exchange rate literature has been witnessing a proliferation and development of many econometric and statistical techniques in this regard. Accordingly, it is an overriding research question to investigate whether the real exchange rate is misaligned in a given economy and adopt the needed measures to correct any misalignments.

The present study employs a behavioral equilibrium exchange rate approach 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 BEER methodology and section VIII concludes.

II. EXCHANGE RATE REGIME AND DEVELOPMENTS – A HISTORICAL OVERVIEW

The conduct of exchange rate policy has witnessed many shifts and developments in Egypt since

launching the Economic Reform and Structural Adjustment Program (ERSAP) in the early 1990s.

Before the official launch of the ERSAP, several measures were undertaken to switch from a fixed parity to a flexible peg regime and from multiple rates to a unified rate. The Egyptian overall experience of exchange rate regimes until 1991 can be described as one of repeated failed trials to establish a unified exchange rate. During the 1970s, Egypt maintained a multiple exchange rate regime with a relatively appreciated or subsidized exchange rate for food imports¹. 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).

Egypt started the ERSAP in 1991, which was designed to achieve macroeconomic stability and create a decentralized open market oriented economy. At the heart of the program were a massive fiscal adjustment, a supportive monetary policy, exchange rate liberalization and unification, and price deregulation (Mohieldin and Kouhouk, 2003; El-Shazly, 2011).

A significant step was undertaken in February 1991 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 (Kheir-El Din and El-Shawar by, 2000; Central Bank of Egypt, Economic Review, 2009/2010).

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 (see appendix).

Due to the persistent pressures on the Egyptian pound and in an attempt to prevent extra drainage of the foreign reserves, a series of devaluations started in 2000 and 2001². Such devaluations represented a gradual

movement to a more flexible exchange rate regime in late 2000. In 2003, the objective of price stability was formally declared to be the main objective of the monetary policy (Mabrouk and Hassan, 2012). In addition, it was the prominent feature of the monetary policy up to 2003 to officially peg or manage the Egyptian Pound against the US Dollar. At the end of January 2003, the official exchange rate shifted to a free float (Moursi and Mossallamy 2010; Ahmed, 2012).

A free float of the Egyptian pound was announced on January 28, 2003, abandoning the managed peg exchange rate system. The floatation of the pound came 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. Accordingly, the exchange rate ceased to be the nominal anchor of monetary policy in Egypt (Galal, 2003; Hassan, 2003). This caused the real effective exchange rate to lose nearly 69 percent of its value between 1999 and 2003.

In 2005, the CBE announced its intension to adopt the policy of Inflation Targeting (IT), which introduced a new framework for the monetary policy in Egypt. However, these developments were not sufficient to achieve the price stability objective under the lack of an official nominal anchor since 2003. 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).

During 2006 and 2007, the Egyptian economy has witnessed several positive external factors 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. On the contrary, the Egyptian Pound exchange rate depreciated by roughly 4.7 percent against the US dollar during the FY 2008/2009 as a result of the global downturn caused by the global financial crisis and a parallel current account deficit (World Bank, 2009; 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.

Furthermore, the Egyptian economy has suffered from unstable political and economic conditions since the outbreak of the January 25th revolution in 2011. Some adverse consequences included a rise in capital outflows, a decline in tourism receipts, an increase in the dollarization process and a

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).

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). The CBE introduced a new system of dollar auctions through which domestic banks can buy or sell US dollars to avoid further declines in the net international reserves (Brixiova, Égert and Essid, 2013).

The improvement on the political spectrum in 2012 has 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.

III. THEORETICAL BACKGROUND AND EMPIRICAL LITERATURE

The BEER is one of the most popular approaches for estimating the equilibrium real exchange rate. It is based on the theoretical model developed in Edwards (1989) and Edwards (1994). Edwards' model is an intertemporal general equilibrium model, which defines the equilibrium real exchange rate as that relative price of tradables to non-tradables that, for given sustainable or equilibrium values of a number of variables (known as real exchange rate fundamentals), results in the attainment of simultaneous internal and external equilibrium. According to this model, the internal equilibrium reflects the case in which the non-tradable goods market clears in both the current and future periods while the external equilibrium occurs when the discounted flows of the current account balances is equal to zero (i.e. current and future values of the current account balances should be compatible with the long-run capital flows).

Edwards' model has been extended by Clark and MacDonald (1998) who introduced the BEER as a new framework for empirical analysis. They provided a comparison between the FEER and BEER estimates for the German mark, the Japanese yen, and the US dollar. The model they apply starts from the risk-adjusted uncovered interest parity (UIP) condition, which can be expressed by the following equation:

$$E_t(\Delta_k S_{t+k}) = (i_t - i_t^*) - c \quad (1)$$

where S_t is the foreign currency price of a unit of home currency, i_t denotes a compounded nominal

interest rate for k periods on a bond with the maturity horizon k and an asterisk denotes a foreign variable, Δ_k is the k -period difference operator so that $E_t(\Delta_k S_{t+k}) = E_t(S_{t+k} - S_t)$, E_t is the rational expectations operator conditional on the information set at time t , and c is a constant risk premium.

Equation (1) can be expressed in real terms by subtracting the expected inflation differential, $E_t(\Delta_k P_{t+k} - \Delta_k P_{t+k}^*)$, from both sides of the equation. Thus, after rearrangement, we obtain the following equation:

$$q_t = E_t(q_{t+k}) - (r_t - r_t^*) + c \quad (2)$$

where q_t is the real exchange rate, $r_t = i_t - E_t(\Delta_k P_{t+k})$ is the expected compounded real interest rate for k periods. Accordingly, equation (2) is a condition for the risk-adjusted real UIP such that the real exchange rate is determined by three components; the expectation of the real exchange rate, the real interest rate differential and the risk premium (Clark and MacDonald, 2004; Nilsson, 2004). Assuming that the unobservable expectation of the exchange rate, $E_t(q_{t+k})$, is the long-run equilibrium exchange rate, \bar{q}_t , then the current equilibrium exchange rate defined as \hat{q}_t (which is different from the actual rate q_t) will be expressed as a function of the component, \bar{q}_t , and the real interest rate differential⁴:

$$\hat{q}_t = \bar{q}_t + (r_t - r_t^*) \quad (3)$$

The long-run equilibrium exchange rate is mainly driven by three key fundamentals; the relative price of traded to non-traded goods as a proxy for the BS effect, the net foreign assets, which is explained by the determinants of national savings and investment (particularly, demographics and fiscal balances), and the TOT (MacDonald, 2000; Clark and MacDonald, 2004). Real interest rates are excluded since they are used to explain the current equilibrium exchange rate and not as a determinant of the long-run equilibrium rate (Dufrenot and Égert, 2005; Clark and MacDonald, 2004).

In practice, the BEER approach amounts to estimating a reduced-form relationship between the real exchange rate and some fundamental variables, which themselves should be at sustainable or equilibrium levels⁵ (Ndlela, 2010). The "B" for "behavioral" in BEER means that the approach does not impose any particular functional form. Unlike the MB approach, it does not include certain normative assumptions and

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).

⁴ Clark and MacDonald (2004) clarify that equation (3) can be modified to include the risk premium term included in equation (2). However, in their empirical work, this term proved to be insignificant and thereby, was removed.

⁵ The current equilibrium exchange rate (\hat{q}_t) is determined by the current values of the economic fundamentals. The long-run equilibrium exchange rate (\bar{q}_t), however, is determined by the long-run values of these fundamentals. The latter are obtained using the Hodrick-Prescott filter (Baak, 2012).

only searches for a significant econometric relationship between the real exchange rate and the fundamental variables with no specific conditions on the structure of that relationship⁶ (Stein, 2003; Driver and Westaway, 2004; AlShehabi and Ding, 2008).

Below is a summary of the various possible determinants of the equilibrium real exchange rate (\bar{q} in equation 3) that are used under the BEER approach.

a) *Productivity Differential*

The impact of productivity differential is expected to follow the BS theory. Hence, it is predicted that an increase in the productivity of the tradable goods sector of an economy will lead to a real currency appreciation resulting from the upward pressure on wages and prices of the non-tradable goods.

b) *Investment to GDP Ratio*

The effect of this variable can be ambiguous. On one hand, an increase in the investment to GDP ratio is expected to raise the productivity of an economy leading to real appreciation. On the other hand, this increase in the investment ratio can be driven by an increase in imports, which negatively affect the current account causing the opposite effect (Ajevskis et al., 2012).

c) *Net Foreign Assets*

An increase in the net foreign debt of a country (caused for instance by a deficit in the current account) has to be financed by capital inflows. This requires a depreciation of the debtor country's currency at the given interest rates. Moreover, the accumulated foreign debt, serviced with interest payments, can be financed by a surplus in the trade balance. Thus, a depreciation of the currency is needed to boost the country's exports.

d) *Openness of the Economy*

The effect of this variable on the real exchange rate is uncertain or unpredictable. Openness may lead to a decline in the domestic prices of the tradable goods resulting from a decrease in tariffs for instance. This leads, through the substitution effect, to an increase in the demand for importables causing a deteriorated trade balance and consequently, real currency depreciation. However, if openness is dictated by higher income effects and increased income is spent more on non-tradable goods, then it will lead to an appreciation of the real exchange rate (Tang and Zhou, 2013).

e) *Government Consumption*

Higher levels of government consumption, which are biased toward the non-tradable goods sector is expected to raise the relative price of non-tradable goods and hence, leads to a real exchange rate appreciation. However, if this increased consumption is financed through higher taxes, it may lead to the opposite effect (Dubas, 2009; Tang and Zhou, 2013).

f) *Terms of Trade*

It is expected that higher TOT will lead to an appreciation of the real exchange rate through the income effect of increased exports, which increases the demand for non-tradable goods. If the improvement in the TOT reflects a decline in import prices, however, then a demand shift from non-tradable goods to imports will drive the prices of non-tradable goods down causing a depreciation in the real exchange rate (Terra and Valladares, 2010; Tang and Zhou, 2013).

g) *Fiscal Balance*

An increase in the budget balance linked to contractionary fiscal policy should lead to an increase in national savings, lower levels of domestic demand and therefore, a depreciation of the real exchange rate (assuming that the nominal exchange rate does not change). Expansionary fiscal policy is expected to have the converse effect⁷ (Ajevskis, 2012).

Finally, it should be noted that once the economic fundamentals are identified, the BEER approach benefits from the co-integration technique to test for the existence of an equilibrium relationship between the real exchange rate and its main determinants, which can then be used to calculate the misalignments in the actual real exchange rate (Zhang, 2001).

A number of recent studies have applied the above methodology to explore the determinants of exchange rate and derive an estimate for its long-run path in various countries. Elbadawi (1994) estimated the long-run equilibrium exchange rate for Chile, Ghana and India. His set of economic fundamentals included economic openness, terms of trade, government expenditures ratio to GDP and a measure of excess money supply and covers the period from 1965 till 1990. Zhang (2001) uses the BEER methodology to calculate the real exchange rate misalignment of the Chinese RMB between the mid-1950s and 2000. He formulate the variable space such that investment ratio, government consumption, growth of China's exports and degree of economic openness are included. Clark and MacDonald (2004) analyze the real exchange rate misalignments of the US dollar, the Canadian dollar and

⁶ The selection of these fundamental variables is based on sound theoretical foundations and hence, they vary as different theories are applied. This feature allow the BEER approach to be flexible enough to include various model specifications with different explanatory variables in estimating the equilibrium real exchange rate. Moreover, this makes it possible to design country specific relationships since countries may differ in the set of economic fundamentals that determine their equilibrium real exchange rate (AlShehabi and Ding, 2008; Tang and Zhou, 2013).

⁷ These effects assume the absence of the Ricardian Equivalence. The Ricardian Equivalence proposition is an economic hypothesis holding that both budget deficits and taxation have equivalent effects on the economy. A decline the government savings will lead to an offsetting increase in the desired private savings and hence, the desired national savings do not change (Barro, 1989).

the pound sterling for the period (1960-1997) based on the BEER approach. Their economic fundamentals are real interest rate differential, net foreign assets and the relative price of non-traded to traded goods.

Using monthly data from January 1995 to December 2001, Kemme and Roy (2006) employ four economic fundamentals (terms of trade, economic openness, net capital inflows and government consumption) to estimate the extent of real exchange rate misalignments for Poland and Russia. Employing a sample of quarterly data that encompasses the period from 1995 to 2006, AlShehabi and Ding (2008) estimate the equilibrium exchange rate in both Armenia and Georgia. The BEER methodology is employed and four economic fundamentals are incorporated. Namely, terms of trade, government spending as share of GDP, openness to trade and net foreign assets.

Sidek and Yusoff (2009) employ the BEER approach to estimate the ringgit equilibrium exchange rate using quarterly data spanning from 1991 till 2008. They incorporate the productivity differential, government consumption, economic openness and net foreign assets in their model. Terra and Valladares (2010) examine periods of appreciations and depreciations for a sample of 85 countries using data from 1960 to 1998 by applying the BEER approach to exchange rate. Four economic fundamental are used; terms of trade, economic openness, government consumption and international interest rate. Cui (2013) uses monthly data from 1997 till 2012 to estimate the equilibrium exchange rate for China by applying the BEER approach. His model incorporated the productivity differential, economic openness, terms of trade and the ratios of foreign reserves and foreign direct investment to GDP.

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.

This paper represents a recent estimation of the equilibrium real *effective* exchange rate in Egypt based on the BEER approach. Real effective exchange rate is used rather than the bilateral rate. The former constitutes a finer and more accurate index for the real exchange rate misalignment measurement. Moreover, the present paper covers a longer period covering annual data from 1974 till 2012.

IV. THE ECONOMETRIC FRAMEWORK OF THE BEER METHODOLOGY

The exploratory stage of the regression results starts with the estimation of an unconstrained vector auto-regression (VAR) where the lag length is determined by Akaike Information Criterion (AIC). The VAR shows two lags in levels for the endogenous variables employed. The Johansen method is then used to test for the existence and number of co-integrating equations between the variables. In this context, the model variables are introduced to the estimation process without any adjustments such that the transitory and the permanent components are maintained. Afterwards, the estimated long-run coefficients for all variables are used to calculate the equilibrium exchange rate for Egypt through filtering the variables and excluding the transitory components using the Hodrick-Prescott (HP) Filter.

It is noteworthy that the first round of estimation included an initial set of seven fundamental variables⁸ and resulted in the existence of at least three co-integrating relationships. Because the presence of more than one co-integrating vector complicates the identification process of an equilibrium relationship between the REER and its fundamental variables, one possibility is to consider the combination of variables that incorporate the most important determinants of the REER through one co-integrating vector⁹.

The relationship between equilibrium real exchange rate and the fundamentals is expressed as vector of variables;

⁸ These variables are: the REER, GDP per capita, net foreign assets, openness of the economy, terms of trade, government consumption and capital inflows.

⁹ Moreover, in the case of multiple co-integrating vectors, the restrictions on the estimated parameters (β_s) should be captured from the economic theory. Nevertheless, the theory did not tackle that issue.

$$X_t = (LREER, LGDPC, OPENGDP, INVESTGDP, LGOVCONS) \quad (4)$$

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Thus, in the application of the BEER approach, five endogenous variables are included. Apart from the LREER, which is the logarithm of the real effective exchange rate for Egypt, four fundamental variables serve to uncover the relationship and the extent of REER misalignment; LGDPC, the logarithm of the per capita GDP, OPENGDP, the economy's openness (measured as the sum of exports and imports) as a ratio of GDP, INVESTGDP, the investment ratio. All variables are composed as those for Egypt relative to its trading partners exactly as in the formation of the REER (appendix two describes the construction of data and data sources). The positive and negative signs underneath each of the explanatory variables in the parenthesis are the expected signs. Moreover, two exogenous dummy variables are suggested in the sense that one can control for the exchange rate floatation in 2003 (FLOATDUM), whereas the second one controls for the Global Financial Crisis, which took place in 2008 (CRISDUM).

a) Description of the Econometric Methodology

• Non-Stationarity and Unit Root Tests

Because most macroeconomic time series are trended, they tend to be non-stationary. The problem with non-stationary or trended data is that the standard OLS regression procedures can easily lead to incorrect conclusions. In other words, model estimation in the presence of non-stationary variables yields misleading results. Therefore, the analysis starts by testing for unit roots in all variables to determine whether the data series are stationary and avoid spurious regressions.

Two asymptotically equivalent tests are applied: the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test.

As the error term is unlikely to be white noise, the Dickey-Fuller test was extended to an augmented version, which includes extra lagged terms of the dependent variable in order to eliminate autocorrelation. The lag length on the extra terms can be determined by data dependent methods such as the Akaike Information criterion (AIC) or Schwartz Bayesian criterion (SBC). The ADF test may include an intercept, trend and intercept, or none of the depending on the data series properties (Asteriou and Stephen, 2007).

In the present paper, the ADF test with intercept is applied by estimating the following equation for each of the time series:

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^p \beta_i \Delta y_{t-i} + \varepsilon_t \quad (5)$$

$$\Delta Y_t = \mu + \tau_1 \Delta Y_{t-1} + \tau_2 \Delta Y_{t-2} + \dots + \tau_{k-1} \Delta Y_{t-(k+1)} + \pi Y_{t-1} + \varepsilon_t \quad (6)$$

where the matrix τ captures the short-run aspects of the relationship between the elements of Y_t and the matrix π reflects the long-run information. There

where y_t is the variable of choice; Δ is the first-difference operator; t is the time trend; α_i (for $i = 1, 2, \dots, p$) and β_i (for $i = 1, 2, \dots, p$) are parameters; and ε_t is a stationary stochastic process. The null hypothesis that series y_t is non-stationary can be rejected if β_1 is statistically significant with negative sign. The PP test is a semi-parametric procedure that accounts for heteroskedasticity in the data series.

• Time Series Co-integration

If the economic series have become non-stationary at level and have the same integration order then co-integration becomes an over-riding requirement for any econometric model. The co-integration in multiple equations can be tested by Johansen (1988) method. The testing hypothesis is the null of non-co-integration against the alternative of co-integration. We use Johansen co-integration procedure to test for the presence of a co-integrating vector between capital account liberalization and economic growth in Egypt. When the variables or series are having co-integrated relationships then the linear combination of these series would be stationary and gives long relationship between the variables. Johansen's procedure proposes two test statistics for testing the number of co-integrated vectors; the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}) statistics where

✓ The λ_{trace} statistic tests the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative hypothesis that there are more than r .

✓ The λ_{max} statistic tests the null hypothesis that the number of co-integrated vectors is r against the alternative of $(r + 1)$ co-integrated vectors. Thus, the null hypothesis $r = 0$ is tested against the alternative that $r = 1$, $r = 1$ against the alternative $r = 2$, and so forth.

• Vector Error Correction Model

If the variables included in the model are found to be co-integrated, the next step is to specify and estimate a vector error correction model (VECM) including the error correction term to investigate the short-run relationship in the model. The VECM model describes how the examined model is adjusting in each time period towards its long-run equilibrium state. The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state. With an ECM specification, we can express the relationship as follows:

can be one or more co-integrating relations in a multivariate co-integration model depending on the number of linear combinations of Y_t . The rank of

denoted by r , can determine the number of co-integration relations. The matrix π can be decomposed in two matrices, α and β where $\pi = \alpha\beta'$. The speed of adjustment (the error correction coefficients) are contained in matrix α that force the series back towards their underlying equilibrium relations and the co-integrating vectors are contained in matrix β that summarize the underlying long-run relations (Johansen and Juselius, 1990; Asteriou and Stephen, 2007).

The advantage of the Error Correction Model (ECM) is that it incorporates variables both in their levels and first differences. By doing this, ECM captures the short-run disequilibrium situations as well as the long-run equilibrium adjustments between variables. ECM term having negative sign and value between "0 and 1" indicates convergence of model towards long run equilibrium and shows how much percentage adjustment takes place every time unit in the analysis.

- *Generalized Impulse Response Function*

The generalized impulse response function (GIRF) is widely used in the empirical literature to uncover the dynamic relationship between macroeconomic variables within VAR models. GIRF is deployed to produce the time path of the dependent variable in the VAR in response to shocks from all the

variable in the VAR in response to shocks from all the explanatory variables either immediately or with various lags (Koop, Pesaran and Potter, 1996).

- *Variance Decomposition Analysis*

Variance decomposition sheds further light on the dynamic interaction of variables in the VAR system. They give the proportion of the movements in the dependent variable that are due to their "own" shocks, versus shocks to the "other variables". In other words, it provides information on the relative importance of the economic variables in the model in accounting for variations in each data series (Maghyreh, 2004).

V. ESTIMATION RESULTS

a) *Univariate Characteristics of the Data*

In this section, we present the estimated results on the data set described above. A necessary condition of the co-integration and VECM analysis is that each of the variables should be stationary and integrated of same order. Hence, the first step of the empirical work is to check the degree of integration of each variable by using unit root (ADF and PP) tests for the levels and first differences of each variable. The estimated results of this part are reported in table (1).

Table 1: Unit Root Test Results

Unit Root Tests at:	Augmented Dicky-Fuller Test Results	Phillips-Perron Test Results
Levels Variables	Model Form: Trend and Intercept	Model Form: Trend and Intercept
LREER	-3.489972	-2.447663
LGDP	-0.811132	-0.772468
OPENGDP	-0.643166	-0.717175
INVESTGDP	-1.702153	-2.266043
LGOVCONS	-2.436753	-1.653006
First Differences Variables	Model Form: Trend and Intercept	Model Form: Trend and Intercept
LREER	-4.235938*	-3.785989*
LGDP	-3.594536*	-4.890056*
OPENGDP	-4.479195*	-6.433917*
INVESTGDP	-5.262540*	-10.18479*
LGOVCONS	-4.632161*	-6.673644*

* 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.

We find that each of the series is non-stationary when the variables are defined in levels. But first-differencing the series removes the non-stationary components in all cases and therefore, the null hypothesis of non-stationarity is clearly rejected at the 5 percent significance levels. Both the ADF and PP stationarity tests suggest that all the variables are integrated of order one [I (1)] in their levels and found stationary in their first differences [I (0)].

Since the variables are non-stationary and integrated of order one, the second task is to employ

co-integration technique of Johansen to test whether there exist a long-run relationship among the variables. This provides a unified framework for estimation and testing of co-integrating relations in context of a VAR error correction model. The co-integration rank r of the time series was tested using two test statistics; λ trace and λ max. Denoting the number of co-integrating vectors by r_0 , the maximum eigenvalue (λ max) test is calculated under the null hypothesis $r_0 = r$ against an alternative hypothesis $r_1 = (r + 1)$. The trace test (λ trace) is calculated under the null hypothesis that $r_0 \leq$

r against $r_1 > r$. The results of both statistics are reported in table (2).

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

Trace Statistic				Maximum Eigenvalue Statistic			
H_0	H_A	λ_{trace}	$CV_{1\%}$	H_0	H_A	λ_{max}	$CV_{1\%}$
$r_0 = 0$	$r_1 > 0$	108.60*	76.07	$r_0 = 0$	$r_1 = 1$	58.07*	38.77
$r_0 \leq 1$	$r_1 > 1$	50.53	54.46	$r_0 = 1$	$r_1 = 2$	27.86	32.24
$r_0 \leq 2$	$r_1 > 2$	22.66	35.65	$r_0 = 2$	$r_1 = 3$	13.70	25.52
$r_0 \leq 3$	$r_1 > 3$	8.96	20.04	$r_0 = 3$	$r_1 = 4$	6.14	18.63
$r_0 \leq 4$	$r_1 > 4$	2.82	6.65	$r_0 = 4$	$r_1 = 5$	2.82	6.65

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

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

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

The results of the co-integration show that both the trace and the maximum eigenvalue test statistics suggest the existence of only one co-integrating relationship among the variables at the 1 percent significance level. This gives an evidence for a long-run equilibrium relationship between the real effective exchange rate in Egypt, GDP per capita that can be used for indicating the productivity differential between

Egypt and its main trading partners, investment as a share of GDP, openness of the Egyptian economy, and government consumption.

To determine the sign and magnitude of the long run relationship, we normalize the co-integrating vectors so that the co-integrating regression of the REER in Egypt can be given as shown in table (3).

Table 3 : Normalized Co-integrating Coefficients: 1 Co-integrating Equation (Reduced-form Estimates)

LREER	LGDP	OPENGDP	INVESTGDP	LGOVCONS	C
1.000000	0.854949	-0.596277	-0.531042	0.610104	-1.008690
	[7.91626]*	[-7.07989]*	[-2.25875]**	[4.21509]*	

Notes: Figures in parentheses are the t-ratios.* (**) Denotes significance at the 1 percent (5 percent) level.

The long run estimated coefficients appear to be consistent with the economic theory concerning their expected signs¹⁰. It appears that the productivity differential cause an appreciation of the real effective exchange rate in Egypt. The effect of the openness of the economy is dominated by substitution effects since it leads to a depreciation of the real effective exchange rate as well. Regarding the investment ratio, it has a depreciating effect on the real effective exchange rate in Egypt. This can be explained by the import intensive investment projects and thus; an increase in the ratio of investment to GDP is expected to increase absorption, worsen the current account and lead to depreciation of the REER. Government consumption causes an appreciation of the REER since it raises the prices of non-traded goods.

The results show the following magnitude of effects:

- A 1 percentage point increase in the differential between the rate of growth of the real per capita GDP in Egypt and its main trading partners is associated with a 0.85 percentage point appreciation of the REER in the long run.
- A 1 percentage point increase in the relative openness of the Egyptian economy is associated with a 0.596 percentage point depreciation of the REER in the long run.
- A 1 percentage point increase in the relative investment ratio of the Egyptian economy is associated with a 0.53 percentage point depreciation of the REER in the long run.
- A 1 percentage point increase in the relative government consumption of the Egyptian economy is associated with a 0.61 percentage point appreciation of the REER in the long run.

¹⁰Notice that the definition of the REER in the present study is such that an increase (decrease) denotes a depreciation (appreciation).

Since long run association has been observed among these variables, it is possible to explore the possibility of a short run relationship by using an error correction model (ECM) framework. ECM permits the introduction of past disequilibrium as explanatory variables in the dynamic behavior of existing variables and thus, facilitates in capturing both the short run dynamics and long run relationships among variables¹¹.

Table (4) gives the speed of adjustment from disequilibrium along with the short run coefficients of the VECM. In the ECM specifications, it is shown that the coefficient of the error correction term (ECT_{t-1}) of the REER is significant and does have the correct sign (negative). The error correction term is the short-run forward looking self-correcting mechanism. If for instance, there is a real undervaluation in the REER, then there will be a real appreciation in the next period, self-correcting the undervaluation. The term indicates the speed of adjustment and in this case, 53 percent adjustment is observed. In other words, about 53 percent of disequilibrium (the gap between the

equilibrium REER and its actual value) is corrected each year caused by the REER itself. This means that when the exchange rate deviates from its equilibrium path caused by some temporary shocks, it returns back to that path within nearly two years in the absence of any further shocks. This implies a stable long-run co-integrating relationship.

Another point to observe is that both the per capita GDP and government consumption do not help in bringing the real effective exchange rate to its equilibrium level. The two variables have a destabilizing effect on the system. A positive sign of the adjustment coefficient of the government consumption – as a determinant of the equilibrium exchange rate – means that; an undervalued exchange rate (caused by a decline of the equilibrium exchange rate), for instance, will lead to an increase in the government consumption (which in turn leads to an appreciation of the equilibrium REER) causing an increasingly undervalued REER. The same applies for the productivity differential variable.

Table 4 : Results of Error Correction Model (Short-run Dynamics)

$ECT_{t-1} (-1)$	D(LREER)	D(LGDPC)	D(OPENGDP)	D(INVESTGDP)	D(LGOVCONS)
Coefficient	-0.532781	0.377458	0.707195	0.191666	0.183057
[t-statistic]	[-4.4419]*	[2.2492]*	[2.1506]*	[3.0688]*	[3.2437]*
Short Run Dynamics					
Variable	Estimates			[t-statistic]	
D(LREER(-1))	0.616513			[3.54900]	
D(LGDP(-1))	0.420893			[1.63886]	
D(OPEN(-1))	-0.241882			[-1.84655]	
D(INVEST(-1))	-0.350876			[-1.70692]	
D(LGOVCONS(-1))	0.802357			[2.10005]	
C	0.015103			[0.48294]	
CRISDUM	-0.238799			[-2.09408]	
FLOATDUM	0.096741			[1.14355]	

*indicates significance at the 5 percent level.

Results of variance decomposition process are shown in table (5). Variance decomposition process shows that the main source of variance in the real effective exchange rate arises from its own shocks during all periods. In the first period, the change of the exchange rate can be explained by its own shock at 100 percent. In the medium to long term, two variables represent important sources of variation in the exchange rate. These are the openness and investment ratios. For example and starting from the third period, it is seen that economic openness explains the variation in real effective exchange rate at a rate that ranges between nearly 7percent and 35 percent. Between 1.5 percent

and 26 percent of the variation in the exchange rate can be explained by the investment ratio. Government consumption plays a more significant role in the variations of the real effective exchange rate from the fourth period onwards while productivity differential do not exceed the rate of 0.8 percent variation of exchange rate during all periods.

¹¹As a robustness check for the results, a residual test was conducted

Table 5 : Results of Variance Decomposition Analysis

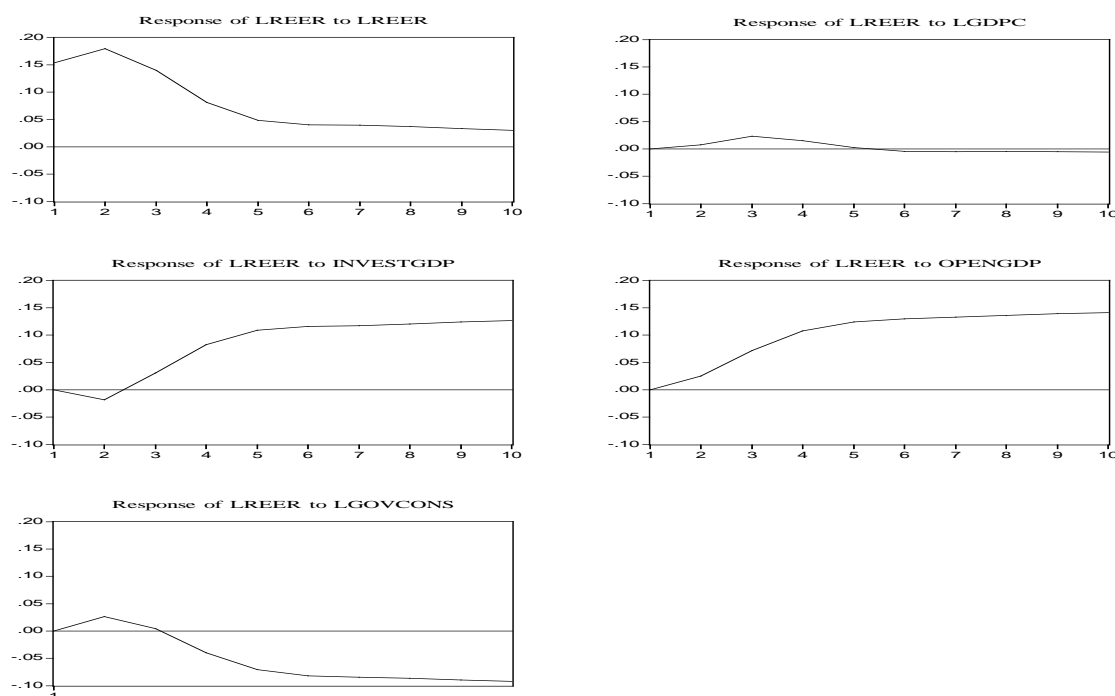
Period	S.E.	LREER	LGDP	OPENGDP	INVESTGDP	LGOVCONS
1	0.153767	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.239862	96.99968	0.104174	1.074640	0.585517	1.235985
3	0.289336	90.02097	0.727642	6.861336	1.521275	0.868776
4	0.332485	74.13023	0.751258	15.68004	7.343081	2.095393
5	0.381093	58.03508	0.574909	22.54783	13.77880	5.063372
6	0.428734	46.73881	0.464301	26.95411	18.15387	7.688905
7	0.473253	39.06328	0.392964	29.99569	21.03136	9.516710
8	0.515719	33.41823	0.339437	32.24836	23.15353	10.84045
9	0.556776	29.03055	0.299576	33.93716	24.83525	11.89746
10	0.596247	25.57345	0.270955	35.20686	26.17531	12.77342

The above results are also verified by the generalized impulse response functions (GIRFs), which indicates the causal properties of the system. The estimated GIRFs are plotted in figure (1) reflecting the response of LREER to 1 percent standard-deviation shocks to the explanatory variables. The results indicate that real effective exchange rate depreciates by shocks in itself starting from the first year. Shocks to GDP per capita leads to an appreciation of the REER starting

from the sixth period suggesting that the Balassa-Samuelson(B-S) effect is working for Egypt.

Shocks to both the investment and openness ratios have a positive effect on the REER suggesting the dominance of the substitution effect for the latter ratio. Conversely, a 1 percent standard-deviation to the government consumption affects real effective exchange rate negatively (leading to an appreciation) and only clearly starting from the fourth period.

Figure 1: Impulse Response Analysis



VI. THE EMPIRICAL ESTIMATE OF THE EQUILIBRIUM REAL EXCHANGE RATE

An important feature of the BEER approach is the recognition that the equilibrium exchange rate change over time with the changes in its main fundamentals. The long-run relationship estimated above allows for the calculation of the equilibrium rate

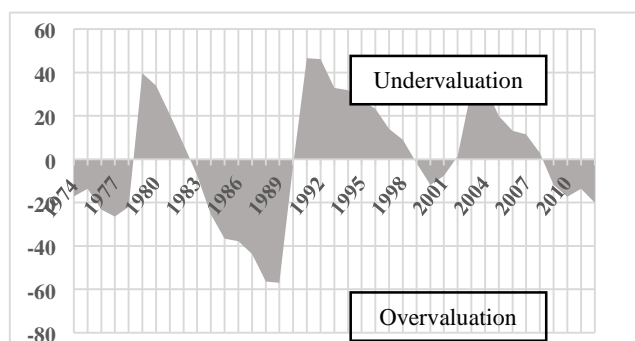
by using the permanent components of the fundamentals that are imposed on the long-run relationship obtained from the Johansen co-integration method. The HP filter with a smoothing factor of 100 was used to smooth the variables¹². Figures (2) and (3) show the actual and equilibrium real effective exchange rate

¹² This smoothing factor is what Hodrick and Prescott suggested for annual data (Hodrick and Prescott, 1997).

and the extent of currency misalignments during the period (1974-2012).

When the actual real effective exchange rate is above the equilibrium, it is undervalued, and when it is below the equilibrium, it is overvalued. 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 (1979-1982). Starting from 1991, Egypt witnessed an undervaluation of the exchange rate that continued till 1998. This means that the unification of the multiple exchange rates that existed before the ERSAP brought a temporary end to the currency overvaluation. Thus, despite the real appreciation of the Egyptian pound during that period, it was not as much as is needed to keep the value of the pound in line with the equilibrium rate in real terms. In addition, this is suggestive of the role of active and periodical foreign exchange market intervention that was practiced during that period to maintain the pegged

Figure 2 : Misalignments of the Actual REER in Egypt Based on the BEER Approach (1974-2012) in Percent



VII. CONCLUDING REMARKS

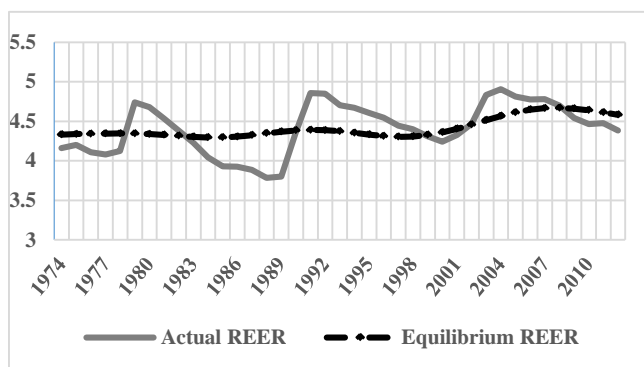
This paper estimates the equilibrium real effective exchange rate for Egypt between 1974 and 2012. In particular, the relative ability of different economic fundamentals in explaining the path of the real effective exchange rate is examined. To do so, a behavioural equilibrium exchange rate approach is specified in line with Edward's model (1994).

With regard to the policy advice concluded from the paper, the BEER estimation provides several implications to decision making and exchange rate management. The obtained estimates indicate the importance of the incorporated variables in determining the path of the real effective exchange rate in Egypt. The appreciating influence of the relative per capita GDP suggests that economic growth would be a significant factor in directing the real trade-weighted exchange rate in Egypt. The government's efforts to design growth enhancing strategies can succeed in raising the value of the Egyptian pound relative to foreign trading partners. Trade policies directed to discourage import intensive production will be vital to avoid the adverse effects on the current account and strengthen the currency as well.

exchange rate – mainly through international reserves – which, prevented the free market determination of the pound's value. Mohieldin and Kouchouk (2003) describes the first half of the 1990s decade by an undervalued currency based on their own calculations as well.

A short overvaluation period during the three years between 1999 and 2001 was followed by an undervaluation period that lasted between 2002 and 2008. The latter period marked the consequences of the series of devaluations adopted in 2000 and 2001 and the floatation of the Egyptian pound in 2003. Overvaluation of the Egyptian real effective exchange rate was resumed in 2009 and lasted till the end of the sample employed in the present study. This conforms to the judgment of the IMF's 2010 Article IV consultation report on the Egyptian economy and the arguments by Ghanem and Shaikh (2013).

Figure 3 : Actual and Equilibrium REER in Egypt Based on the BEER Approach (1974-2012)



Moreover, since the impact of openness of the Egyptian economy is dictated by the substitution effect, it leads Egyptian consumers to prefer cheaper foreign goods. As such, further incentives should be offered to domestic producers and exporters to develop their industries and better serve the domestic market. An appreciation of the pound caused by the above mentioned factors is not expected to reduce the competitiveness of the Egyptian economy in international market since it is attributed to a stronger and healthier economy.

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APPENDIX ONE

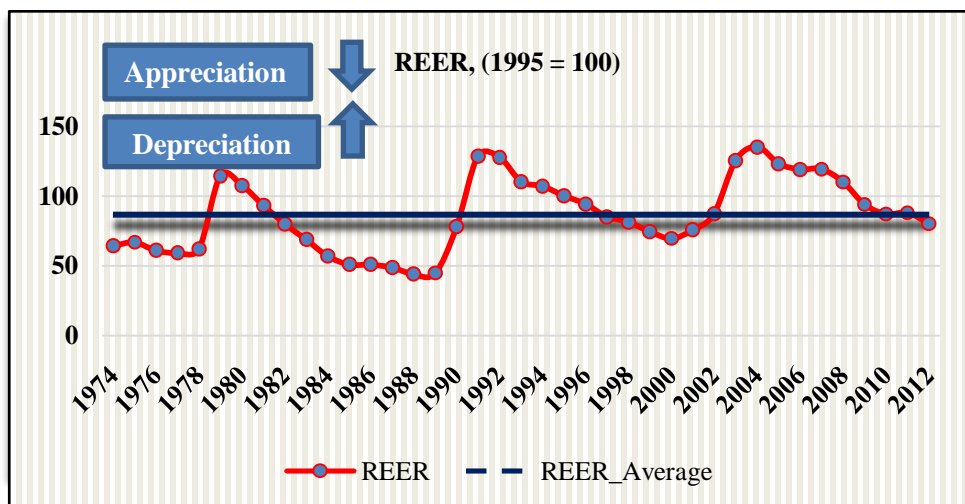
a) Real Effective Exchange Rates for the Egyptian Economy (1974-2012)

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 weights 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 currency (US dollar) were obtained from the IFS, IMF as well.

The calculation 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.

Figure 4: Real Effective Exchange Rate for Egypt during the Period (1974-2012)



APPENDIX TWO

Variables Definition and Data Sources of the BEER Model

The study makes use of annual data. Data availability constrains the sample period to 1974 to 2012. Apart from the data on Egypt, the study uses data on the 10 trading partners, which were included in the calculation of the REER. As such, all the fundamental variables are obtained by weighting them in the same manner. Definitions of the five endogenous variables and two exogenous variables along with their sources are as follows:

LREER: Ln of REER. Source: constructed by the researcher using data from the IMF, IFS and IMF, DOTS databases.

LGDP: Ln of per capita GDP as a proxy for relative productivity differential between Egypt and its trading partners. Source: The WB, WDI database.

OPENGDP: Exports and Imports as a ratio of GDP. Source: The IMF, DOTS and WB, WDI database.

INVESTGDP: Investment ratio to GDP. Source: The WB, WDI database.

LGOVCONS: Ln of government consumption. Source: The WB, WDI database.

FLOATDUM: A dummy for the float of the Egyptian pound that takes a value of one starting from 2003.

CRISDUM: A dummy for the global financial crisis that takes a value of one starting from 2008.

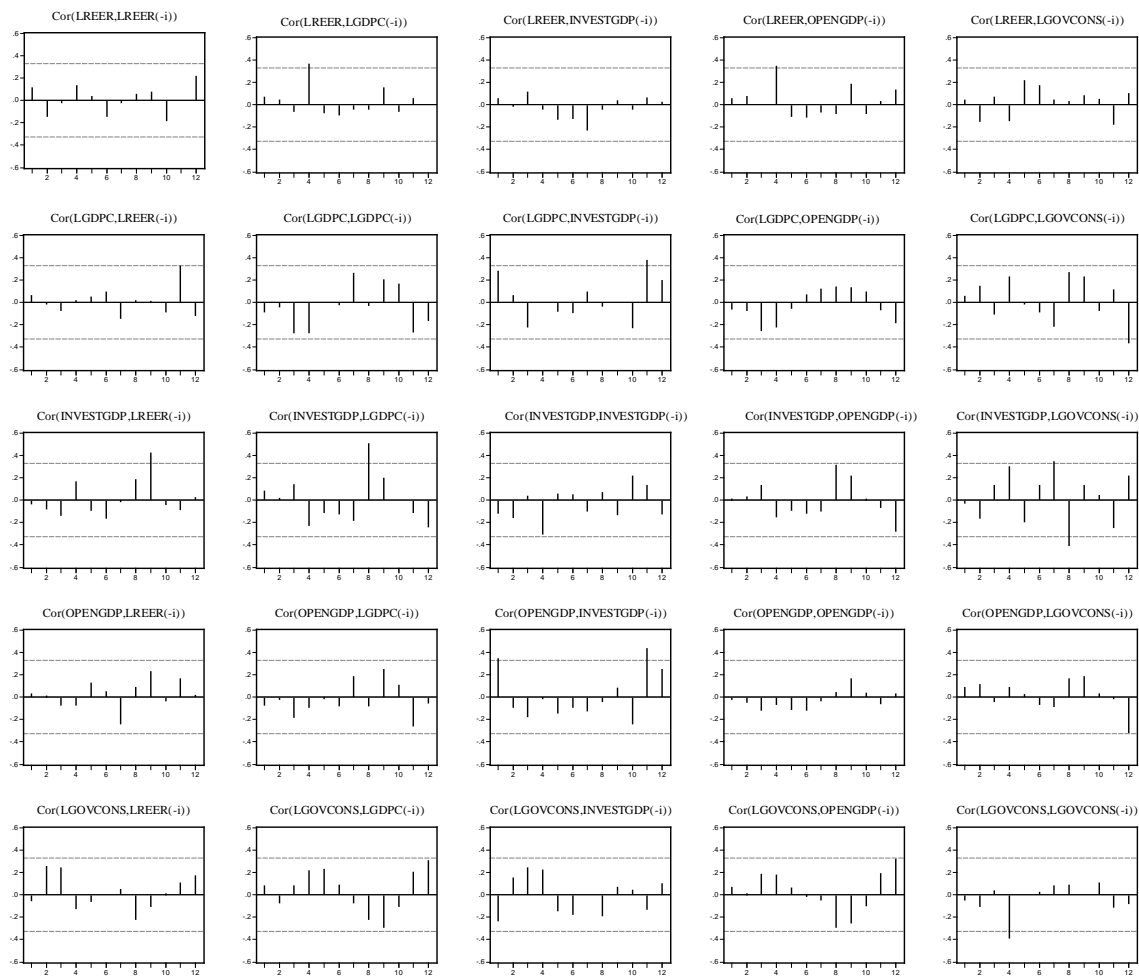


Figure 5 : Residual Test – Correlogram on the Estimated BEER Model