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WPS7679

Policy Research Working Paper 7679

Money Demand in the Arab Republic of Egypt

A Vector Equilibrium Correction Model

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WORLD BANK GROUP
Finance and Markets Global Practice Group
May 2016

Policy Research Working Paper 7679

Abstract

Money demand is critical for defining monetary policy options and is not driven necessarily by developed country standards of transaction demand, speculation motive, and opportunity costs grounded by fully functioning financial markets. However, market imperfections in less developed economies can also play a critical role in the dynamics of demand for money. This paper estimates a vector equilibrium correction model to investigate the nature of short-term and long-term interactions for money demand in the Arab Republic of Egypt. The paper concludes that real money demand in Egypt during (1958–2013) is stable and can be considered confidently by monetary authorities to adjust for long-term growth in the real economy. The rate of devaluation of the official exchange rate and inflation have a serious effect on the public's trust in the national currency in the long term. Money is not neutral for long-term portfolio decisions, because of the increase in real income in the economy that couples with an uptrend in monetization as the ratio of money stock over output also uptrends. The paper also provides quantitative evidence that the devaluation within the parallel market is negatively related to the change in demand for real money balances in the short term. Economic agents hold more domestic currency if the official exchange rate slides, and arbitrage opportunities are sought in the parallel market.

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Produced by the Research Support Team

Money Demand in the Arab Republic of Egypt – A Vector Equilibrium Correction Model

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JEL codes: C32, C52, E41, E65.

Keywords: Time-Series Models, Model Evaluation, Validation, Selection, Money Demand, Economic Reform Policies

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1. Introduction

In essence, money is a financial asset that facilitates the interchange of goods and services. People demand money for several reasons: to purchase goods and services now (transaction motive) or in the future (precautionary motive); or as economic agents to conserve value over time (reserve of value motive). Moreover, demand for money is also considered an important function of stabilization and structural adjustment policies where such policies depend on the ability to adjust money supply to its demand to prevent monetary disturbances from affecting real output. Therefore, understanding the dynamics of money demand is essential in macroeconomic policy and management.

In addition, quantitative analysis plays a significant role in specifying money demand equations in order to assist the policy making process, especially in monetary policy. Robust modeling of money demand functions helps to influence monetary aggregates on output, interest rate, and consumption.

The literature on money demand focuses on developed and stable economies. There was no, or very little if any, attention paid to less developed—transitioning—open economies in the published literature, particularly during the past five years.[2] These economies consist of a group of countries that have undergone social, economic, and political transition during the past five years of what is called the "Arab Spring."[3]

Some of these economies either still struggle with political turbulence, such as the Syrian Arab Republic and Libya, while others–including the Arab Republic of Egypt and Tunisia,—are struggling for economic recovery. A deeper understanding of how the recent political and social turmoil affected the monetary and real economy, as well as liquidity preference and portfolio composition in these countries, will definitely be of interest to the economics profession.

These economies were subject to several exogenous shocks that reflected on the monetary dynamics, price levels, and therefore the pattern of economic growth. Moreover, the nature of

[2]This statement is based on thorough investigation of the published literature during the past five years in key, high impact factor academic journals,

[3]This term is usually used to reference countries that witnessed political regime changes in the Middle East during the past five years including the Arab Republic of Egypt, Tunisia, Libya, the Republic of Yemen and the Syrian Arab Republic.

imperfect financial markets and huge uncertainties, as well as fiscal dominance inherent in these economies, impair the ability of monetary authorities to maintain price stability and challenge their choice of relevant operational and intermediate targets (Alvarez et. al. 2009). Despite the fact that many central banks in these economies explicitly announced targeting inflation and abandoning exchange rates as nominal anchors, stable money growth remains a cornerstone for these central banks to control inflation (Jahan 2012).

With respect to Egypt, money demand represents the main tool used by Egyptian authorities to conduct monetary policy. Other monetary policy channels are still in the development phase. Historically, monetary authorities in Egypt relied on a money supply tool through contractionary monetary policy to control the inflation rate and boost the real economic growth rate and per-capita income (Kheir-El-Din 2008).

In light of this, this paper investigates an empirical model of money demand in Egypt over the past six decades and ensures that economic policy reforms are in place. Egypt's monetary and financial sectors qualify as an ideal laboratory that can well represent the space of less developed economies. The objective of this paper is to answer a set of key research questions that would help the economics profession better understand the monetary and financial economics of less developed—transitioning—economies with application to Egypt. I will examine factors that influence the demand for money, and will answer questions relating to the stability of money demand, and the attachment of unitary income elasticity in alignment with Friedman's Quantity Theory of Money (QTM). Also, I will assess the nature of the relationship between monetary aggregates and price levels. The novelty and authenticity of this paper will contribute in several respects to the empirical literature on money demand.

First, it bridges the gap in the current literature in the understanding of the short and long run dynamics of monetary aggregates, interest rates, exchange rates, and output in less developed—transitioning—open economies.

Second, it provides in-depth quantitative analysis and employs robust econometric modeling techniques using high quality data.

Third, the data set that covers the period under study, i.e., the past 60 years, is rich with structural events and exogenous shocks that would contribute to a better understanding of monetary dynamics. This includes three revolutions that occurred in 1952, 2011, and 2013 and five wars (Suez Crisis, 1956, the Arab-Israeli War, October, 1973, a major terrorist attack on tourists in 1986, the First Gulf War, 1991, and the Second Gulf War, 2003). I will track the developments in Egypt's economy closely, from a centralized command during the period 1950–1975, to full economic liberalization in 1976, then domestic economic and financial crises in the late 1980s, followed by a stabilization program lead by the International Monetary Fund (IMF) during the 1990s and early 2000s. On the global level, this entire time span well covers the implications of the global oil crises in the 1970s, the Asian crises of the 1990s, and the global food and financial crises in the early 2000s, the global financial crises in 2008, and finally the Euro zone crises in 2011. These events have reflected on the portfolio composition and preference of individuals, as well as the aggregate demand for liquid assets.[4] Moreover, the shift from strict capital controls in the 1970s to a fully open economy since the 1980s, followed by a shift from a fixed exchange rate in 2003 towards a crawling peg and, finally, abandoning the exchange rate as a nominal anchor and adopting a—non operative—inflation targeting framework for monetary policy in 2004. All these events have imposed many queries on the response of monetary aggregates during the past six decades on the nature of long term relation between monetary aggregates and real economic activity in a robust and coherent manner.

The goal is to contribute in a comprehensive approach to a better understanding of monetary dynamics within less developed economies. The variety of shocks and transformations support the argument that Egypt is a feasible candidate for testing the stability of money demand in less developed open economies that are undergoing political and social transitions.

This paper is organized as follows: section 2 describes the theoretical motivation; section 3 reviews the recent relevant literature on money demand; section 4 summarizes the hypothesis to be tested, and section 5 explains the selection of variables and provides a brief description of the data. Section

[4]For a detailed assessment on how the crisis affected the Egyptian economy please see the World Bank's report "Egypt and The Global Economic Crisis: A Preliminary Assessment of Macroeconomic Impact and Response", accessible at http://siteresources.worldbank.org/INTMNAREGTOPPOVRED/Resources/MacroPolicyNoteGrayCoverVolume1June16.pdf

6 describes the econometric methodology and modeling strategy; and section 7 the analysis estimation and testing. Section 8 provides a conclusion and a set of policy recommendations.

2. Theoretical Motivation

The theoretical motivation of modeling money demand in this paper extends from the post-Keynesian theoretical contributions with their variation. This school of thought developed theories that are based on explicit motives for holding money, taking into consideration its key functions. These are summarized in money acting as (1) medium of exchange function which leads to transaction models that consider a transaction cost for shifting from using money to alternative assets; (2) a store-of-value function which gives rise to asset or portfolio models where money is held as part of the portfolio of assets of the individuals.[5]

Baumol (1952) and Tobin (1956) proposed that the medium-of-exchange function of money imposes viewing money as an inventory that is held for transactions purposes. The proposition indicates that holding money rather than investing in -alternative yield bearing financial assets is subject to a transaction cost. Later, Lucas (1980) developed the cash-in-advance theoretical framework to illustrate the medium-of-exchange function of money through the imposition of many constraints on production and consumption. This was later developed—by the Yale School—to analyze the store of value function of money within an asset or portfolio approach. Under this approach, the demand for money is evaluated in the context of a portfolio choice problem. Under this approach, money is seen as a component of many other financial assets within a portfolio (see Tobin, 1958) and (Judd and Scadding, 1982). These assets differ in yields' and risks' characteristics. The Cambridge School later analyzed demand for money within a consumer's utility maximization problem. The utility function includes money along with other assets within a portfolio; and solving the utility maximization problem provides the optimal portfolio composition (see Friedman, 1956 and Barnett, 1980).

The takeaway of this brief survey of key theoretical underpinnings is to develop a solid setup for a money demand function. We can confidently portray money demand as a function of interest

[5] Sriram (2001) provides an exhaustive literature review of theories of money demand models and extensions; transaction models for money demand are based on contributions by Barro and Fischer (1976) and Cuthbertson and Barlow (1991). Roley (1985) lists the theoretical work done by Clower and Howitt (1978), Akerlof (1979), Akerlof and Milboume (1980a), and Santomero and Seater (1981), among others, as alternatives to the transactions demand approaches of Baumol (1952) and Tobin (1956) and Smith (1986).

rate and a scale variable—money income is a usual proxy for that (see Hendry, 1993)—in addition to an appropriate opportunity cost for holding money (Sriram 2001), this is represented as follows:

$$M/_P = \text{f (S, OC)} \tag{1}$$

Where:

$M/_P$: Real Money Balances

S: Scale Variable

OC: Opportunity Cost for Holding Money

Laidler (1993) defined the opportunity cost for holding money as the money's own rate of return and the return on assets that are substitutes for money in a portfolio balance outset shown above. While the own rate of return on M1 is zero by definition of it being the sum of currency in circulation, demand deposits and checking accounts. Yet the own rate of M2 is the prevailing interest rate on deposits since it includes interest bearing accounts. On the other hand, yield on alternative assets is defined by the return rate on financial and real assets other than money. The expected inflation rate is considered the relevant proxy for this variable, particularly in less developed financial systems that are over regulated and suffer government control (Friedman (1956) and Hendry and Starr (1988)). Accordingly, the above formulation is rewritten as:

$$M/_P = f\ (S, r_d, \pi_e) \tag{2}$$

Where:

$M/_P$: Real Money Balances $\qquad S: Scale\ Variable$

$r_d: Domestic\ Deposit\ Rate(s)$ $\qquad \pi_e: Expected\ Inf ation\ Rate$

Taking the logarithm of the variables under consideration would entail interpreting the estimated coefficients as elasticities. However, literature recommended that some variables are to be considered in level form to be interpreted as slopes rather than elasticities. Friedman and Schwartz

(1982) emphasized that interest rates should be considered in levels since theory favors a constant slope rather than constant elasticity. While Friedman and Schwartz (1982) also indicated that the inflation rate is also to be considered in levels since it might be negative, Hendry and Ericsson (1990) introduced the first difference of logs of price levels. The regression equation therefore reads as follows:

$$m - p = \propto_0 + \propto_1 s + \propto_2 {r_d}^o + \propto_3 {r_d}^a + \propto_4 \pi_e + \varepsilon \quad (3)$$

Where:

$m - p$: Logarithm of *Real Money Balances*

s: Logarithm of $Scale\ Variable$ π_e: $Expected\ Inf ation\ Rate$

${r_d}^o$: $Own\ Domestic\ Deposit\ Rate$ ${r_d}^a$: $Domestic\ Deposit\ Rate\ on\ Alternative\ Assets$

ε: $Error\ Term$

In open economies, money demand is influenced by foreign asset holdings. The portfolio balance approach imposes agents that decide on the balance of foreign and domestic asset holdings. This is influenced by the opportunity cost of holding each class of these assets. Kamin and Ericsson (1993) conclude that inflation is a significant variable when modeling money demand and currency substitution. In this case, currency substitution is referred to by altering portfolio holdings of domestic assets for foreign assets due to volatility of exchange rates. Foreign interest rates are also considered a variable of interest if investment decisions and portfolio allocations involve investment in foreign securities within open economies. As discussed earlier with regards to domestic interest rates, the foreign interest rate enters the regression equation in levels as well as depreciation, since it might take negative values.

The open economy's money demand regression equation reads:

$$m - p = \propto_0 + \propto_1 s + \propto_2 {r_d}^o + \propto_3 {r_d}^a + \propto_4 \pi_e + \propto_5 r_f + \propto_6 \Delta XR_e + \varepsilon \quad (4)$$

Where:

$m - p$: Logarithm of *Real Money Balances*

s: Logarithm of $Scale\ Variable$ π_e: $Expected\ Inflation\ Rate$

$r_d{}^o$: $Own\ Domestic\ Deposit\ Rate$ $r_d{}^a$: $Domestic\ Deposit\ Rate\ on\ Alternative\ Assets$

r_f : $Foreign\ Deposit\ Rate$ ΔXR_e: $Expected\ Exchange\ Rate\ Depreciation$

ε: $Error\ Term$

3. Literature Review

Understanding the relationship between money, output, and interest rate is key for managing macroeconomics and determining priorities of monetary policy. The European Central Bank continues to assign a prominent role to money in its monetary policy strategy.[6] Moreover, while the United States Federal Reserve Board relied less on money when conducting monetary policy, money is still the vehicle by which the Board exerts direct control over bank reserves. This enables it to influence the federal funds rate, thereby broadening economic conditions.[7] As a result, money demand has received great attention in the literature.

Golfeld and Sichel (1990); Fase (1993); Sriram (2001); and Knell and Stix (2006) provided a comprehensive review of 198 studies contributing to the literature on money demand since 1972. These surveys outlined the rationale for testing the stability of the money demand function, particularly in the long run. This is a necessary condition for sustainable and balanced economic growth in the long run.

Poole (1970)[8] emphasized the need to understand money demand for the design and implementation of optimal monetary policy. In his view, the monetary authority should compare

[6] The ECB calls its two-pillar strategy; one pillar is "economic analysis," which assesses the short-to-medium-term determinants of price developments." According to the ECB, this analysis takes account of the fact that price developments over those horizons are influenced largely by the interplay of supply and demand in the goods, services and factor markets." But in addition, a second pillar, "monetary analysis", assesses the medium-to-long-term outlook for inflation, exploiting the long-run link between money and prices." The two alternative frameworks for assessing risks to price stability are intended to provide cross-checks" for one another (ECB, 2004, p.55).

[7] See Richmond Fed Economic Brief 2013, accessible at https://www.richmondfed.org/publications/research/economic_brief/2013/pdf/eb_13-05.pdf

[8] He is a strong supporter to the role of money demand in conducting monetary policy.

the volatility of money demand to aggregate expenditure variability, the sole source of instability in aggregate demand with an interest-rate instrument.

Friedman (1975) showed that understanding money demand is highly relevant, particularly in an environment where a central bank chooses to use a monetary aggregate as an intermediate target. Its usefulness appears to be measured in terms of enhanced stability of output, increasing with lower money demand elasticity and with greater money demand stability.

On the other hand, Meltzer (2002) contributed to a more rigorous understanding of changes in the real monetary base and its influence on real output in the United States (US) and the United Kingdom (UK), and demonstrated that it was independent of effects arising through the channel of short-term interest rates.

Nevertheless, the role of money demand in the formulation of monetary policy was recently debated in the monetary literature. There were arguments that money demand has a minor role under an interest-rate-based (Taylor-rule type) monetary policy (McCallum, 2003). However, Duca and VanHoose (2004) carefully voted for the continued relevance of the money demand in conducting monetary policy. They argued that monetary policy does not work only through the interest rate channel, and that money demand can provide useful information about liquidity and portfolio allocations. This clarified why monetary authorities in advanced economies (US, UK, Germany, Australia, and others) give special attention to modeling the behavior of the demand for money to ensure effectiveness of monetary policy.

i. Recent Developments in Global Literature on Money Demand

The empirical modeling of money demand witnessed substantial progress during the past five years to take into account many factors that influence desired levels of money holdings within a panel of countries as well as on an individual country level. What follows is a brief review of key contributions to the literature subsequent to the most recent comprehensive literature review by Knell and Stix (2006).

Panel studies focused on addressing issues of uncertainty and the impact of such uncertainty on money holdings, and also looked at how data aggregation impairs the econometric findings due to heterogeneity of agents on the micro level. The impact of uncertainty on money demand in six

Central and Eastern European emerging economies and four other emerging economies was considered by Oskooee, Kutan and Xi (2013). Results confirmed that the uncertainty's impact is transitory in most countries and money demand was correctly specified and stable in most countries.

Bahmani and Kutan (2010) tested the stability of money demand for Armenia, Bulgaria, the Czech Republic, Hungary, Poland, the Russian Federation, and the Slovak Republic. They used the bounds testing approach to co-integration that shows stable money demand in these countries.

To address issues of data aggregation, Hsiao, Shen and Fujiki (2005) used Japanese aggregate and disaggregate money demand data to show that conflicting inferences can arise. Aggregate data appear to support the contention that there was no stable money demand function, while disaggregate data showed that there was a stable money demand function. The diametrically opposite results are attributed to the neglected heterogeneity among micro units.

During the past five years, new modeling techniques have evolved for country level research related to money demand. Focus was directed to investigating the presence of a non-linear relationship between monetary aggregates and interest rate, as well as the possibility of considering time-varying behavior of coefficients.

Lee and Chang (2013) employed second-generation Random Coefficient (RC) modeling to investigate the time-varying behavior and the predictability of the money demand function in Taiwan, China, over the period 1982Q1 to 2006Q4. Empirical results indicated that the values of elasticity in the RC estimation are significantly different from those in other studies, because of the use of coefficient drivers that can make an association with real events occurring in Taiwan, China, such as the financial liberalization after 1989 and the Asian financial crisis of 1997–1998.

Bae and De Jong (2007) combined the logarithmic specification, which models liquidity better than a linear model, with the assumption that the interest rate itself is an integrated process. Results for the US produced larger coefficient estimates than previous research in addition to superior out-of-sample prediction.

Recent research also challenged the conventional wisdom of instability of demand for narrow money in many advanced economies across the globe (mainly the US, Australia, and Italy). These

studies focused on the relevance of the opportunity cost for money particularly in the short run in addition to the redeployment of classical modeling technologies in the short and long runs using partial adjustment models and auto-regressive distributed lag models.

In his paper, Ball (2012) challenged the conventional wisdom about the instability of the short-run money demand by examining quarterly data for the US from 1959 through 1993. Following the work of Hoffman and Rasche (1991) and Stock and Watson (1993), Ball interpreted long-run money demand as a co-integrating relationship among real narrow money balances M1 interest rates and output. To explain short-run deviations from the long-run relationship, Ball used Goldfeld's partial-adjustment model. The key innovation of his paper is the choice of the interest rate in the money demand function. Instead of using a short-term market rate, such as the treasury bill rate or the commercial paper rate, Ball used the average return on ''near-monies.''[9] His findings showed that the long-run money demand is stable regardless of whether the interest rate is measured by the return on near monies or a money-market rate (the T-bill rate). However, the deviations of money holdings from their long-run levels are smaller with the return on near monies. In addition, Goldfeld's partial-adjustment model yielded reasonable parameter estimates using the return on near monies, and it is not rejected in favor of a less structured error-correction model. Most importantly, he found that the deviations of money holdings from the predictions of the model are small. Thus, there is little evidence of shifts in the money demand function, even in the short run.

Hossain (2012) also challenged the conventional wisdom of the instability of money demand function in developed countries since the mid-1980s. He investigated the presence of an economically meaningful, stable narrow money demand relationship using annual data for Australia for the period 1970–2009. He employed an Auto-regressive Distributed-lag (ARDL) co-integration approach. The results suggested the presence of a long-run equilibrium relationship between real narrow money balances, real income, a representative domestic interest rate (e.g., the yield on Australian government short-term bonds) and the nominal effective exchange rate of the Australian dollar. The statistical tests suggested no significant instability in the narrow money demand relationship despite financial deregulation and innovation in Australia since the early

[9] Near-monies is defined as savings accounts and money market mutual funds that are close substitutes for M1.

1980s. In contrast, the paper reported statistical results which suggest no meaningful, stable broad money demand relationship in Australia over the sample period. These results implied that while financial deregulation has made the broader monetary aggregates more volatile, given the increasing availability of financial assets with competitive returns, there have been only steady changes in transaction technology in Australia since the early 1980s; therefore, the demand for narrow money has remained stable. An implication is that money remains important for Australia in its use of monetary policy to target price stability. Thus, narrow monetary aggregate can be used to measure excess liquidity for forecasting or predicting its impact on inflation, asset prices, and the output gap.

Capasso and Napolitano (2012) investigated the consistency of the stability of money demand in Italy, before and after the European Monetary Union (EMU) and tried to determine the effect of a change in the currency regime on the monetary aggregates. They estimated the money demand function in Italy using quarterly data from 1977 to 2007, using the bounds testing co- integration procedure proposed by Pesaran et al. (2001). In order to compute the short- and long-run elasticities of the demand for money, they implemented Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) stability tests proposed by Brown et al. (1975). The analysis is performed on broader money M2 and M3 also. Their findings revealed significant stability of money demand coefficients[10] in the short- and long-terms. This result applied to both M2 and M3. In order to further investigate long-term dynamics in the coefficients of money demand, Pesaran, et al. also employed Kalman filtering (Kalman 1960). They found that the introduction of the Euro has significantly increased the stability of money demand parameters particularly for M3, and the effects occurred before the introduction of the new currency in 1996 when the Lira was strongly linked to the Euro in preparation to the EMU.

ii. Literature on Money Demand in Egypt

With regard to Egypt, ten research papers studied money demand during the past three decades; the most recent was issued four years ago. As part of my research plan, I conducted a

[10] Income, interest rate and nominal effective exchange rate.

comprehensive review for modeling money demand in Egypt. These studies are reviewed in detail and summarized in Annex VIII.

Scobie (1983) is one of the early empirical studies on estimating money demand in Egypt. It was conducted to examine the monetary impact of subsidy expenditures on domestic inflation, the balance of payment, and the exchange rate. These variables were determined simultaneously within a framework of the monetary approach of the balance of payment. The demand for real money balances was estimated within a system of four structural equations, including domestic inflation, the black market exchange rate, and the balance of payments equation by adopting a two stage least squares estimation using annual data for the period 1947–1981. The study concluded that the elasticity of real money demand was estimated to be 0.38 in the short run and 1.42 in the long run. With respect to inflation, it was found to be -0.86 in the short run and -2.71 in the long run.

El-Erian (1987) adopted Ordinary Least Squares (OLS) framework to identify the absolute and relative determinants of currency substitution that took place during the period 1980–1986. He used data related to individuals' expectations regarding foreign balances. A reduced form of the money demand model was estimated using quarterly data of relative holdings of foreign currency deposits and specifications of the associated impact on the portfolio balance decisions of asset holders. Empirical results indicated that agents tend to hold foreign balances for two main reasons: (1) higher financial yields due to expectations of exchange rate induced capital gains; and (2) greater political stability and fewer institutional changes, especially banking regulations. Results also proved that the impact of enhancing these causal factors to influence agents to limit currency substitution will require a time lag to alter the actual holdings of foreign currency balances.

Alami (1999) tested for a long-run equilibrium relationship (co-integration) between the ratio of foreign currency denominated deposits to total liquidity, the expected rate of change of the exchange rate, and an interest rate differential between domestic and foreign currency deposits. He used quarterly data for Egypt covering the period 1981:IV to 1993:IV and tested for co-integration among the different variables utilizing the Engle-Granger methodology (Engle and Granger 1987). The co-integration results were further assessed by implementing the Johansen methodology (Johansen and Juselius 1990) to confirm the uniqueness of the co-integrating vector.

Finally, Alami estimated a dynamic error correction model for the dollarization ratio. The results showed that demand for foreign currency deposits varies with changes in the interest rate differential and not the exchange rate, which implies that the reason behind holding foreign currency denominated deposits is related to portfolio shifts and not to currency substitution, i.e., Egyptian residents substitute the currency in an attempt to preserve the value of money rather than using it as a medium of exchange. The empirical evidence in this paper suggested that foreign currency denominated deposits will have no significance when studying money demand as a monetary instrument.

Handy (1999) estimated a standard money demand function to measure the impact of inflation on money demand in Egypt using annual data during the period 1970/71–1996/97. Nominal monetary aggregate was regressed on the Consumer Price Index (CPI), real gross domestic product index, inflation rate, average interest rate measured in local currency, and an equivalent offshore interest rate using the augmented ARDL procedure. To check the stability of the money demand function, the monetary aggregate was identified first as currency in circulation, then as domestic liquidity, excluding foreign currency deposits, and finally, as total liquidity. The results indicated that: (1) money demand in Egypt is strongly related to price level, real output, and inflation; (2) in the second half of 1980s, there was a tendency towards dollarization that took the form of foreign currency deposits; and (3) the two forms of money defined as currency in circulation and total liquidity were robust over the period. Thus, targeting money demand should not be regarded when setting monetary measures in Egypt.

El-Sheikh (2002) estimated demand function of M1 using quarterly data covering the period 1960–1973 using the maximum likelihood technique. M1 was regressed on the expected real income, seasonal income variations, a set of relevant yields, and a set of institutional, distributional, and war variables. The following variables were found to be significant in determining M1 demand; saving deposit yields, post-office deposit yields. The study concluded with four important findings related to the estimation of the money demand function: First, the estimate of the elasticity of M1 with respect to seasonal income was far below unity, while the corresponding estimate with respect to expected income was far higher than unity. The estimate of the elasticity of M1 with respect to long run seasonal income is in line with those estimated by Baumol (1952) and Tobin (1956). El-Sheikh was able to differentiate between holding the currency to preserve the value of the money

rather than using it as a medium of exchange. He argued that, during seasonal times in Egypt, currency is mainly used for transaction purposes, but in off peak periods, currency will be held also as an asset. Second, contrary to the case in developed economies, the quarterly adjustment is conducted slowly. Third, the estimated long run elasticity of M1 with respect to the interest rate exceeded the values found by other studies in developed economies. El-Sheikh suggested that the narrow asset menu available in Egypt might be the reason behind this finding. Finally, assuming there is no change in the structural behavior of the asset holder following the studied period, the Egyptian government should refer to money demand in Egypt when designing monetary policy.

Baliamoune-Lutz and Haughton (2004) tested Friedman's hypothesis with application to Egypt. The research question was whether increased variability in the growth of the money supply causes velocity to decline. They used annual data from the period 1960–99. The monetary aggregates M1 and M2 are decomposed into anticipated and unanticipated components, and the variability of money growth is computed as the standard deviation of five years of monetary growth rates. Applying Johansen and Juselius' (1992) co-integration tests provided evidence that in the case of Egypt there is a statistically significant long-run relationship between the variability in money growth and velocity for both M1 and M2. However, while increased variability in the growth of M2 is found to be associated with lower velocity, supporting Friedman's velocity hypothesis, increased variability in the growth of M1 seems to have no influence on velocity, possibly because the definition of M1 has changed over time. The findings also suggested that anticipated movements in M2 volatility are not neutral, in the sense that they do affect velocity. The main contribution of this research is that in the short run, discretionary monetary policy in Egypt is somewhat circumscribed and constrained. However, if the Central Bank of Egypt were to make its decisions more transparent and pre-announce its policies, then velocity would be more predictable and monetary policy would be more potent and effective.

In an attempt to investigate whether Egypt should implement an inflation-targeting approach to pursue its monetary policy, the Central Bank of Egypt's annual report for the year 2010 examined the stability of the money demand function. Using monthly data over the period July 1997–June 2009, this exercise starts by estimating the long-run co-movement vector based on the Johansen method. The model incorporated data on real GDP, 3-month Treasury bill rate, annual inflation rate, and an impulse dummy to account for the exchange rate regime change in 2003, while 3-

months deposit rate, and expected depreciation of bilateral nominal exchange rate were found to be insignificant. The model turned out to be well specified since the wealth effect approached positive unity. Also, it was empirically found that the Treasury bill rate weakly impacted money demand, while inflation rate is highly related to money demand. Then in order to identify the short-run dynamics and structural adjustments, the Error Correction Model was used. The results showed that only the Treasury bill rate and expected inflation rates affect the money demand short-run dynamics, while real GDP was found to be insignificant in the short run. Finally, this paper estimated the Reduced Form to assess the stability of the money demand function. There no evidence was found to signify the instability of the money demand function, neither in the long run nor in the short run, except for the period (2005–2007) during which two structural shocks occurred: the implementation of a new monetary policy framework, and the avian flu epidemic. It concluded by advising the Egyptian government not to shift to the inflation-targeting framework.

In the context of purposing an effective monetary targeting regime in Egypt, Awad (2010) estimated the long run money demand function and tested its stability using quarterly data covering the period 1995–2007. Money demand was estimated as a function of the following variables: real income, lagged inflation, a nominal exchange rate, and the 3-month deposit interest rates. Awad adopted the Johansen co-integration test, and variables were co-integrated of order one. Using the OLS framework, as well as Durbin-Watson and Breusch-Godfrey serial correlation, a Lagrange Multiplier (LM) test detected first order serial correlation in the residuals. Accordingly, an autoregressive term was included in the regression equation as an explanatory variable and the model was re-estimated. The main findings confirmed that the money demand function was proven to be unstable via both the Chow breakpoint test and Chow forecast test (Chow 1960) and using both nominal and real exchange rates. Thus, it was concluded that the Central Bank of Egypt (CBE) should alter its monetary policy from monetary targeting regime to inflation targeting regime to achieve price stability.

iii Potential Areas for Improving Empirical Investigation of Money Demand in Egypt

The aforementioned literature review shows that earlier research left many gaps that need to be filled; this paper will contribute to filling these gaps as follows:

- **Longer Time Horizon:** Eight studies concluded that money demand in Egypt was stable during various intervals; many of which missed key events mentioned in the theoretical motivation section above. This research will encompass previous studies through analyzing over a longer period to ensure robustness of the analysis and soundness of tests for co-integration and quality of inference in both the short and the long runs.

- **Financial Market Imperfection:** This paper will incorporate a proxy for market imperfection in the money demand function. This was overlooked in earlier money demand studies in Egypt despite the existence of a significant parallel exchange rate market.[11] The premium of the parallel exchange rate over the official market rate is considered as a proxy for market imperfection and currency substitution. This is relevant to the less developed economies that suffer distorted financial markets (Osokee et. all 2011).

4. Hypothesis to Be Tested

In view of the theoretical motivation, we can represent the general model in the following specification:

$$M2t^{12} = f\,(gdp_t,,\text{Interest Rate}_t,\ \text{Discount Rate}_t,\ \text{Inflation}_t,\ \text{Exchange Rate}_t)$$

$$(+) \qquad (+/-) \qquad (-) \qquad (+/-) \qquad (-) \qquad (5)$$

The null hypothesis H_0 that demand for real broad money (M2) in Egypt positively relates to real GDP and/or real consumption as portrayed by theory will be tested.

However, when it comes to price levels, some ambiguity emerges depending on the position of the economies within the business cycle and the prevailing level of inflation rate. When inflation is

[11] See IMF article IV consultation report for Egypt ; various issues; accessible at http://www.imf.org/external/country/egy/

[12] Expected signs between brackets based on theory. Keynesian theory identified three motives for holding real money balances and liquidity preference including transactions, precautionary and speculative motives. The rationale behind the later was questioned by several authors paving the way for more emphasis on transactions demand (Baumol, 1952; Tobin, 1956) and the asset motive (Tobin, 1958; Friedman, 1956).

high, households will tend to spend more and keep less money on hand to avoid loss of value, pointing to a negative relationship between inflation and real narrow money. On the other hand, if inflation is relatively low, then households will keep more money on hand assuming—under static expectations—that it is better to keep more money on hand to meet any transaction costs. Accordingly, the relation will be positive in this case.

Moreover, broad money balances that have a negative relationship with depreciation of the exchange rate[13] due to portfolio reallocation will also be tested.

This is in addition to testing the hypothesis whether speculation motive reflects negatively on a relationship between money demand and interest rates.

The null hypothesis of a unit income elasticity of money demand will also be tested. This will test the theoretical proposition of the QTM that the volume of produced goods and services and the money supply will grow at the same speed. Rejecting this null will provide evidence that inefficiencies and rigidities related to costs of holding money and transaction motive for money demand holds for the economy under consideration and provides guidance to policy on the need for further innovation and development of the financial system (Knell and Stix 2005).

Another null hypothesis that will be tested is whether the spread between the deposit rate and the interest rate is statistically not different from zero. The discount rate reflects the interest rate that the Central Bank of Egypt charges commercial, depository banks for loans to meet temporary shortages of funds. It can be seen as a channel to influence the financial market's liquidity. This was a primary monetary policy instrument in Egypt until the interbank system was introduced in 2001.[14]

A significant foundation of QTM proposes that money supply growth is followed by equal changes in the inflation rate and, by the force of the Fisher effect, in the nominal interest rate. A hypothesis test of a one-to-one relationship between price level and monetary aggregate will test whether this proposition holds for Egypt.

[13] Based on the definition of: value in national currency per unit of foreign currency.
[14] Please see Central Bank of Egypt's Economic Review Vol. 50. No.3, 2009-10, available at www.cbe.org.eg.

5. The Variable Selection and Description of Data

i. Variable Selection

The analysis employs annual data covering the period from1959 until 2013. Data were obtained from the IMF's International Financial Statistics (IFS) database, and were last accessed in January 2015. The data series that was obtained included the following:

- **Monetary Aggregates:** this is defined as nominal local currency in circulation in addition to demand deposits and time deposits (M2) deflated by the CPI with base year 2010 in logarithms.
- **Scale Variable:** This is a measure of activity of the real sector that reflects transaction demand for money. The volume of transactions is greater as the output grows. The scale variable will be represented as real GDP deflated by the CPI with a base year of 2010 in logarithms. The real consumption will also be employed to assess the feasibility of both variables and identify the most appropriate scale variable for modeling the demand for money in Egypt. This paper will assume absence of money illusion following Tobin (1972).[15] This means that people will not behave differently when they receive payoff information in real or nominal terms. Dropping this assumption is beyond the scope of this paper.
- **Price Variable:** The price variable is included to represent yields on real assets as alternatives to holding money. This will reflect on individuals' preferences of portfolio holdings. The choice of the price variable has been constrained by data availability and the degree of the openness of the economy (Sriram 1999). The literature has shown flexibility using a GDP deflator, a GNP deflator, and a wholesale price index in addition to the consumer price index. The Egyptian economy has been suffering from chronic inflation problems. Accordingly, inflation should be included as an opportunity cost for real assets in Egypt. This paper will use CPI to compute inflation as a price variable since it is the best available consistent series that can serve as a price deflator. This is defined as the year on year percentage growth in the CPI with base year 2010 (not in logarithms). It is worth noting that many earlier studies employed inflation as one of the price variables including Ericsson and Sharma (1996), Ericson, Campos and Tran (1990), and Johansen (1992).

[15] Tobin argues that "an economic theorist can, of course, commit no greater crime than to assume money illusion".

- **Opportunity Cost for Holding Money:** (1) Own rate of return is represented by the three months' deposit rate (not in logarithms). This is driven by the fact that quasi money's share of M2 jumped from 12 percent on average in the 1960s to read almost 50 percent by the mid-1980s, then it dominated M2 calling for around 70 percent on average during the 1990s and 2000s. Three months' deposit rate is the main preference for banks' clientele as it contributes to around 55 percent of banking sector's deposits. (2) The discount rate should be considered also as an opportunity cost for M2 under the proposed model structure (not in logarithms). This is driven by the fact that monetary authorities relied on it as an operational monetary policy instrument since the 1950s until 2006 when it was linked to the treasury bills' rate as the domestic debt market became more active.
- **Foreign Interest Rate:** The foreign interest rate is included to proxy for capital mobility in an open economy setup. Under conditions of perfect capital mobility, the uncovered interest rate parity condition holds, i.e. the domestic interest rate is equal to the foreign interest rate plus the expected depreciation of the domestic currency. Under market imperfections and capital controls, the foreign interest rate provides a proxy for opportunity cost for holding money. Since the US is the largest trading partner and foreign investor in Egypt and due to data availability, the US federal funds' rate will be incorporated as a non-modeled variable under the open economy scenario for modeling money demand (not in logarithms).
- **Expected Exchange Rate Depreciation:** This accounts for the effect of external shocks on money demand in Egypt. The small open economies are usually vulnerable to external balance of payment shocks that in turn trickle down to affect propensity of holding domestic currency under a portfolio balance approach. The current model will consider the change of the logarithm of the nominal exchange rate for this purpose.

Note that while the monetary aggregate and the scale variable (variables a and b) are considered in the logarithm format, the price variable, opportunity cost, and foreign interest rates (variables c, d, and e) are not included in logarithms. This setup of a semi-log model implies that the estimated slope coefficients for variables c, d, and e are interpreted as semi-elasticities of real money relevant to these three variables. This measures the relative change in real money for a given absolute change in the value of these three explanatory variables at time (t).

Moreover, while theory considers expected inflation as a proxy for price variable and the expected exchange rate depreciation, this paper will adopt a simplistic approach that assumes rational expectations and perfect foresight that allows exchange rate at time (t) to serve as a proxy for the expected exchange rate at time (t+1).

ii. Brief Description of Key Variables

As expected, graph 1 indicates that GDP shows an upward trend during the sample space. Visual inspection of a log of real GDP indicates that the Egyptian economy grew in real terms at an increasing rate during 1960–1990, where it suffered a slow down during 1990–1995, which was the result of adoption of the stabilization reform program. The economy reverted back to increasing growth rates during 2000–2009 and slowed down during the Arab Spring years 2010–2013.

Yet, a log of real money balances showed a turbulent uptrend. This, in turn, confirms that money demand in Egypt plays a significant role in responding to propagations of business cycles. The opportunity cost of holding money had been decreasing at an increasing rate during the 1960s, which is pertinent to the Suez war decade. The decline rate slowed down in the 1970s, reflecting a relatively higher opportunity cost for holding money during this period that witnessed the enactment of the open door policy. This is when Egypt liberalized its capital account. The decline rate was accelerating until the mid-1990s when Egypt adopted a stabilization program to control growing inflation that accompanied the open door policies. The program adopted liquidity supply control as the main tool for controlling inflation and accelerating real economic growth. With this motivation, the following section conducts an investigation of the presence of a long term relationship among money, GDP, consumption, and nominal interest rates. (see Annex VII for a comprehensive review of the main historical developments of the Egyptian economy).

6. Econometric Methodology and Modeling Strategy

Inspecting the stochastic properties of the variables is the first step in analyzing the relationship between the variables. This procedure involves visual inspection of variables to check whether series are trending smoothly. The smooth trending pattern makes it feasible to quantitatively test for the presence of unit roots following the Augmented Dickey Fuller procedures (ADF) (see Dickey and Fuller 1979, Campbell and Perron 1991, and Enders 1995). This step is vital as it determines the strategy and methodology for modeling. Using variables with unit roots in linear

regression violates the basic assumptions needed for asymptotic analysis and consistency of estimation as it leads to spurious results (Davidson and Mackinnon, 1999).

The unrestricted (or general) form of the ADF (1981) unit root test equation is:

$$\Delta y_t = b_0 + b_1 y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \sum_{i=1}^{3} \gamma_i CS_{it} + \psi trend + \xi_t \qquad (6)$$

trend is time trend, ξ is a white noise errors

The ADF test maintains the null hypothesis of non-stationarity of the given time series. If test results provide evidence on the presence of unit roots in levels of the series, the test is repeated for a differenced series to identify the order in which the series is stationary. This is defined as "order of integration of the series". Variables of interest interact to enter into equilibrium in the long run if they are integrated of the same order. This is the key objective of this paper that attempts to test the nature of the equilibrium relationship between the real monetary aggregates, the real sector, and the external sector.

Accordingly, a system of equations will be modeled to investigate the existence of a stable relationship between the variables of interest employing a Vector Auto Regression (VAR) procedure and testing for optimal lag length using the general to specific criteria[16] (see Enders 1995).

This is complemented by inspecting the graph of residuals and their distribution visually, as well as residual diagnostic tests to ensure that residuals are white type and do not influence the parsimony of the model. The Chow test and break point test for model stability are also implemented in order to ensure consistency of estimation and inference. The Johansen (1988) and Johansen and Juselius (1990) tests for co-integration are then employed upon ensuring that the series are integrated of the same order. Tests of weak exogeneity will also provide evidence on the nature of the long run equilibrium relationship between variables.

[16] The optimal lag length is defined as lags are reduced without losing information.

The full information maximum likelihood of a Vector Error Correction Model is as following:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \mu + \varepsilon_t \tag{7}$$

Where, y_t is a (n x 1) vector of the n variables in interest, μ is a (n x 1) vector of constants, Γ represents a (n x (k-1)) matrix of short-run coefficients, ε_t denotes a (n x 1) vector of white noise residuals, and Π is a (n x n) coefficient matrix. If the matrix Π has reduced rank ($0 < r < n$), it can be split into a (n x r) matrix of adjustment coefficients α , and a (n x r) matrix of co-integrating vectors β . Testing for co-integration, using the Johansen's reduced rank regression approach, centers on estimating the matrix Π in an unrestricted form, and then testing whether the restriction implied by the reduced rank of Π can be rejected. In particular, the number of the independent co-integrating vectors depends on the rank of Π which, in turn, is determined by the number of its characteristic roots that are different from zero. The test for nonzero characteristic roots is conducted using Max and Trace tests statistics. It is important to note that as Johansen (2002) shows, since these tests tend to reject the null hypothesis of no co-integration in small samples; it is useful also to use the degree of freedom adjusted test statistics in the co-integration analysis.

A VECM is then determined following Johansen (1988) and Johansen and Juselius (1990). The last step would be identifying a conditional VECM, including endogenous variables that rejected the null hypothesis of being excluded from the co-integrating relation. For this deliberation, Oxmetrics 6.1 will be used as the key econometric package for related quantitative modeling.

We run a co-integrated VAR then analyze the standardized eigenvectors. These are defined as the matrix containing the parameters of the co-integrating vectors. The rows of the β matrix—as defined in the earlier methodology section—represent the standardized coefficients of the variables entering into the respective co-integrating vector. These coefficients are then normalized to unity along the principal diagonal of this matrix.

7. Empirical Results

The time series properties of the data as well as different diagnostic tests are conducted. The series are tested for stationarity using the ADF, order of integration, co-integration between the variables, significance of the variables, and weak exogeneity were also undertaken for a closed and open economies formulations. (Full details on the econometric procedures are available in Annex VIII.)

Long-run Modeling—Closed Economy Formulation

The estimation process is then followed by a set of tests for weak exogeneity and stationarity. Table (7d & e) shows the results of various hypothesis tests for statistical significance of beta coefficients (elasticities) in addition to the weak exogeneity tests of alphas.

The test statistics show that betas for the constant and inflation—individually and jointly—are not statistically different from zero at a 5 percent significance level. This indicates that the inflation rate does not enter the long run equation for real broad money balances.

However, when the joint statistical significance for betas of constant and inflation is tested together with the alpha coefficient for real money, the test fails to reject that these three coefficients are jointly different from zero at a 5 percent significance level with $\chi 2\ (2) = 10.602$. This provides ample evidence that the model converges towards equilibrium.

The individual tests for betas of all other variables reject the null hypothesis that they are excluded from the long run—co-integrating—relationship at a 5 percent significance level for real income and a 1 percent significance level for the interest rate and the discount rate.

The joint test for statistical significance of betas strongly rejects the null hypothesis at all significance levels as well giving $\chi 2\ (5) = 32.104$. Therefore, the three variables (real income, opportunity cost, and real consumption) have a long run relationship to real money demand in Egypt.

Further tests of statistical significance of alphas were conducted to determine the feedback effects of the co-integrating relationship. The money demand own alpha was negative and statistically significant at a 5 percent level, hence a long run relation can be identified.

The test statistics show strong evidence to reject the null that (real income, inflation rate, and interest rate) are weakly exogenous and hence their respective alphas are significantly different from zero with a 1 percent significance level. This still holds when these three alpha coefficients are jointly tested with betas of inflation rate and the constant.

The joint test for statistical significance of all alphas strongly rejects the null hypothesis at a 1percent significance level giving $\chi 2\ (4) = 32.175$. This in turn confirms the fact that we cannot work with a single equation framework.

Further individual and joint significance tests were conducted and summarized in table (7e) and indicate that the alpha of discount rate is not statistically different from zero at 1 percent, and when tested jointly with betas of inflation rate and the constant, it can be concluded that these three coefficients are different from zero at a 5 percent significance level. Joint tests of statistical significance for the aforementioned hypothesis, together with alpha for real income, provided strong evidence that these coefficients are not statically equal to zero. Accordingly, real income is not weakly exogenous.

It can be concluded that the feedback between the real money balances, real income, the inflation rate, and the interest rate equations provides significant information needed to determine the long run relation between these variables.

The long run equilibrium relation for real money demand in Egypt under a closed economy formulation is provided in equation 10 below.

The implied long run equilibrium relationship for real money balances (rm2) can be outlined (see table 7b):

$$\mathbf{rm2 = 1.0351 * rgdp - 0.82178 * Interestrt + 0.69302* DISC} \tag{10}$$

It can be seen that income homogeneity applies as the coefficient for real income is closed to unity in accord with the quantity theory of money. However, the signs of the own rate of return is negative and the opportunity cost of money was positive. The coefficient represents the semi-elasticity of real balances with respect to interest rates, and its value is -0.82178 if using

percentages. At a 5 percent interest rate, the elasticity of money balances with respect to interest rates is -0.04. Whereas at a 5 percent discount rate, the elasticity of real money balances is estimated to be positive and reads 0.035.

The negative long term relationship between money and interest rate is common in less developed economies. Hoffinan and Chakib (1994) explained the mixed inconclusive evidence on the response of real money balances to interest rates in less developed economies. They show that the empirical literature provides mixed evidence, as some studies show that interest rates are not significant at all, and in other cases the demand for money is elastic to interest rates. The negative relationship between real money and interest rate in the Egyptian context is interpreted in macroeconomics text books as the "liquidity effect". The increasing interest rates, for example, require a decrease in the stock of money. According to this interpretation, money demand is a decreasing function of the nominal interest rate because the interest rate is the opportunity cost of holding cash (liquidity). So a decrease in the supply of money must cause interest rates to increase in order to keep the money market in equilibrium.

It is worth noting that many other studies on less developed economies reached a similar conclusion on the money—interest rate negative relation. Lacayo-Anderson (2001) reported -0.45 interest rate elasticity to real money in El Salvador. Martner and Titelman (1993) also find a negative long run elasticity for real narrow money of - 0.61 for Chile. Another study on real money demand in Brazil during the 1980s estimated that long-run interest rate elasticity was -0.30 (see Rossi (1989)). The state of the Egyptian economy throughout the modeling period is very much closer to the state of the Chilean economy in terms of suffering chronic inflation, while El Salvador and Brazil also experienced wars and political instability during the 1980s that featured structural issues and mismanagement of monetary and fiscal policies.

An alternative test for stationarity of rm2 was conducted through testing if beta coefficients of (real income, inflation rate, interest rate, and discount rate) are jointly different from zero. The null hypothesis was strongly rejected at a 1 percent significance level with $\chi 2$ (4) = 32.063, thereby providing strong evidence that real broad money balance is non-stationary.

Moreover, the hypothesis that the interest rate and the discount rate are statistically equal in magnitude and opposite in signs couldn't be rejected at a 5 percent significance level and $\chi 2$ (3) =

7.1491. This provides statistical evidence that the impact of raising interest rates is offset by lowering the discount rate in a closed economy setting. The diagnostic statistics for the VECM's system of equations indicate that the system is free from serial correlation since the Vector (SEM-AR 1-2) test statistic F(50,99) = 1.1727 [0.2485]. It is also free from hetrokedasity since the Vector ZHetero test statistic reads F(110,97) = 1.0653 [0.3761].

However, the systems residuals as well as a single equation—with exception of real income—suffer from non-normality due to a couple of outliers that can be visually inspected in graph (5). The visual inspection of this graph also confirms that the residuals are seen to be fairly normally distributed. The individual equations are all free from serial correlation except for the difference equation for the interest rate where the AR 1-2 F-test indicates the presence of serial correlation at a 5 percent significance level, yet the ARCH1-1 test indicates the opposite.

The model was also tested for overall stability. It can be visually inspected in graph 6 that the overall model is stable and fails to reject the one step Chow test (1up) and the breakpoint test (Ndn) of stability at a 1 percent significance level. Moreover, the individual coefficients were tested for stability and it can be confirmed from graph 7 that the coefficients are fairly stable. Upon graphing the roots of the companion matrix, they all lay within the unity circle and fairly near the middle. It can be concluded confidently from the aforementioned graphical inspection of stability tests that the VECM system is stable and that it is feasible to rely on the model for inference.

Short-run Modeling—Closed Economy Formulation

Having identified the long run relationship, the analysis moves to defining the short run relation. We build on the outcomes of the weak exogeneity test that real income, inflation rate, and interest rate aren't weakly exogenous. Accordingly, a short term four equation model is constructed.

The VECM results in model (4) of (Annex I) indicate the unrestricted short term system of the four equations. Overall, the model is considered to be well identified. The diagnostic tests of the residuals indicate that equations of the real money balances and interest rate suffer non-normality. This, in turn, reflected on the non-normality of the overall system's residuals. However, individual equations and the system are free from hetreskoedasticity at a 1 percent significance level. They are also free from serial correlation at a 1 percent level with the exception of the interest rate equation that fails to reject the AR 1-2 test of absence of serial correlation at 10 percent. However,

residuals diagnostics substantially improve as we proceed to the parsimonious model. Moreover, the general unrestricted short run system is reasonably stable, as seen in graphs 6 and 7. The roots of the companion matrix are comfortably within the unity circle to provide assurance that the data generating process is stationary and the model can be used for inference.

The speed of adjustment in the short run money demand equation is negative, statistically significant, and lies between zero and unity. It therefore satisfies the needed criteria to set up a robust model that converges to equilibrium in the long run. This also translates to the fact that real money demand is above or below its long run equilibrium level. Finally, the negative sign and the magnitude that is less than unity ensure that the money demand converges to the long run equilibrium.

Reduction of the General Model—Closed Economy Formulation

The estimation of the short term system with unrestricted constant and dummies indicated that a number of variables are statistically insignificant. Since our empirical analysis reached a general statistical model that captures the key characteristics of the underlying dataset, we proceed to reducing the complexity of the general model by eliminating statistically insignificant variables and checking the validity of the reductions at every stage to ensure congruence and parsimony of the finally selected model (see Hoover and Perez (1999) and Campos, Ericsson, and Hendry (2005)).

Throughout the reduction process, 62 regressors were eliminated based on statistical insignificance. Throughout the process, a progress test was conducted to test for the validity of the elimination in each step. This test is built on the likelihood ratio of the restricted model (after reduction) versus the unrestricted model (before reduction) Moreover, an encompassing test was conducted to ensure that no critical information was lost throughout the reduction process.[17] The parsimonious model was accordingly formulated based on minimizing the Schwartz (SC) and Hannan-Quinn (AIC) information criterion based on which it was found to encompass the general unrestricted system as well as all the reduced systems. However, the proposed parsimonious system didn't minimize the Akaike information criteria. This system reads:

[17] Full details are available upon request.

```
Drm2 =  + 0.679*Drm2_1 – 0.016*Cia_1 – 0.115*dumm2008
(SE)     (0.0836)       (0.00678)     (0.0455)

Drgdp =  - 0.00456*DINFL_1 – 0.0222*Dinterestrt_1 + 0.459*Drm2_2
(SE)      (0.000871)        (0.00565)              (0.0603)
         - 0.0167*Cia_1 – 0.0604*dumm1986 + 0.127*dumm2013
          (0.00429)      (0.0273)          (0.027)

DINFL =  + 32.5*Drgdp_1 – 0.377*DINFL_1 + 15.4*Drm2_2 + 2.19*Cia_1
(SE)      (10.3)         (0.106)         (7.05)        (0.476)
         + 7.19*dumm1986 + 7.17*dumm2008
          (3.29)          (3.26)

Dinterestrt =  + 2.68*Drm2_1 – 4.21*Drgdp_1 + 0.0293*DINFL_1 + 0.551*DDISC_1
(SE)            (1.57)        (2.27)         (0.0173)         (0.093)
               - 3.9*Drm2_2 + 0.184*Dinterestrt_2 – 0.497*Cia_1
                (1.44)       (0.111)               (0.109)
               - 5.41*dumm1992 – 2.68*dumm2009 + 0.991*dumm2010 + 2.82*dumm2013
                (0.931)         (0.649)         (0.575)             (0.653)
```

(11)

The residuals diagnostics of the parsimonious system indicate that the individual equations, in addition to the whole system's residuals, are free from serial correlation and hetroskedasticity. Residuals of all individual equations are also normally distributed, with the exception of the interest rate equation. This influenced the normality of the system's residuals that reject the null hypothesis of the normality test. Moreover, the visual inspection of the residuals diagnostic graphs showing the plots of actual and fitted values, cross plot of actual and fitted values, and scaled residuals show close fits, and the residuals aren't seen to exhibit a pattern; despite the presence of several outliers. (see graph 8). The visual inspection of the residual correlograms, residual density, residual histogram, and residual distribution reconfirm the proposition of absence of serial correlation with distributions close to the normal bell shape.

Moreover, the parsimonious system is remarkably stable. Visual inspection of the Chow one step test and the break point Chow test at a 1 percent significance level. Also, the roots companion matrix lies within unity circle. Accordingly, the model converges in the long term. In addition to each of the four individual equations, a one step residuals test shows remarkable stability within

the 1 percent confidence interval (see stability test graphs 9 and 10). This provides additional confidence to the predictive power of the model and robustness of related findings and analysis.

Key Economic Findings of the Short Run Parsimonious Model—Closed Economy Formulation

The short run equation for the real money balances in the parsimonious indicates that short run movements of money demand varies positively with the lagged change in money and negatively with the error correction term. Accordingly, the demand for money in the current period influences the demand in the next period. The stability of the short run money demand requires a pulse dummy for the year 2008. This pulse dummy captures a 12 percent decline in the change in demand for real balances. As earlier discussed, this marks the year of the global financial crises. It is evident that the public lost trust in national currency during this year, influenced by the potential impact of the crises on the domestic economy.

It worth noting that the government launched a stimulus package that reached almost 5 percent of GDP to revitalize the economy; this, coupled with a hike in public spending and inflation rates. The money adjustment to a 1 percent deviation from disequilibrium is around 1.6 percent. This is a bit higher than the CBE's 2010 study that read 1.3 percent for monthly data covering the years 1990–2010. Yet the later was under an open economy formulation.

The growth in GDP varies positively with the change in real money two periods ago, and negatively with the previous period's interest rate. If the change in inflation rate is 5 percent, the change in output would drop by around 0.001. In case the interest rate is 10 percent, the change in real income will drop by 0.002. The change in real income would be 0.45 if the money grows by 1 percent.

The change in the current period's' inflation varies positively with the growth in real money balances two periods ago and the previous period's income. Yet inflation changes negatively with the change in the previous period's inflation. The change in inflation by 1 percent in the previous period lowers the change in inflation by 0.03 percent in the current period.

The change in the interest rate in the current period is responsive to lagged changes in real money and inflation. It also changes negatively with the real money change two periods ago and lagged change in both real income and the discount rate. A rise in the change in inflation by 5 percent in the previous period leads to a 1 percent increase in the change in interest rates. The impact of a 1 percent increase in the discount rate leads to a 0.5 percent increase in the change of interest rate. Accordingly, the monetary authority can indirectly influence the interest rate in the short run through a raise in the discount rate. The change interest rate was negatively affected by the 1992 economic reform program, and the 2009 response to the global crises. However, the first wave of the revolution in 2010 and the second wave in 2013 reflected on a positive change in the interest rates. The closed economy formulation provides a stable model for demand for real money balances in Egypt. In the long run, money income homogeneity holds and the real money balances change negatively with the interest rate and positively with the discount rate. Inflation does not influence real money demand in the long term.

We cannot statistically reject that the interest rate and the discount rate operate in opposite directions in the long term. This is a significant and new contribution to the policy guidance that was not tested in earlier research. Since interest rates have been liberalized since the mid-1970s, the monetary authority can use the discount rate to influence interest rates in the long term.

The speed of real money demand adjustment to equilibrium, using low frequency data in the proposed model, is a bit larger than high frequency data covering a shorter horizon.

The matrix below provides a summary for the short term interaction between variables in a VECM under a closed economy setting. The change in real money balances two periods earlier influences positively the change in current real income and inflation. The change in the previous period's real money balance positively effects the change in the current period's change in real money balances and interest rate.

		Independent Variables								
		Drm2_1	Drm2_2	Drgdp_1	Drgdp_2	DINFL_1	DINFL_2	Dinterest_1	Dinterest_2	DDISC_1
Dependent Variables	Drm2	+								
	Drgdp		+			-		-		
	DINFL		+	+		-				
	Dinterest	+	-	-		+			+	+

While these findings are robust and in line with theoretical underpinnings, they still miss the fact that Egypt is a small open economy that is subject to the influence of foreign developments in the global economy. Moreover, the need to include a pulse dummy to the co-integrating space of the short run money demand equation, that captures the impact of the 2008 crises, supports the need to consider re-estimating the money demand function to account for the external interaction with the global economy.

Long-run Modeling—Open Economy Formulation

The long run equilibrium relationship for real money balances under the open economy formulation:

$$\mathbf{rm2 = 1.2990 * rgdp - 1.2506* Interestrt + 1.0733 * DISC - 8.5118* Dexrtend - 0.13232 * INFL} \quad (12)$$

It is evident that the open-economy formulation provides additional information regarding the nature of the demand for real money. This formulation revealed that interest rates and devaluation have a significant and negative impact on the demand for real money in the long term. The inflation also enters the long run equilibrium relationship for real money under the open economy formulation, and has a negative relationship with money demand. The signs of all variables in the long run relationship are in line with theory. Tests for significance of individual betas show that the constant and federal funds' rates are individually and jointly insignificant statistically.

The income elasticity is larger than that of the closed economy and bears the correct sign. A unit change income leads to a 1.3 increase in the demand for real money balances.

The interest rate and the discount rate enter the long term relationship with the same signs as in the closed economy formulation, yet with a larger magnitude for coefficients. This makes perfect sense as it reflects the influence of interacting with the outer world on the monetary system.

The long term relationship accounts for the impact of devaluation of the Egyptian pound against the US dollar on money demand. It shows that the rate of devaluation of the official exchange rate has a serious effect on the public's trust in the national currency and, accordingly, on the demand for money. When devaluation changes by 1 percent, this leads to a drop in demand for money by 8 percent. Accordingly, a decision of devaluation of the official exchange rate leads to abandoning trust in the national currency. This provides strong emphasis on the importance of currency substitution in the economy as economic agents determine the motives of demand for money balances and decide on a portfolio composition of their holdings.

It is worth noting that incorporating the parallel exchange rate did not provide meaningful results at the VAR formulation, nor did it influence the long term relationship. Accordingly, it was decided to introduce it in the short run formulation to capture the impact of the foreign exchange market imperfection on money demand in the short term.

While the inflation rate had no impact on the demand for money in the closed economy formulation, it enters the long term equation for real money under the open economy formulation. The interpretation of the semi log coefficient of inflation shows that at a 10 percent inflation rate, the money demand decreases by 1.3 percent.

The open economy formulation is free from serial correlation and heteroskedasticity at the individual equation level as well as for the entire system. The diagnostics tests for residuals also indicate that the hypothesis of normality is rejected at the 5 percent level for equations of money and discount rate, and the whole system. This was explained earlier to have been caused by a couple of outlier observations. The visual inspection of the distribution of residuals shows a well-defined bell shape. This provides more comfort regarding the normality of the distribution of residuals and the reliability of the inference.

The VECM is also stable, as confirmed by the visual inspection of the recursive Chow step test and the Chow break point test. The one step residuals stability test also confirms the stability of the model (see graphs 17, 18 and 19).

Short-run Modeling—Open Economy Formulation

The obtained short term system includes three equations. This is slightly different than the closed economy formulation. The introduction of the exchange rate and the federal funds' rate as proxy for openness introduced a modified short term formulation.

Tests of weak exogeneity indicated that income and the discount rates are endogenous in the short term, together with real money.

Under an open economy, the inflation and interest rates are found to be weakly exogenous since the adjustment coefficient of both variables was found statistically insignificant at a 5 percent significance level reading Chi^2 (1) 1.9441 [0.1632] and 3.2193 [0.0728], respectively.

This makes more sense within a developing economy's perspective since the monetary authority decides and announces the interest rates and the economy receives that as given.

Moreover, a weak exogeneity of inflation in the money demand variable space implies that money demand equations should not be considered as price equations (MacKinnon and Milbourne, 1988). The implied intuition is that there is no feedback effect for disturbances from the steady-state of the money demand function that can enter into a dynamic equilibrium relationship with inflation. Accordingly, domestic inflation is determined by factors beyond those lying in the money demand variable space.

The VECM results in model (3) of (Annex IV) indicate the unrestricted short term system of the three equations. The diagnostic tests of residuals indicate that equations of the real money balances and discount rate experience nonnormality at a 5 percent significance level. The same applies to the overall system's residuals. However, individual equations and the system are free from hetreskoedasticity and serial correlation at a 1 percent significance level. This is a remarkable improvement over the closed economy formulation. This system is also stable, as seen in graphs 18 and 19. The roots of the companion matrix are comfortably within the unity circle, which

provides assurance that the data generating process is stationary and the model can be used for inference.

The speed of adjustment in the short run money demand equation is negative, statistically significant, and lies between zero and unity. However, the magnitude of the speed of adjustment reads (-0.03) under the open economy, slightly lower than the closed economy reading (-0.04), yet, it still satisfies the criteria for a robust, well specified model that converges to equilibrium in the long run.

Short-run Parsimonious Modeling—Open Economy Formulation

The reduction process proposed by Hoover and Perez (1999) and Campos, Ericsson, and Hendry (2005) was adopted, as explained earlier in the closed economy formulation. This reflected on the exclusion of 40 insignificant regressors. The short run parsimonious model indicates:

```
Drm2 =  + 0.824*Drm2_1 + 0.217*DDexrtend_1 - 0.00845*CIa_1 + 0.02*DInterestrt_1
(SE)     (0.0835)       (0.0472)            (0.00361)       (0.00923)
        - 0.00828*DINFL - 0.0698*Dexrtprmium_1
         (0.00161)       (0.0256)

Drgdp =  + 0.139*DDexrtend_1 - 0.00359*DINFL_1 + 0.449*Drm2_2
(SE)      (0.0265)            (0.000872)        (0.0503)
         - 0.0135*CIa_1 + 0.141*dumm2013 - 0.00415*DINFL + 0.027*Dexrtprmium
          (0.0023)       (0.0248)         (0.000921)      (0.0144)

DDISC =  + 4.78*Drm2_1 + 0.243*CIa_1 + 4.04*dumm1991 + 2.93*dumm2008
(SE)      (1.17)        (0.0546)      (0.774)         (0.718)
         - 2.77*dumm2012
          (0.713)
```

(13)

The exchange rate premium was also found to interpret the dynamics of real money balances as well as the real GDP growth. It was added to both equations to achieve parsimony of the model. The premium is calculated as the difference between the black market exchange rate and the official exchange rate. It is a proxy for market imperfection. It indicates that the larger the gap the higher level of capital controls and inability of the official exchange market to for domestic

currency conversion to foreign currency. Accordingly, individuals and businesses resort to unofficial channels to acquire foreign currency. Based on statistical significance, the lag of the first difference of the exchange rate premium is included in the money demand short term equation, whereas the contemporaneous first difference was included in the income short term equation.[18]

The progress—log likelihood ratio—test for validity of restrictions, as well as the encompassing test, ensure that the parsimonious model is well specified and encompasses the general unrestricted model. The parsimonious system does minimize the AIC, Schwartz criterion (SC) and Hannan-Quinn criterion (HQ). Accordingly, it is able to better explain the short term dynamics of money demand.

Moreover, the parsimonious system is stable as per the Chow one step test and the break point chow test at a 1 percent significance level. Also, the roots companion matrix lies within the unity circle. The plot of roots of the companion converges in the long term. In addition to each of the four individual equations, the one step residuals test showed remarkable stability within the 1 percent confidence interval (see stability test graphs 18 and 19). We can therefore conclude that this system's predictive power is strong and relevant findings and analysis are reliable.

Key Economic Findings of the Short Run Parsimonious Model—Open Economy Formulation

The short term real money demand varies positively with its own lagged values. The increase in lagged money demand by 10 percent leads to an 8 percent increase in money demand in the current period. Moreover, in the short term, an increase of 5 percent in the interest rate in the previous period leads to a 1 percent increase in contemporaneous demand for real money.

The money adjustment to a 1 percent deviation from disequilibrium is approximately 1 percent. This is a little slower than the closed economy formulation. It also indicates that economic openness makes an adjustment to shocks and reverting to the steady state more challenging.

[18] Earlier literature by Beljer (1978) indicate that the demand for money is significantly reduced when expectations of black-market depreciation intensify in Brazil, Chile, and Colombia. Hassan, Choudhury, and Waheeduzzaman (1995) suggest that depreciation in black market exchange rate exerts a significant negative impact on the domestic demand for money in Nigeria, Bahmani-Oskooee and Tanku (2006) find that out of 25 LDCs some LDCs, the black market rate enters into the formulation of the demand for money, in some others the official rate is the determinant. The black market premium also played a role in some countries and Tanku (2011) introduced the black market premium directly to money demand in 8 emerging economies.

The demand for real money increases with the higher devaluation of the official exchange rate in the previous period. This is against the Mundell conjecture that devaluation of national currency leads to a lower demand for money. One interpretation could be attributed to the fact that the devaluation of the official rate usually couples with devaluation in the parallel exchange market. Accordingly, the public would want to maximize returns and seek arbitrage opportunities through resorting to the parallel market. Moreover, the devaluation of the official exchange rate in Egypt is accompanied by extreme administrative controls to minimize speculation over foreign currency through the official financial system. The monetary authorities' resort ceilings on an individual's foreign currency purchases from banks and prioritizes the allocation of foreign exchange resources to cover critical imports. This is further explained by the negative relationship between the change in the exchange rate premium in the previous period and demand for real money in the current period. The increase in the premium by 1 percent leads to a decline of 8 percent in real money demand. The altered sign for official exchange rate devaluation can be viewed therefore within the context of portfolio adjustment.

Higher inflation also reflects on loss of trust in domestic currency as stipulated in theory. The estimation in the short term real money demand equation shows a decline of 8 percent in real money demand for a 10 percent increase in the inflation rate.

The growth in real income was positively affected by the 2013 revolution. The 2013 dummy captures a rise of 0.14 percent in real income growth. Moreover, real income adjusts by 1.3 percent in case of a 1 percent deviation off equilibrium.

The real income's response to a change in inflation and real money is in line with theory. It responds negatively to the increase in lagged inflation and positively to the increase in real money balances two periods ago.

Finally, within an open economy setup, devaluation of domestic currency in the official exchange rate reflects positively on real income growth. The magnitude of the devaluation through the parallel exchange rate channel is weaker compared to the official exchange rate. This makes perfect sense as most of the exports, remittances flows, and Suez Canal proceeds (accounting to 70 percent of foreign currency income) are routed through the formal financial system, which

adopts the official exchange rate in the current account conversion; whereas the tourism and services sector might resort to the parallel exchange rate market

The following matrix summarizes the short term dynamics within the system:

		Independent Variables								
		Drm2_1	Drm2_2	DDexrt end_1	Dexrt prmium	Dexrt prmium_1	DDexrt end_1	DInterest rt_1	DINFL	DINFL_1
Dependent Variables	Drm2	+		+		-		+	-	
	Drgdp		+	+	+				-	-

The discount rate responds positively to the lagged real money balances. It can also be perceived as a shock absorber to the 1991 IMF structural adjustment program that lead to raising the average discount rate by 4 percent as part of the monetary tightening plan and fighting dollarization. It was hiked by 3 percent in 2008 to defend the domestic currency and rebuild trust in the Egyptian pound in the aftermath of the global financial crises. Finally, the model captures a drop of 2.7 percent in 2012 as a reaction to the attempt to relax monetary policy to expedite a post 2011 revolution economic recovery. It is also seen as a source of disequilibrium in the system and a deviation of 0.24 percent off the stay state for a 1 percent increase in the discount rate.

8. Conclusion

The money demand equation for Egypt is stable under both closed and open economy formulations. The monetary authority can resort to monetary aggregates to achieve monetary policy objectives and adjust for long run growth in the real economy.

The money income elasticity under an open economy formulation remained within acceptable norms of 1.3 and is statistically not equal to unity. This is due to the fact that the increase in real income in the economy is coupled with an uptrend in monetization as the ratio of money stock over output is uptrending.

One key finding of this research confirms that the adjustment of real money to disequilibrium in the short term is slow. This might be attributed to structural factors related to financial underdevelopment and stagnant wages and prices. The Egyptian economy has undergone massive transformation during the past five decades, yet exhibited low employment levels and strong inflation inertia. Moreover, domestic inflation has a weakly exogenous characteristic in the money

demand space. Combining this with a slow adjustment of money suggests the presence of a ratchet effect. The finding of a ratchet effect suggests that the disequilibrium might become a new equilibrium as individuals adapt to operating with lower money holdings. Accordingly, inflation influences money demand in the medium and long terms.

The expected depreciation rate of the domestic currency against the US dollar remains a significant opportunity cost for holding money. This reveals that currency substitution is a determinant factor for motivating money holdings. The higher rate of devaluation reflects on an accelerated drop in money demand in the long term. Moreover, devaluation within the parallel market is negatively related to the change in demand for real money balances in the short term. Individuals hold more domestic currency if the official exchange rate drops and arbitrage opportunities are sought in the parallel market.

Annex I: Summary Tables and Integration Tests for Money Demand Model

Table (1): Data Description for Money Demand Model:

Acronym	Description	Source	Adjusted	Date Accessed
rm2	**Monetary Aggregate:** Log of Real Broad Money (including money in circulation, demand and time saving deposits)	IMF International Financial Statistics	Yes (log of levels less)	January 25th 2015
rgdp	**Scale Variable (1):** Log of real Gross Domestic Product; proxy for wealth	IMF International Financial Statistics	Yes (log of levels deflated by CPI: base year 2010)	January 25th 2015
INFL	**Price Variable:** (Inflation Rate: annual change in CPI)	IMF International Financial Statistics	No	January 25th 2015
Interestrt	**Opportunity Cost for Holding Money (1):** Three months deposit rate	IMF International Financial Statistics	No	January 25th 2015
Disc	**Opportunity Cost for Holding Money (2):** The discount rate	IMF International Financial Statistics	Yes (log household consumption)	January 25th 2015
rcons	**Scale Variable (2):** Log of real household consumption	IMF International Financial Statistics	No (log of levels deflated by CPI: base year 2010)	January 25th 2015
Dexrtend	**Expected Exchange Rate Depreciation:** of differenced log of official nominal exchange rate	IMF International Financial Statistics	Yes (differenced log of levels)	January 25th 2015
FFUNDSRT	**Foreign Interest Rate:** US Federal Funds Rate	IMF International Financial Statistics	No	January 25th 2015

Table (2): Summary Statistics: Sample: 1959 – 2013 (55 observations; annual data:

Variable	Leading sample	#obs	#miss	Minimum	Mean	Maximum	std.dev
rm2	1959 to 2013	54	0	3.6784	5.5563	6.9803	1.0718
rgdp	1959 to 2013	54	0	4.7337	6.0125	7.2877	0.73388
INFL	1959 to 2013	54	0	-3.0000	9.0673	23.860	6.5032
Interestrt	1959 to 2013	54	0	3.0000	7.6578	12.000	2.8304
Disc	1959 to 2013	54	0	3.0000	9.3560	20.000	4.0601
rcons	1959 to 2013	54	0	4.3882	5.6571	7.0969	0.77611
Dexrtend	1959 to 2013	54	0	-0.097638	0.054311	0.59784	0.14879
FFUNDSRT	1959 to 2013	54	0	0.10000	5.4071	16.380	3.4471

Variable	t-adf	beta Y_lag	t-DY_lag	Maximum Lags	AIC
rm2	-1.956	0.93461	0.9578	2	-5.636
rgdp	-2.198	0.87358	1.337	2	-6.341
INFL	-1.693	0.80466	0.8232	4	3.115
Interestrt	-1.714	0.92756	0.2542	4	-0.7156
Disc	-0.5471	0.96391	-0.6173	4	0.7336
rcons	-2.302	0.76491	0.1102	4	-5.783
Dexrtend	-3.731*	0.086784	0.8326	4	-3.747

Constant and Trend Included - Critical Values; T=55; 5%=-3.49 1%=-4.13

P-values are in brackets; *** Significance level at 1%; , ** Significance level at 5%; *Significance level at 10%

Table (3a): Augmented Dickey-Fuller Tests for Unit Roots: Second Differences of Log Levels of Real Data - Sample 1959 - 2013

Variable	t-adf	beta Y_lag	t-DY_lag	Maximum Lags	AIC
DDrm2	-9.329**	-0.26068		0	-5.425
DDrgdp	-5.181**	-1.7868	1.628	4	-6.148
DDINFL	-14.87**	-0.62725		0	3.749
DDInterestrt	-6.885**	-1.5104	1.621	2	-3.656
DDDisc	-5.882**	-2.0901	1.623	3	0.9403
DDrcons	-5.475**	-2.6611	1.525	4	-5.548
DDexrtend	-6.073**	-3.4492	1.739	4	-3.156
Constant and Trend Included - Critical Values; T=55; 5%=-3.49 1%=-4.13					

P-values are in brackets

*** Significance level at 1%; , ** Significance level at 5%; *Significance level at 10%

Table (3b): Augmented Dickey-Fuller Tests for Unit Roots: First Differences of Log Levels of Real Data - Sample 1959 - 2013

Variable	t-adf	beta Y_lag	t-DY_lag	Maximum Lags	AIC
Drm2	-2.659	0.55287	-0.03925	4	-5.492
Drgdp	-2.977	0.38232	-0.9231	4	-6.265
DINFL	-3.810*	-0.85657	0.4357	4	3.169
DInterestrt	-3.467	-0.12022	0.3913	4	-3.838
DDisc	-3.393	-0.18911	0.1345	4	0.7395
Drcons	-2.879	0.024227	0.4270	4	-5.682
DDexrtend	-4.909**	-1.3961	0.2195	4	-3.524
Constant and Trend Included - Critical Values; T=55; 5%=-3.49 1%=-4.13					

P-values are in brackets

*** Significance level at 1%; , ** Significance level at 5%; *Significance level at 10%

Table (3c): Augmented Dickey-Fuller Tests for Unit Roots: Levels of Real Data - Sample 1959 - 2013

Variable	t-adf	beta Y_lag	t-DY_lag	Maximum Lags	AIC
rm2	-1.956	0.93461	0.9578	2	-5.636
rgdp	-2.198	0.87358	1.337	2	-6.341
INFL	-1.693	0.80466	0.8232	4	3.115
Interestrt	-1.714	0.92756	0.2542	4	-0.7156
Disc	-0.5471	0.96391	-0.6173	4	0.7336
rcons	-2.302	0.76491	0.1102	4	-5.783
Dexrtend	-3.731*	0.086784	0.8326	4	-3.747
Constant and Trend Included - Critical Values; T=55; 5%=-3.49 1%=-4.13					

P-values are in brackets;

*** Significance level at 1%; , ** Significance level at 5%; *Significance level at 10%

Annex II: Diagnostic Tables for Closed Economy Formulation

Table (4): Baseline Closed Economy Money Demand Model Lag Structure and Reduction Tests, Sample 1959 - 2013

	Significance of Each Lag					Joint significance of all lags	AIC	SC	F Test
Restricted Lags	**5**	**4**	**3**	**2**	**1**				
5	**2.8685 [0.0001**]**	0.77681 [0.7607]	1.2612 [0.2109]	**1.7419 [0.0297]***	**8.7956 [0.0000]****	**2.8685 [0.0001]****	3.329	8.073	F(25,94)
4		1.0083 [0.4631]	0.85883 [0.6591]	**1.7294 [0.0282]***	**8.7966 [0.0000]****	1.0083 [0.4631]	4.519	8.352	F(25,112)
3			1.0739 [0.3814]	**1.7249 [0.0264]***	**9.6736 [0.0000]****	1.0739 [0.3814]	4.359	7.278	F(25,131)
2				**2.8582 [0.0000]****	**13.112 [0.0000]****	**2.8582 [0.0000]****	**4.140**	**6.147**	F(25,150)
1					**121.86 [0.0000]****	**121.86 [0.0000]****	.NaN	.NaN	F(25,168)

P-values are in brackets ; *** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

The Closed Economy Model VAR system is presented as follows:

$$\begin{bmatrix} GDP_t \\ Interest\ Rate_t \\ Discount\ Rate_t \\ Inflation_t \end{bmatrix} = \alpha_0 + \sum_{j=1}^{3} \beta_{j,t} \begin{bmatrix} GDP_{j,t-1} \\ Interest\ Rate_{j,t-1} \\ Discount\ Rate_{j.t-1} \\ Inflation_{j,t-1} \end{bmatrix} + \text{dumm1986} + \text{dumm1991} + \text{dumm1992} + \text{dumm2008} + \text{dumm2009} + \text{dumm2010} + \text{dumm2011} + \text{dumm2012} + \text{dumm2013} + \varepsilon_t$$

Where:
GDP is in Logs
dummXXXX: dummy variable (year) ε_t: error term

Table (5): Tests on the significance of each variable

Variable	F-test Value	[Prob]
rm2	**F(15,72) = 6.2812**	**[0.0000]****
rgdp	**F(15,72) = 6.2104**	**[0.0000]****
INFL	**F(15,72) = 3.0388**	**[0.0008]****
Interestrt	**F(15,72) = 1.5745**	**[0.1000]***
DISC	**F(15,72) = 2.1325**	**[0.0174]***
dumm1986	F(5,26) = 1.5760	[0.2018]
dumm1992	**F(5,26) = 2.4659**	**[0.0589]**
dumm2008	**F(5,26) = 4.7243**	**[0.0033]****
dumm2009	**F(5,26) = 3.8180**	**[0.0100]**
dumm2010	F(5,26) = 0.40268	[0.8425]
dumm2011	**F(5,26) = 2.1938**	**[0.0857]**
dumm2012	**F(5,26) = 7.0776**	**[0.0003]****
dumm2013	**F(5,26) = 2.1997**	**[0.0850]**
dumm1991	**F(5,26) = 17.779**	**[0.0000]****
Constant	F(5,26) = 1.7887	[0.1503]

P-values are in brackets

*** Significance level at 1%; ** Significance level at 5%; * Significance level at 10%

Table (6): Residual Diagnostics Tests for the - 3 Lags VAR- Closed Economy

Money Demand Model:

Single-equation diagnostics using reduced-form residuals:
rm2 : Portmanteau(7): Chi^2(4) = 7.5270 [0.1105]
rm2 : AR 1-2 test: F(2,28) = 0.32520 [0.7251]
rm2 : ARCH 1-1 test: F(1,53) = 2.2940 [0.1358]
rm2 : Normality test: Chi^2(2) = 0.32008 [0.8521]
rm2 : Hetero test: F(30,15) = 1.5193 [0.1974]
rm2 : Hetero-X test: not enough observations
rgdp : Portmanteau(7): Chi^2(4) = 6.4001 [0.1712]
rgdp : AR 1-2 test: F(2,28) = 0.37855 [0.6883]
rgdp : ARCH 1-1 test: F(1,53) = 0.78215 [0.3805]
rgdp : Normality test: Chi^2(2) = 1.1438 [0.5644]
rgdp : Hetero test: F(30,15) = 2.8876 [0.0167]*
rgdp : Hetero-X test: not enough observations
INFL : Portmanteau(7): Chi^2(4) = 3.5036 [0.4773]
INFL : AR 1-2 test: F(2,28) = 1.2216 [0.3100]
INFL : ARCH 1-1 test: F(1,53) =0.00096847 [0.9753]
INFL : Normality test: Chi^2(2) = 1.8518 [0.3962]
INFL : Hetero test: F(30,15) = 0.67094 [0.8287]
INFL : Hetero-X test: not enough observations
Interestrt : Portmanteau(7): Chi^2(4) = 7.8441 [0.0975]
Interestrt : AR 1-2 test: F(2,28) = 4.3289 [0.0230]*
Interestrt : ARCH 1-1 test: F(1,53) =0.00044828 [0.9832]
Interestrt : Normality test: Chi^2(2) = 42.311 [0.0000]**
Interestrt : Hetero test: F(30,15) = 0.58780 [0.8949]
Interestrt : Hetero-X test: not enough observations
DISC : Portmanteau(7): Chi^2(4) = 7.5435 [0.1098]
DISC : AR 1-2 test: F(2,28) = 1.1853 [0.3205]
DISC : ARCH 1-1 test: F(1,53) = 0.021263 [0.8846]
DISC : Normality test: Chi^2(2) = 17.203 [0.0002]**
DISC : Hetero test: F(30,15) = 0.85468 [0.6554]
DISC : Hetero-X test: not enough observations
Vector Portmanteau(7): Chi^2(100)= 164.09 [0.0001]**
Vector AR 1-2 test: F(50,76) = 1.0344 [0.4409]
Vector Normality test: Chi^2(10) = 44.957 [0.0000]**
Vector ZHetero test: F(150,59) = 1.1354 [0.2926]
ZHetero-X test: not enough observations

Table 7(a): Baseline - 3 Lags VAR- Closed Economy Money Demand Model Cointegration Analysis with Johansen Test: sample 1959–2013

rank	eigenvalue	Log likihood for rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0		**4.707021**	**109.70** **[0.000]****	**52.21** **[0.000]****	**79.78** **[0.029]***	**37.97** **[0.017]***
1	0.61296	30.81082	**57.49** **[0.023]***	24.16 [0.171]	41.81 [0.388]	17.57 [0.622]
2	0.35550	42.89089	33.33 [0.077]	15.28 [0.365]	24.24 [0.452]	11.12 [0.740]
3	0.24261	50.53262	18.05 [0.098]	12.20 [0.180]	13.12 [0.362]	8.88 [0.459]
4	0.19900	56.63454	5.84 [0.210]	5.84 [0.210]	4.25 [0.388]	4.25 [0.387]
5	0.10078	59.55572				

P-values are in brackets, *** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

Table 7(b): Eigen vector of the variables entering into the respective cointegrating vector					
beta (scaled on diagonal; cointegrating vectors in columns					
rm2	1.0000	-0.47695	165.25	21.856	-6.0917
rgdp	-1.2264	1.0000	-259.85	-30.087	8.5706
INFL	0.013214	0.024104	1.0000	-1.2279	-0.086809
Interestrt	0.37234	0.00087224	-17.559	1.0000	-1.3580
DISC	-0.35275	-0.074257	7.6098	-0.41313	1.0000
Constant	1.7232	-2.6453	695.39	71.806	-15.638
alpha					
rm2	-0.088507	0.18350	-0.00024601	0.0010006	0.0032835
rgdp	-0.038323	0.082962	0.00037222	0.0013230	-0.00055115
INFL	7.6654	-5.7450	-0.0025741	0.014953	0.67741
Interestrt	-0.83995	-0.20789	0.0060341	-0.030286	0.047328
DISC	0.77753	1.3702	0.0060106	-0.026798	0.028332

Table 7(c): Reduced Rank Standardized Coefficients (with one covariance)				
	Beta Vector	Std Err	Alpha Vector	Std Err
rm2	1.0000	0.00000	-0.041544	0.016867
rgdp	-1.0351	0.084268	-0.025441	0.010118
INFL	0.00000	0.00000	3.7152	1.0861
Interestrt	0.82178	0.15918	-0.59177	0.14166
DISC	-0.69302	0.10365	0.00000	0.00000
Constant	0.00000	0.00000		

Table 7(d): Hypotheses Tests for the Beta Vector			
rm2	Zero	Chi^2(1)	5.6395 [0.0176]*
rgdp	Zero	Chi^2(1)	3.9278 [0.0475]*
INFL	Zero	Chi^2(1)	1.5497 [0.2132]
Interestrt	Zero	Chi^2(1)	25.429 [0.0000]**
DISC	Zero	Chi^2(1)	24.227 [0.0000]**
Constant	Zero	Chi^2(1)	1.4148 [0.2343]
Joint Significance for betas (including constant)	Zero	Chi^2(5)	32.104 [0.0000]**
Joint Significance for betas (excluding constant)	Zero	Chi^2(4)	32.063 [0.0000]** [strong evidence that rm2 is non stationary]
Joint Significance for Betas for (INFL and Constant)	**Zero**	**Chi^2(2)**	**4.9499 [0.0842]**
Joint Significance for Betas for (INFL and Constant) and alpha for (rm2)	Zero	Chi^2(2)	10.602 [0.0141]*

Table 7(e): Hypotheses Tests for the Alpha Vector: Weak Exogeneity and Joint Tests:			
rm2	**Zero**	**Chi^2(1)**	**6.1845 [0.0129]***
rgdp	**Zero**	**Chi^2(1)**	**3.3496 [0.0672]**
INFL	**Zero**	**Chi^2(1)**	**12.546 [0.0004]****
Interestrt	**Zero**	**Chi^2(1)**	**6.1643 [0.0130]***
DISC	**Zero**	**Chi^2(1)**	**4.2857 [0.0384]***
Joint Significance for alphas	**Zero**	**Chi^2(4)**	**32.175 [0.0000]****
Joint Significance for alphas and betas	**Zero**	**Chi^2(9)**	**50.635 [0.0000]****
Joint Significance for alpha of (rgdp), Interestrt and INFL	**Zero**	**Chi^2(3)**	**17.956 [0.0004]****
Joint Significance for alpha of (rgdp), Interestrt, INFL and betas of (INFL and Constant)	**Zero**	**Chi^2(5)**	**33.825 [0.0000]****
Joint Significance for alpha of (rgdp) and betas of (INFL and Constant)	**Zero**	**Chi^2(3)**	**9.562010 [0.0277]***
Joint Significance for alpha of (DISC) and betas of (INFL and Constant)	**Zero**	**Chi^2(3)**	**7.0710 [0.0697]**
Joint Significance for alpha of (DISC), (rgdp) and betas of (INFL and Constant)	**Zero**	**Chi^2(4)**	**13.440 [0.0093]****
Joint Significance for alphas of (DISC and rm2) and betas of (INFL and Constant)	**Zero**	**Chi^2(4)**	**13.559 [0.0088]****
Joint Significance for alphas of (DISC, rgdp and rm2) and betas of (INFL and Constant)	**Zero**	**Chi^2(5)**	**14.599 [0.0122]***
alpha of (DISC) and betas of (INFL and Constant) are jointly zero and the betas for Interest and Disc have opposite signs		**Chi^2(3)**	**7.1491 [0.0673]**

P-values are in brackets, *** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

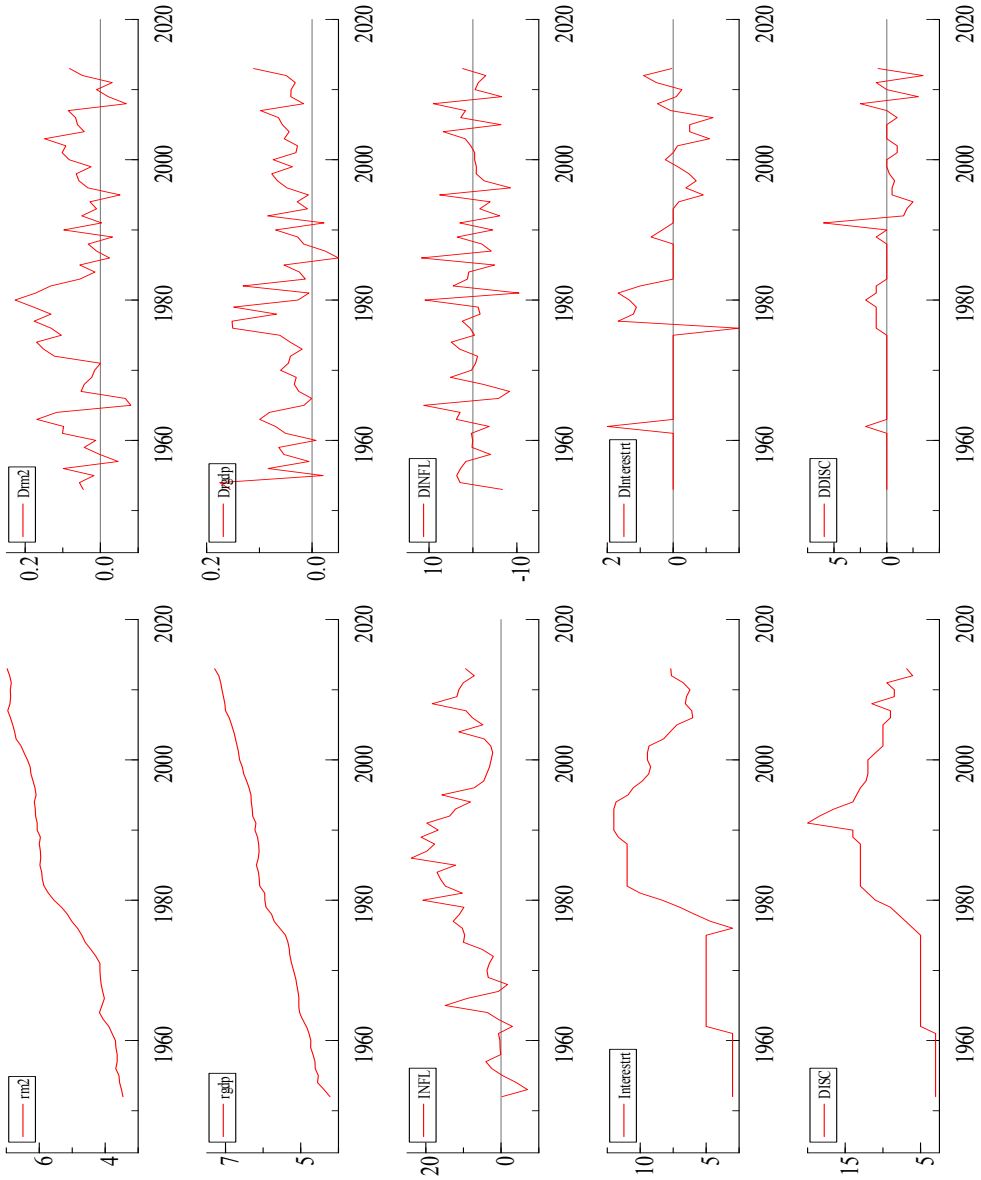
Table 7(f): Parsimonious/Reduced VECM – Closed Economy:

```
MOD(62) Estimating the model by FIML
        The dataset is: C:\EGYMDJAN20151965.in7
        The estimation sample is: 1959 - 2013

Equation for: Drm2
                  Coefficient  Std.Error  t-value  t-prob
Drm2_1               0.678687    0.08360     8.12  0.0000
CIa_1               -0.0160414   0.006776   -2.37  0.0237
dumm2008             -0.115021    0.04550   -2.53  0.0163

sigma = 0.0584738

Equation for: Drgdp
                  Coefficient  Std.Error  t-value  t-prob
DINFL_1           -0.00456193  0.0008713   -5.24  0.0000
DInterestrt_1      -0.0221933   0.005650   -3.93  0.0004
Drm2_2               0.459160    0.06025    7.62  0.0000
CIa_1               -0.0166841   0.004290   -3.89  0.0004
dumm1986            -0.0604373    0.02730   -2.21  0.0336
dumm2013             0.126706    0.02703    4.69  0.0000

sigma = 0.0347738

Equation for: DINFL
                  Coefficient  Std.Error  t-value  t-prob
Drgdp_1              32.5405      10.29     3.16  0.0033
DINFL_1             -0.377184     0.1063   -3.55  0.0012
Drm2_2               15.4206      7.047     2.19  0.0356
CIa_1                2.19206     0.4763     4.60  0.0001
dumm1986             7.19174      3.288     2.19  0.0357
dumm2008             7.16930      3.263     2.20  0.0349

sigma = 3.54329

Equation for: DInterestrt
                  Coefficient  Std.Error  t-value  t-prob
Drm2_1               2.68178      1.574     1.70  0.0975
Drgdp_1             -4.20947      2.275   -1.85  0.0729
DINFL_1            0.0292526    0.01732     1.69  0.1004
DDISC_1             0.550912    0.09303     5.92  0.0000
Drm2_2              -3.90089      1.442   -2.70  0.0106
DInterestrt_2       0.183695     0.1110     1.65  0.1072
CIa_1               -0.497069     0.1093   -4.55  0.0001
dumm1992            -5.41473     0.9314   -5.81  0.0000
dumm2009            -2.67578     0.6491   -4.12  0.0002
dumm2010            0.991003     0.5750     1.72  0.0939
dumm2013             2.82036     0.6527     4.32  0.0001

sigma = 0.502194

log-likelihood      31.986552  -T/2log|Omega|     344.153029
no. of observations        55  no. of parameters          26
```

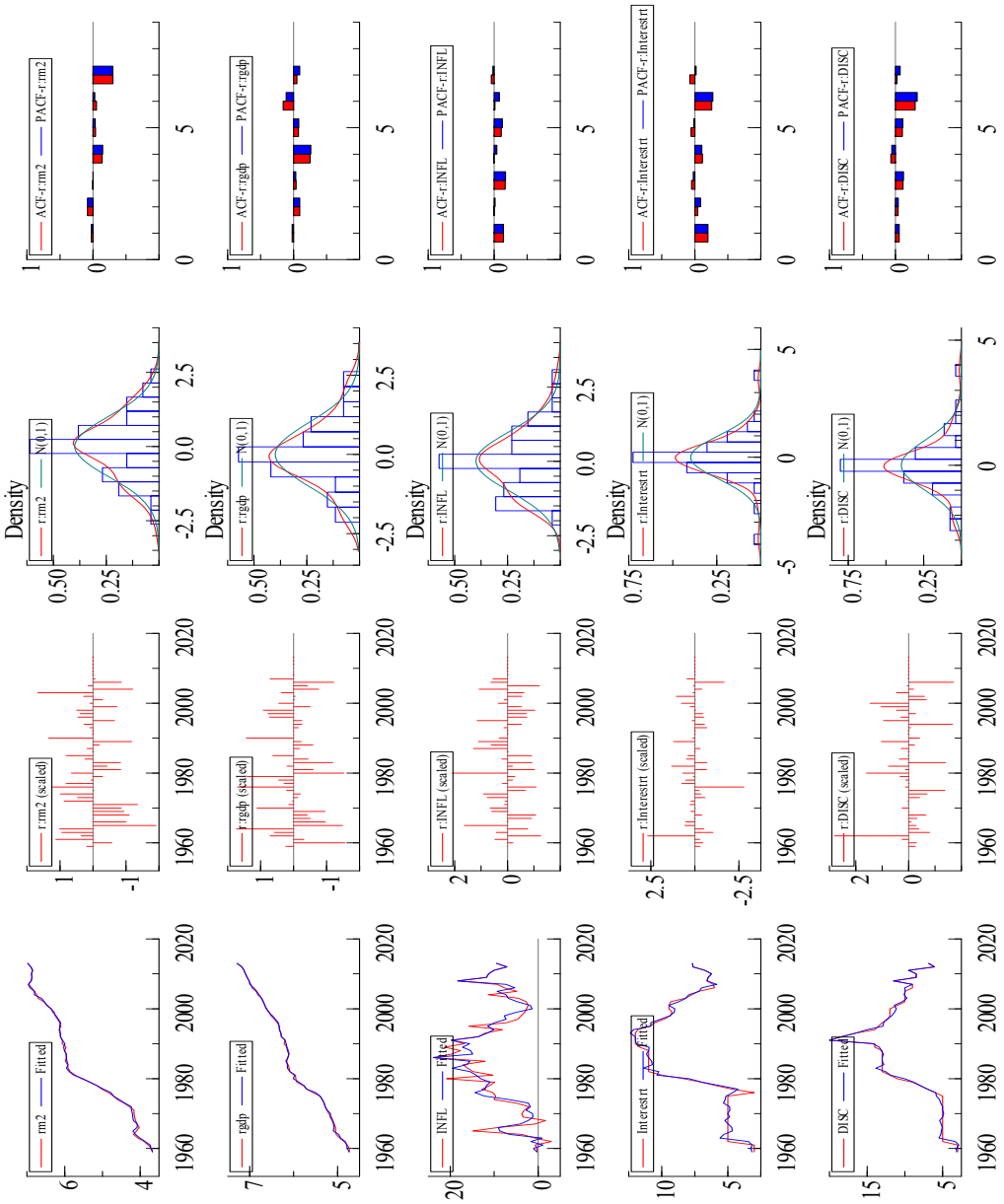
```
   LR test of over-identifying restrictions: Chi^2(58) =   77.674 [0.0433]*
   BFGS using analytical derivatives (eps1=0.0001; eps2=0.005):
   Strong convergence

Single-equation diagnostics using reduced-form residuals:
Drm2        : AR 1-2 test:      F(2,50)   =  0.62435 [0.5397]
Drm2        : ARCH 1-1 test:    F(1,53)   =   1.1254 [0.2936]
Drm2        : Normality test:   Chi^2(2)  =   2.4337 [0.2962]
Drm2        : Hetero test:      F(4,50)   =  0.67772 [0.6106]
Drgdp       : AR 1-2 test:      F(2,47)   =   2.0747 [0.1369]
Drgdp       : ARCH 1-1 test:    F(1,53)   =  0.17532 [0.6771]
Drgdp       : Normality test:   Chi^2(2)  = 0.064306 [0.9684]
Drgdp       : Hetero test:      F(8,46)   =  0.88164 [0.5391]
DINFL       : AR 1-2 test:      F(2,47)   =   2.4575 [0.0966]
DINFL       : ARCH 1-1 test:    F(1,53)   =  0.61288 [0.4372]
DINFL       : Normality test:   Chi^2(2)  =  0.82793 [0.6610]
DINFL       : Hetero test:      F(8,46)   =   1.5749 [0.1587]
DInterestrt : AR 1-2 test:      F(2,42)   =   3.1256 [0.0543]
DInterestrt : ARCH 1-1 test:    F(1,53)   = 0.087662 [0.7683]
DInterestrt : Normality test:   Chi^2(2)  =   21.788 [0.0000]**
DInterestrt : Hetero test:      F(14,40)  =  0.45759 [0.9423]

Vector SEM-AR 1-2 test:  F(32,141) =  0.91562 [0.6010]
Vector Normality test:   Chi^2(8)  =   28.903 [0.0003]**
Vector ZHetero test:     F(96,109) =   1.0398 [0.4205]
```

Annex III: Graphical Representation and Diagnostics for Closed Economy Formulation

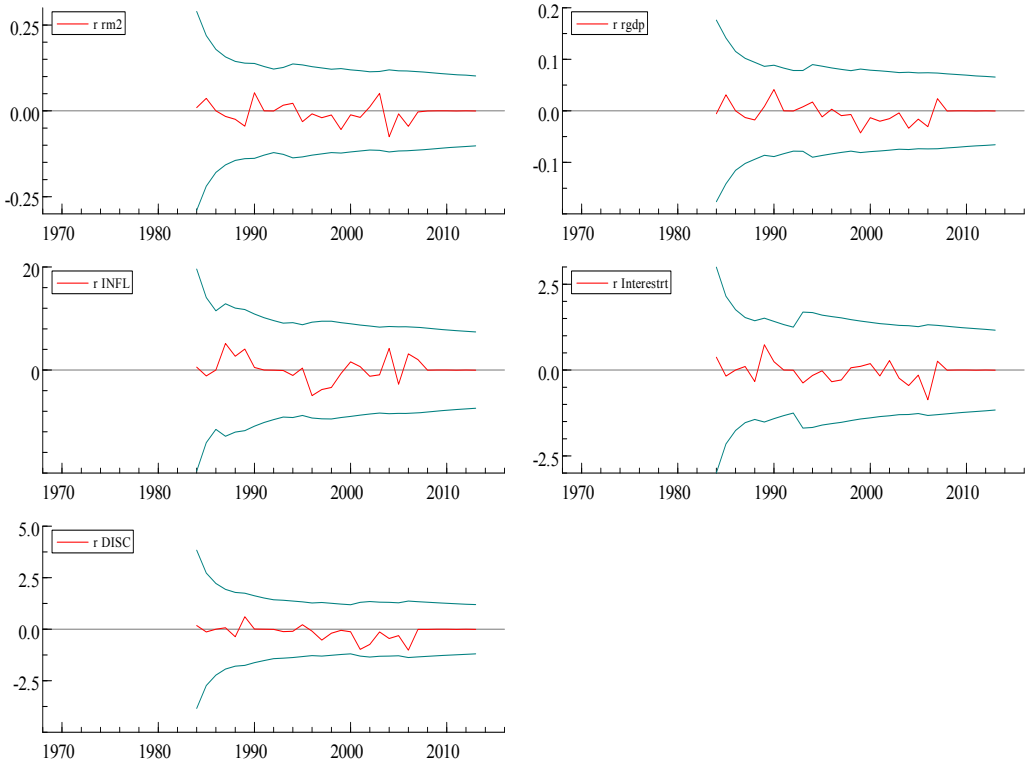
Graph (1): Plot of Log of Levels and First Differences of Logs of Variables for Closed Economy VAR:



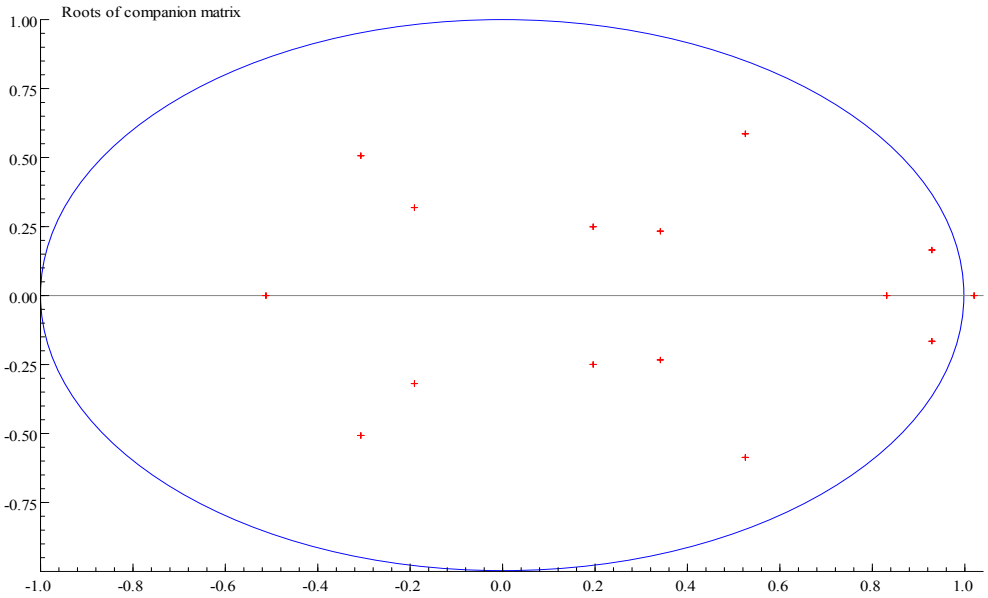
Graph (2): Diagnostic Graphs of - 3 Lags VAR- Closed Economy VAR



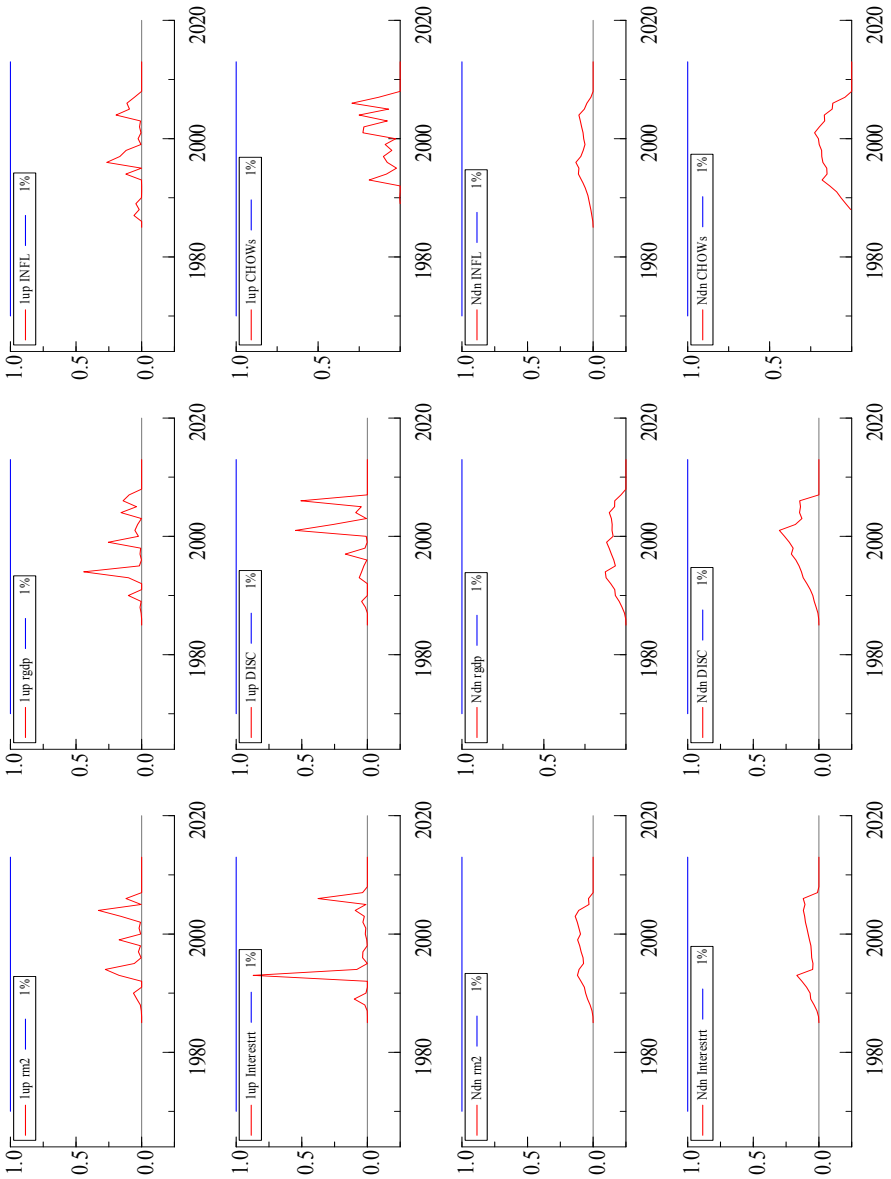
Graph (3a): Scaled Residuals - 3 Lags VAR- Closed Economy VAR



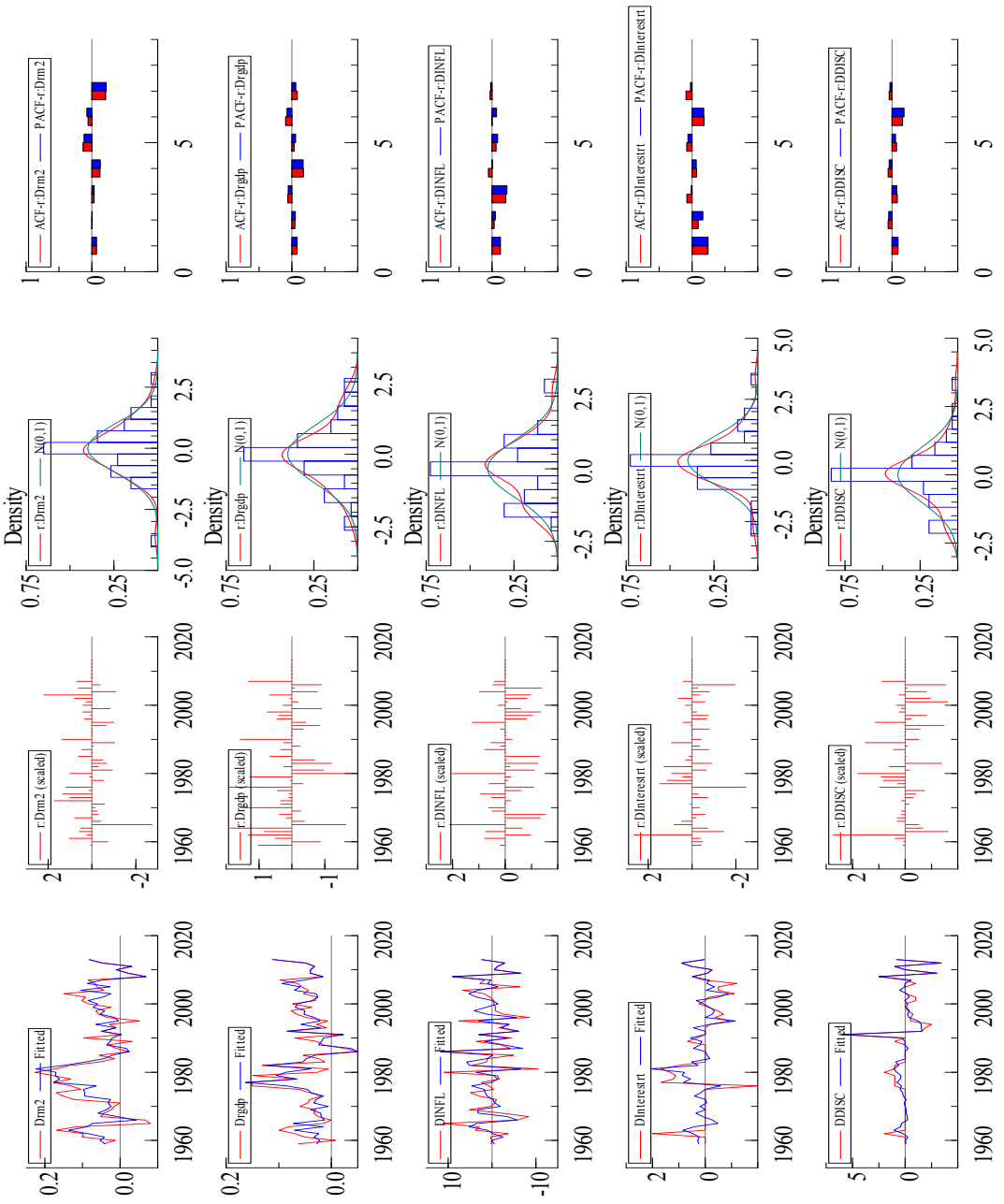
Graph (3b): Long Run Stability Test of - 3 Lags VAR- Closed Economy VAR



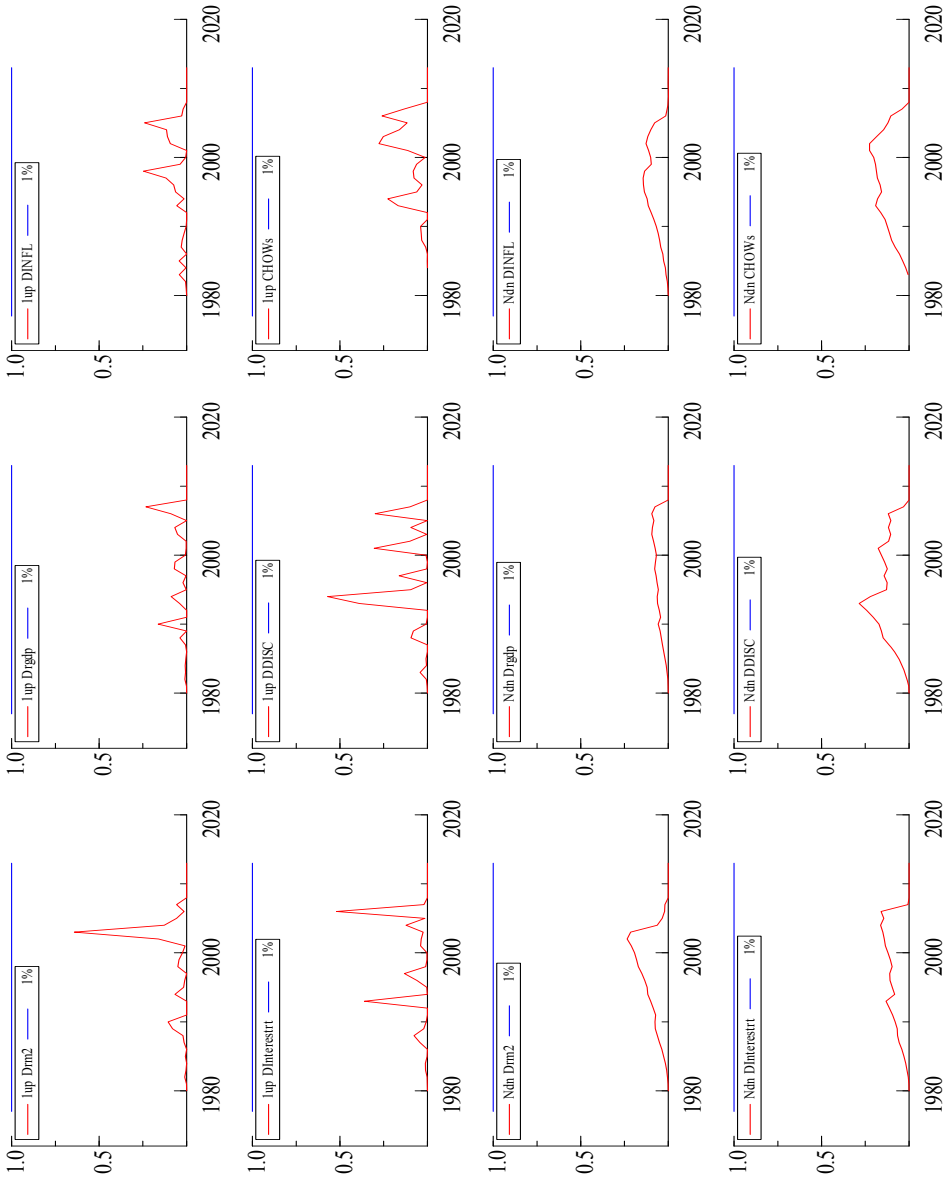
Graph (4): Stability Test (One Step and N Down Chow Test) of - 3 Lags VAR- Closed Economy VAR



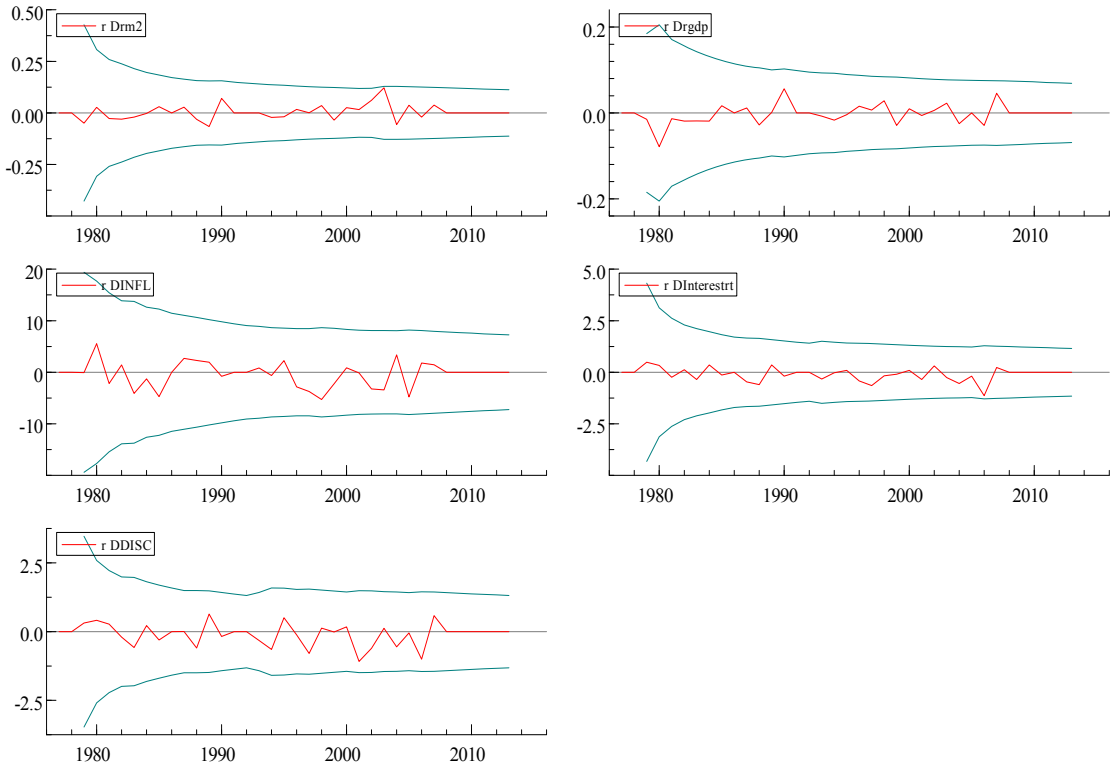
Graph (5): Diagnostic Graphs of Unrestricted Closed Economy VECM:



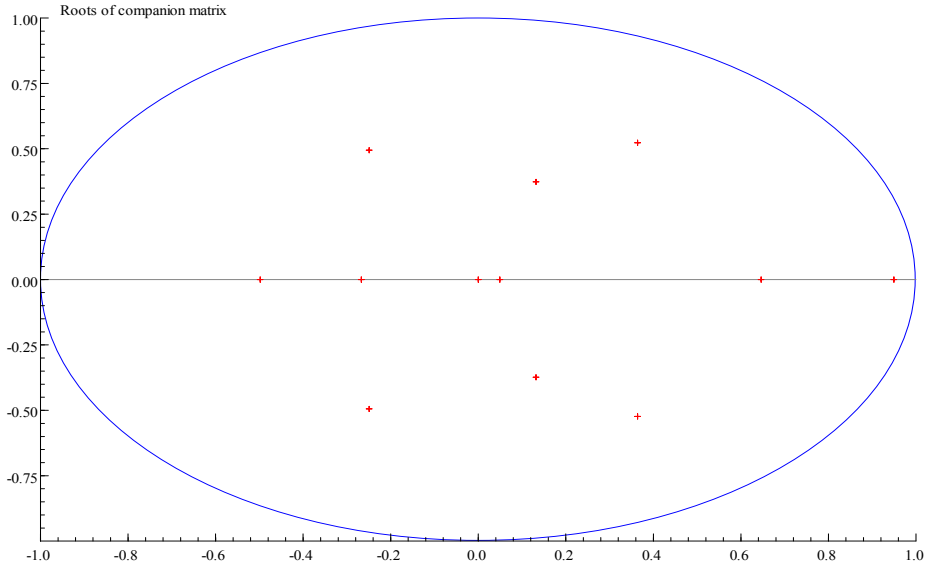
Graph (6): Stability (One Step and N Down Chow Test) of Unrestricted Closed Economy VECM:



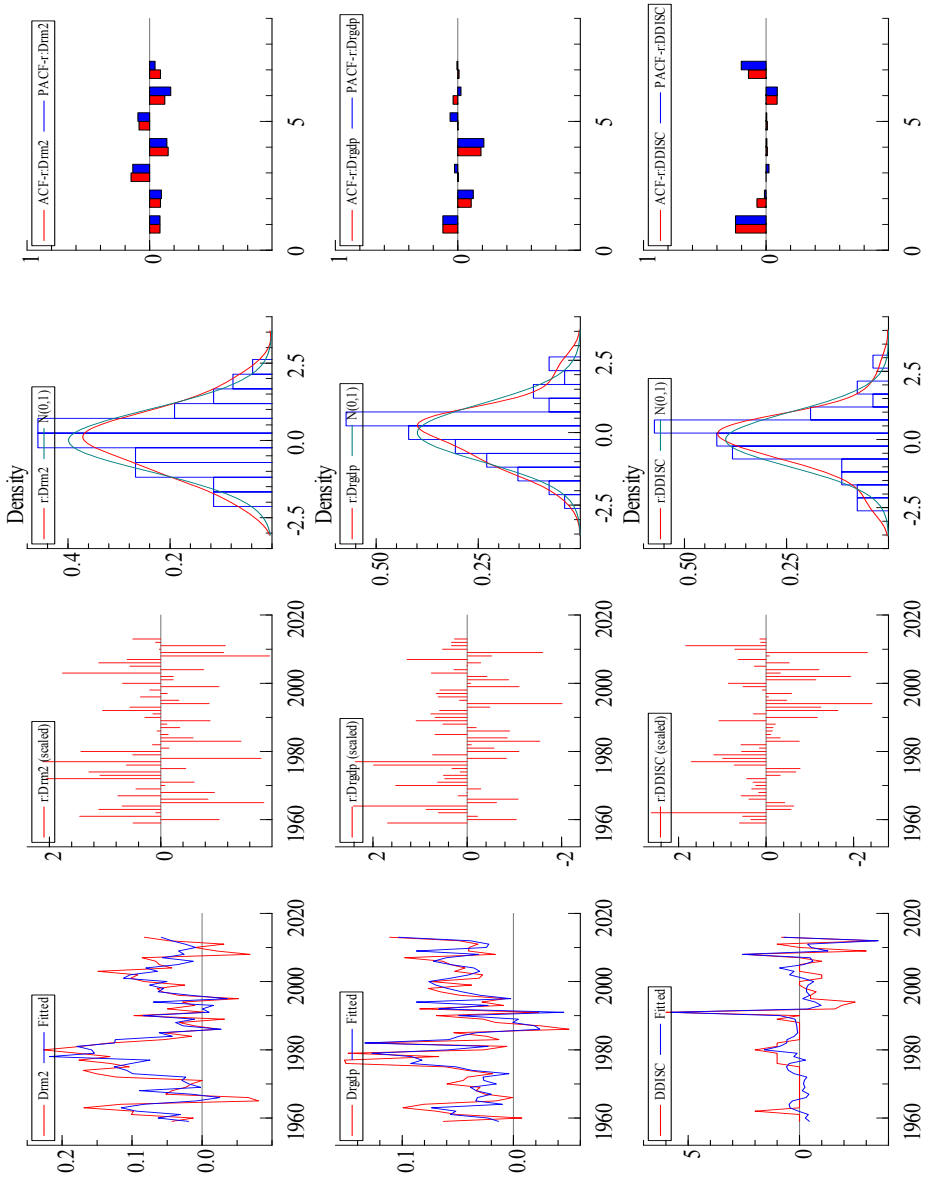
Graph (7a): Scaled Residuals of Unrestricted Closed Economy VECM:



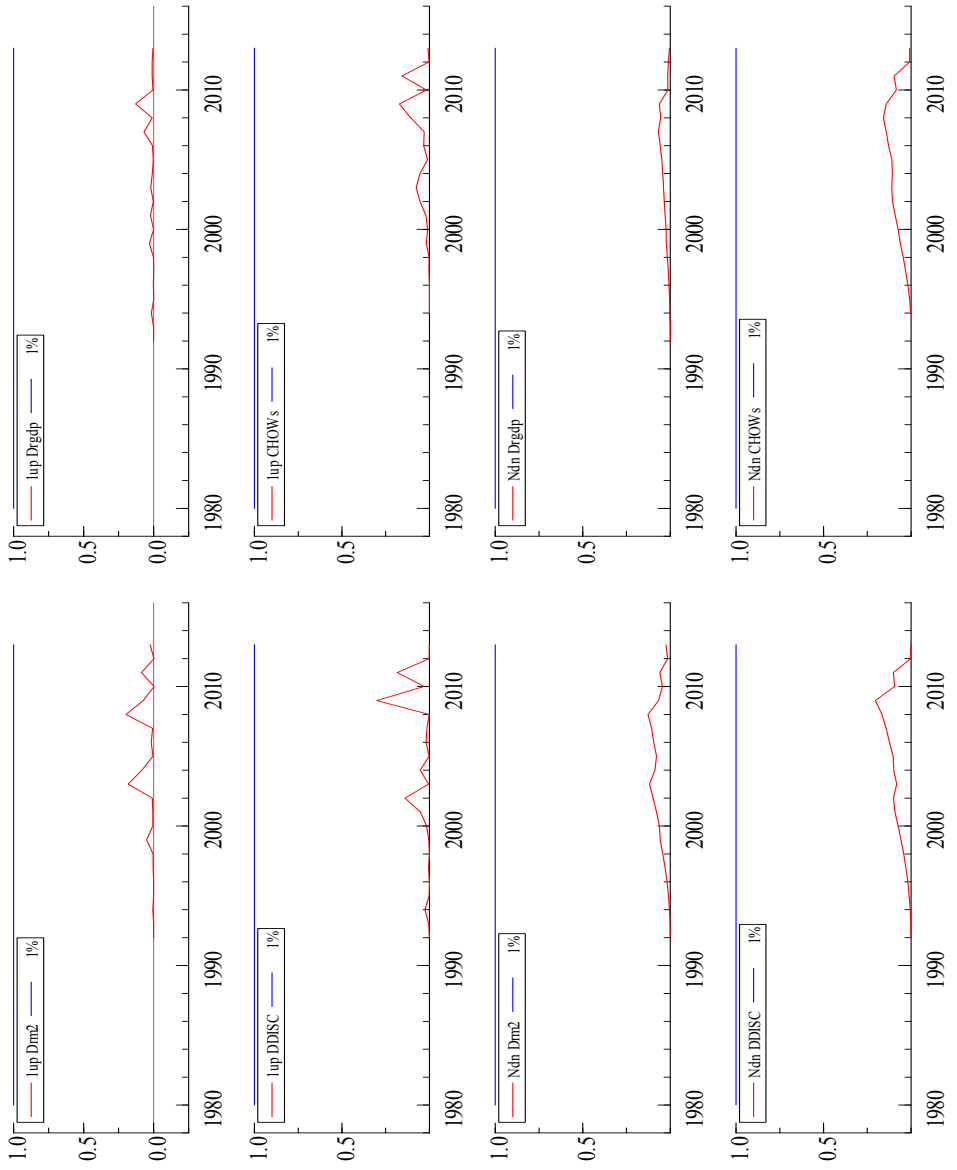
Graph (7b): Long Run Stability Test of Unrestricted Closed Economy VECM:



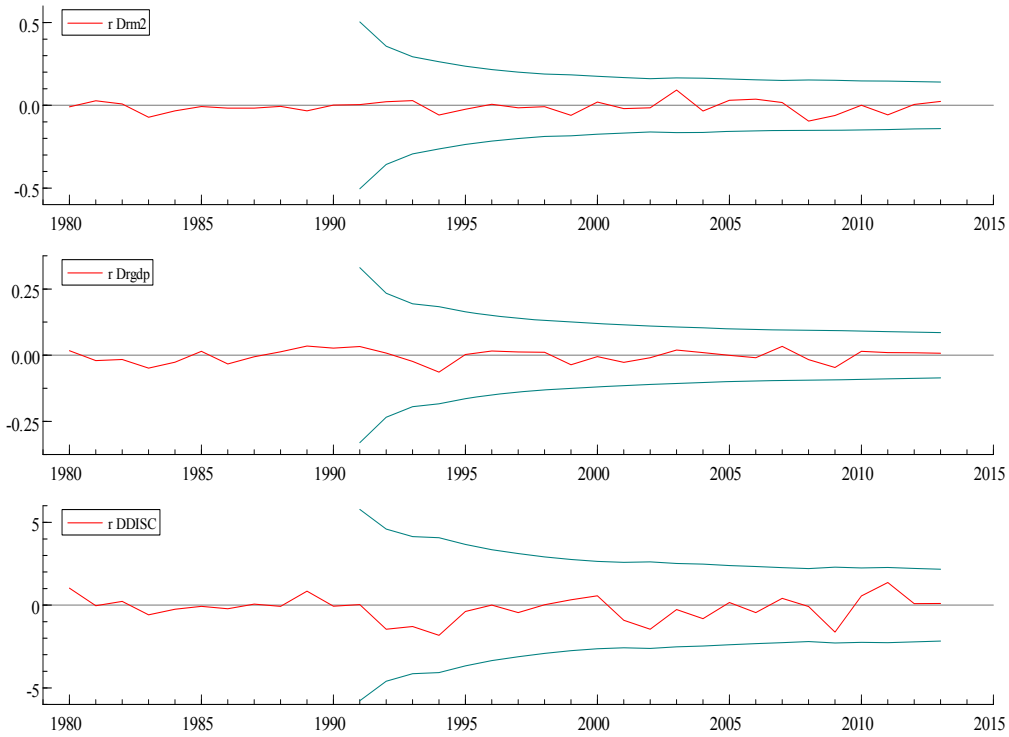
Graph (8): Diagnostic Graphs of Parsimonious Closed Economy VECM:



Graph (9): Stability (One Step and N Down Chow Test) of Parsimonious Closed Economy VECM:



Graph (10): Scaled Residuals of Parsimonious Closed Economy VECM:



Annex IV: Diagnostic Tables for Open Economy Formulation

Table (8): Baseline Open Economy Money Demand Model Lag Structure and Reduction Tests, Sample 1959 - 2013

	Significance of Each Lag					Joint significance of all lags	AIC	SC	F Test
Restricted Lags	**5**	**4**	**3**	**2**	**1**				
5	1.3603 [0.1449]	0.65583 [0.9116]	1.1394 [0.3226]	1.5240 [0.0743]	**4.5069 [0.0000]****	1.3603 [0.1449]	0.256	8.359	F(36,59)
4		1.1279 [0.3196]	1.1682 [0.2757]	1.5371 [0.0544]	**6.0894 [0.0000]****	1.1279 [0.3196]	1.573	8.361	F(36,86)
3			1.0946 [0.3514]	**1.9038 [0.0057]****	**7.3171 [0.0000]****	1.0946 [0.3514]	1.959	7.433	F(36,112)
2				**1.8907 [0.0048]****	**8.4633 [0.0000]****	**1.8907 [0.0048]****	1.968	6.129	F(36,138)
1					**70.426 [0.0000]****	**70.426 [0.0000]****	2.410	5.257	F(36,165)

P-values are in brackets ; *** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

The Open Economy Model VAR System is presented as follows:

$$\begin{bmatrix} GDP_t \\ Interest\ Rate_t \\ Discount\ Rate_t \\ Inflation_t \\ Exchange\ Rate_t \end{bmatrix} = \alpha_0 + \sum_{j=1}^{3} \beta_{j,t} \begin{bmatrix} GDP_{j,t-1} \\ Interest\ Rate_{j,t-1} \\ Discount\ Rate_{j.t-1} \\ Inflation_{j,t-1} \\ Exchange\ Rate_{j,t-1} \end{bmatrix} + \text{dumm1976} + \text{dumm1986} + \text{dumm1990} + \text{dumm2008} + \text{dumm2009} + \text{dumm2013} + \varepsilon_t$$

Where:
GDP and Exchange Rate are in Logs
dummXXXX: dummy variable ε_t: error term

Table 9: Tests on the significance of each variable

Variable	F-test Value	[Prob]
rm2	**F(18,71) = 7.3925**	**[0.0000]****
rgdp	**F(18, 71) = 6.3452**	**[0.0000]****
INFL	**F(18, 71) = 3.1743**	**[0.0003]****
Interestrt	**F(18, 71) = 1.7739**	**[0.0462]***
DISC	F(18, 71) = 1.4601	[0.1007]
Dexrtend	**F(18, 71) = 3.2265**	**[0.0002]****
FFUNDSRT	F(6, 25) = 1.3779	[0.2620]
dumm1976	**F(6,30) = 5.4211**	**[0.0007]****
dumm1986	**F(6, 25) = 2.5657**	**[0.0448]***
dumm1990	**F(6, 25) = 4.0413**	**[0.0058]****
dumm2008	**F(6, 25) = 3.7728**	**[0.0082]****
dumm2009	F(6, 25) = 1.0373	[0.4251]
dumm2013	**F(6, 25) = 4.7097**	**[0.0025]****
Constant	F(6, 25) = 0.78440	[0.5903]

P-values are in brackets

*** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

Table 10: Residual Diagnostics Tests for the - 3 Lags VAR- Open Economy Money Demand Model

Single-equation diagnostics using reduced-form residuals:
rm2 : Portmanteau(7): Chi^2(4) = 4.4285 [0.3511]
rm2 : AR 1-2 test: F(2,27) = 1.3448 [0.2775]
rm2 : ARCH 1-1 test: F(1,53) = 0.034285 [0.8538]
rm2 : Normality test: Chi^2(2) = 6.3129 [0.0426]*
rm2 : Hetero test: F(38,10) = 1.7061 [0.1851]
rgdp : Portmanteau(7): Chi^2(4) = 8.0445 [0.0900]
rgdp : AR 1-2 test: F(2,27) = 0.82838 [0.4476]
rgdp : ARCH 1-1 test: F(1,53) = 1.0172 [0.3178]
rgdp : Normality test: Chi^2(2) = 0.066368 [0.9674]
rgdp : Hetero test: F(38,10) = 1.2495 [0.3708]
INFL : Portmanteau(7): Chi^2(4) = 5.8932 [0.2073]
INFL : AR 1-2 test: F(2,27) = 0.29108 [0.7498]
INFL : ARCH 1-1 test: F(1,53) = 0.21295 [0.6464]
INFL : Normality test: Chi^2(2) = 7.2488 [0.0267]*
INFL : Hetero test: F(38,10) = 1.7271 [0.1794]
Interestrt : Portmanteau(7): Chi^2(4) = 7.1310 [0.1291]
Interestrt : AR 1-2 test: F(2,27) = 1.0070 [0.3786]
Interestrt : ARCH 1-1 test: F(1,53) = 0.11425 [0.7367]
Interestrt : Normality test: Chi^2(2) = 15.172 [0.0005]**
Interestrt : Hetero test: F(38,10) = 0.70863 [0.7873]
DISC : Portmanteau(7): Chi^2(4) = 8.5992 [0.0719]
DISC : AR 1-2 test: F(2,27) = 2.2083 [0.1294]
DISC : ARCH 1-1 test: F(1,53) =0.00045357 [0.9831]
DISC : Normality test: Chi^2(2) = 5.2131 [0.0738]
DISC : Hetero test: F(38,10) = 1.3958 [0.2962]
Dexrtend : Portmanteau(7): Chi^2(4) = 7.0328 [0.1342]
Dexrtend : AR 1-2 test: F(2,27) = 1.1939 [0.3185]
Dexrtend : ARCH 1-1 test: F(1,53) = 0.090908 [0.7642]
Dexrtend : Normality test: Chi^2(2) = 37.593 [0.0000]**
Dexrtend : Hetero test: F(38,10) = 2.0481 [0.1129]
Vector Portmanteau(7): Chi^2(144)= 204.79 [0.0007]**
Vector AR 1-2 test: F(72,71) = 1.2269 [0.1949]
Vector Normality test: Chi^2(12) = 59.437 [0.0000]**
Vector ZHetero test: F(228,38) = 1.7474 [0.0206]*
Vector RESET23 test: F(72,71) = 2.2173 [0.0005]**

Table 11 (a): Baseline Open Economy Money Demand Model Cointegration Analysis with Johansen Test: sample 1959–2013

rank	eigenvalue	Log likihood for rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0		30.84816	165.81 [0.000]**	68.82 [0.000]**	111.55 [0.013]*	46.30 [0.008]**
1	0.71387	65.25920	96.99 [0.001]**	36.22 [0.030]*	65.25 [0.283]	24.37 [0.509]
2	0.48240	83.36951	60.77 [0.010]*	24.04 [0.177]	40.88 [0.432]	16.17 [0.732]
3	0.35405	95.38802	36.73 [0.032]*	16.86 [0.251]	24.71 [0.423]	11.34 [0.720]
4	0.26405	103.8194	19.87 [0.055]	15.02 [0.067]	13.37 [0.343]	10.10 [0.336]
5	0.23897	111.3292				
6	0.084384	113.7536				

P-values are in brackets *** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

Table 11(b): Reduced Rank Standardized Coefficients

	Beta Vector	Std Err	Alpha Vector	Std Err
rm2	1.0000	0.00000	-0.030553	0.0079880
rgdp	-1.2990	0.084212	-0.019096	0.0040082
Interestrt	1.2506	0.17615	0.00000	0.00000
DISC	-1.0733	0.14192	0.70952	0.13679
Dexrtend	8.5118	1.4804	0.00000	0.00000
INFL	0.13232	0.028321	0.00000	0.00000
Constant	0.00000	0.00000		
FFUNDSRT	0.00000	0.00000		

Table 11(c): Hypotheses Tests for the Beta Vector

rm2	Zero	Chi^2(1)	5.1698 [0.0230]*
rgdp	Zero	Chi^2(1)	4.8416 [0.0278]*
Interestrt	Zero	Chi^2(1)	18.221 [0.0000]**
DISC	Zero	Chi^2(1)	25.228 [0.0000]**
Dexrtend	Zero	Chi^2(1)	27.786 [0.0000]**
INFL	Zero	Chi^2(1)	8.2673 [0.0040]**
Constant	Zero	Chi^2(1)	1.6581 [0.1979]
FFUNDSRT	Zero	Chi^2(1)	3.5538 [0.0594]
Joint Significance for beta	Zero	Chi^2(7)	54.023 [0.0000]** strong evidence that rm2 is non stationary]
Joint Significance for FFUNDSRT and Constant	Zero	Chi^2(2)	4.5538 [0.1026]

P-values are in brackets

*** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

Table 11(d): Hypotheses Tests for the Alpha Vector: Weak Exogeneity and Joint Tests			
rm2	Zero	Chi^2(1)	14.854 [0.0001]**
rgdp	Zero	Chi^2(1)	19.511 [0.0000]**
Interestrt	Zero	Chi^2(1)	1.9441 [0.1632]
DISC	Zero	Chi^2(1)	14.246 [0.0002]**
Dexrtend	Zero	Chi^2(1)	1.6468 [0.1994]
INFL	Zero	Chi^2(1)	3.2193 [0.0728]
Joint Significance for alphas	Zero	Chi^2(5)	56.676 [0.0000]**
Joint Significance for alphas and betas	Zero	Chi^2(12)	67.720 [0.0000]**
Joint Significance for alphas of (Interestrt), (Dexrtend), (INFL)	Zero	Chi^2(3)	5.6872 [0.1279]
Joint Significance for alphas of (Interestrt), (Dexrtend), (INFL) and beta of (Constant)	Zero	Chi^2(4)	7.6792 [0.1041]
Joint Significance for alphas of (Interestrt), (Dexrtend), (INFL) and beta of (Constant) and FFUNDSRT	**Zero**	**Chi^2(5)**	**10.497 [0.0623]**
Joint Significance for alphas of (Interestrt), (Dexrtend), (INFL) (rm2) and beta of (Constant) and FFUNDSRT	Zero	Chi^2(6)	27.040 [0.0001]**

P-values are in brackets.

*** Significance level at 1%; , ** Significance level at 5%; * Significance level at 10%

Table 11(e): Parsimonious/Reduced VECM – Open Economy:

```
MOD(40) Estimating the model by FIML
        The dataset is: C:\EGYMDJAN20151965.in7
        The estimation sample is: 1959 - 2013

Equation for: Drm2
                  Coefficient  Std.Error  t-value  t-prob
Drm2_1               0.824396    0.08354     9.87  0.0000
DDexrtend_1          0.216645    0.04725     4.59  0.0001
CIa_1             -0.00845390   0.003614    -2.34  0.0284
DInterestrt_1       0.0200135   0.009229     2.17  0.0407
DINFL             -0.00827521   0.001606    -5.15  0.0000
Dexrtprmium_1      -0.0697568    0.02559    -2.73  0.0121

sigma = 0.048086

Equation for: Drgdp
                  Coefficient  Std.Error  t-value  t-prob
DDexrtend_1          0.138573    0.02646     5.24  0.0000
DINFL_1           -0.00358828  0.0008716    -4.12  0.0004
Drm2_2               0.449434    0.05028     8.94  0.0000
CIa_1              -0.0134603   0.002299    -5.85  0.0000
dumm2013             0.141293    0.02480     5.70  0.0000
DINFL             -0.00415356  0.0009212    -4.51  0.0002
Dexrtprmium         0.0269767    0.01445     1.87  0.0747

sigma = 0.0292693

Equation for: DDISC
                  Coefficient  Std.Error  t-value  t-prob
Drm2_1               4.77892      1.173     4.08  0.0005
CIa_1               0.243018    0.05456     4.45  0.0002
dumm1991             4.03556     0.7739     5.21  0.0000
dumm2008             2.93144     0.7183     4.08  0.0005
dumm2012            -2.77136     0.7128    -3.89  0.0007

sigma = 0.743813

log-likelihood     164.125872  -T/2log|Omega|      398.25073
no. of observations        55  no. of parameters          18

LR test of over-identifying restrictions: Chi^2(78) =   204.33 [0.0000]**
BFGS using analytical derivatives (eps1=0.0001; eps2=0.005):
Strong convergence

correlation of structural residuals (standard deviations on diagonal)
               Drm2        Drgdp        DDISC
Drm2       0.048086      0.48753      0.12477
Drgdp       0.48753     0.029269      0.35703
DDISC       0.12477      0.35703      0.74381

Single-equation diagnostics using reduced-form residuals:
Drm2        : AR 1-2 test:      F(2,47)   =   2.0385 [0.1416]
Drm2        : ARCH 1-1 test:    F(1,53)   = 0.056382 [0.8132]
Drm2        : Normality test:   Chi^2(2)  =0.0076428 [0.9962]
Drm2        : Hetero test:      F(12,42)  =   1.5524 [0.1440]
Drgdp       : AR 1-2 test:      F(2,46)   =   1.5290 [0.2276]
Drgdp       : ARCH 1-1 test:    F(1,53)   =  0.23856 [0.6273]
Drgdp       : Normality test:   Chi^2(2)  =  0.95285 [0.6210]
Drgdp       : Hetero test:      F(12,42)  =  0.92158 [0.5346]
```

```
DDISC       : AR 1-2 test:      F(2,48)   =   1.9985 [0.1467]
DDISC       : ARCH 1-1 test:    F(1,53)   = 0.060582 [0.8065]
DDISC       : Normality test:   Chi^2(2)  =   4.4283 [0.1092]
DDISC       : Hetero test:      F(4,50)   =   1.5092 [0.2137]

Vector SEM-AR 1-2 test:  F(18,116) =   1.1388 [0.3248]
Vector Normality test:   Chi^2(6)  =   3.6767 [0.7203]
Hetero test: not enough observations

Long-run matrix Pi(1)-I = Po
               Drm2         Drgdp         DDISC           CIa
Drm2       -0.17560       0.00000       0.00000    -0.0084539
Drgdp       0.44943       -1.0000       0.00000     -0.013460
DDISC        4.7789       0.00000       -1.0000       0.24302
CIa         -4.8888       0.00000       0.00000      -0.25181

Long-run covariance
               Drm2         Drgdp         DDISC           CIa
Drm2         24.862        17.874        1.5310       -491.43
Drgdp        17.874        12.852        1.0983       -353.41
DDISC        1.5310        1.0983      0.097207       -30.140
CIa         -491.43       -353.41       -30.140        9721.0

Static long run
         DInterestrt     DDexrtend         DINFL      dumm1976      dumm1986
Drm2         -1.9736       -6.1318       -1.1137       0.00000       0.00000
Drgdp        -1.4706       -4.6766      -0.80647       0.00000       0.00000
DDISC         1.1063        7.8774      0.061736       0.00000       0.00000
CIa           43.362        153.00        22.154       0.00000       0.00000
            dumm1990      dumm2008      dumm2009      dumm2013      dumm1991
Drm2         0.00000        9.2070       0.00000       0.53708        12.675
Drgdp        0.00000        6.7122       0.00000       0.53284        9.2403
DDISC        0.00000       0.45443       0.00000      -0.14449       0.62559
CIa          0.00000       -191.25       0.00000       -11.156       -263.28
            dumm2012      FFUNDSRT   Dexrtprmium         rcons
Drm2         -8.7042       0.00000       -5.7733       0.00000
Drgdp        -6.3456       0.00000       -4.0709       0.00000
DDISC       -0.42961       0.00000      -0.45202       0.00000
CIa           180.80       0.00000        111.67       0.00000

Standard errors of static long run
         DInterestrt     DDexrtend         DINFL      dumm1976      dumm1986
Drm2           18.368        59.643        9.9053       0.00000       0.00000
Drgdp          13.185        42.839        7.1093       0.00000       0.00000
DDISC          1.1749        3.7828       0.63463       0.00000       0.00000
CIa            362.25        1177.7        195.31       0.00000       0.00000
            dumm1990      dumm2008      dumm2009      dumm2013      dumm1991
Drm2         0.00000        82.959       0.00000        4.8545        114.55
Drgdp        0.00000        59.546       0.00000        3.4866        82.230
DDISC        0.00000        5.3099       0.00000       0.31012        7.3227
CIa          0.00000        1635.8       0.00000        95.749        2259.5
            dumm2012      FFUNDSRT   Dexrtprmium         rcons
Drm2           78.670       0.00000        50.910       0.00000
Drgdp          56.474       0.00000        36.535       0.00000
DDISC          5.0290       0.00000        3.2683       0.00000
CIa            1551.8       0.00000        1003.7       0.00000

Mean-lag matrix sum pi_i:
               Drm2         Drgdp         DDISC           CIa
Drm2         0.82440       0.00000       0.00000    -0.0084539
Drgdp        0.89887       0.00000       0.00000     -0.013460
DDISC         4.7789       0.00000       0.00000       0.24302
CIa          -5.4726       0.00000       0.00000       0.74819
```

Eigenvalues of long-run matrix:

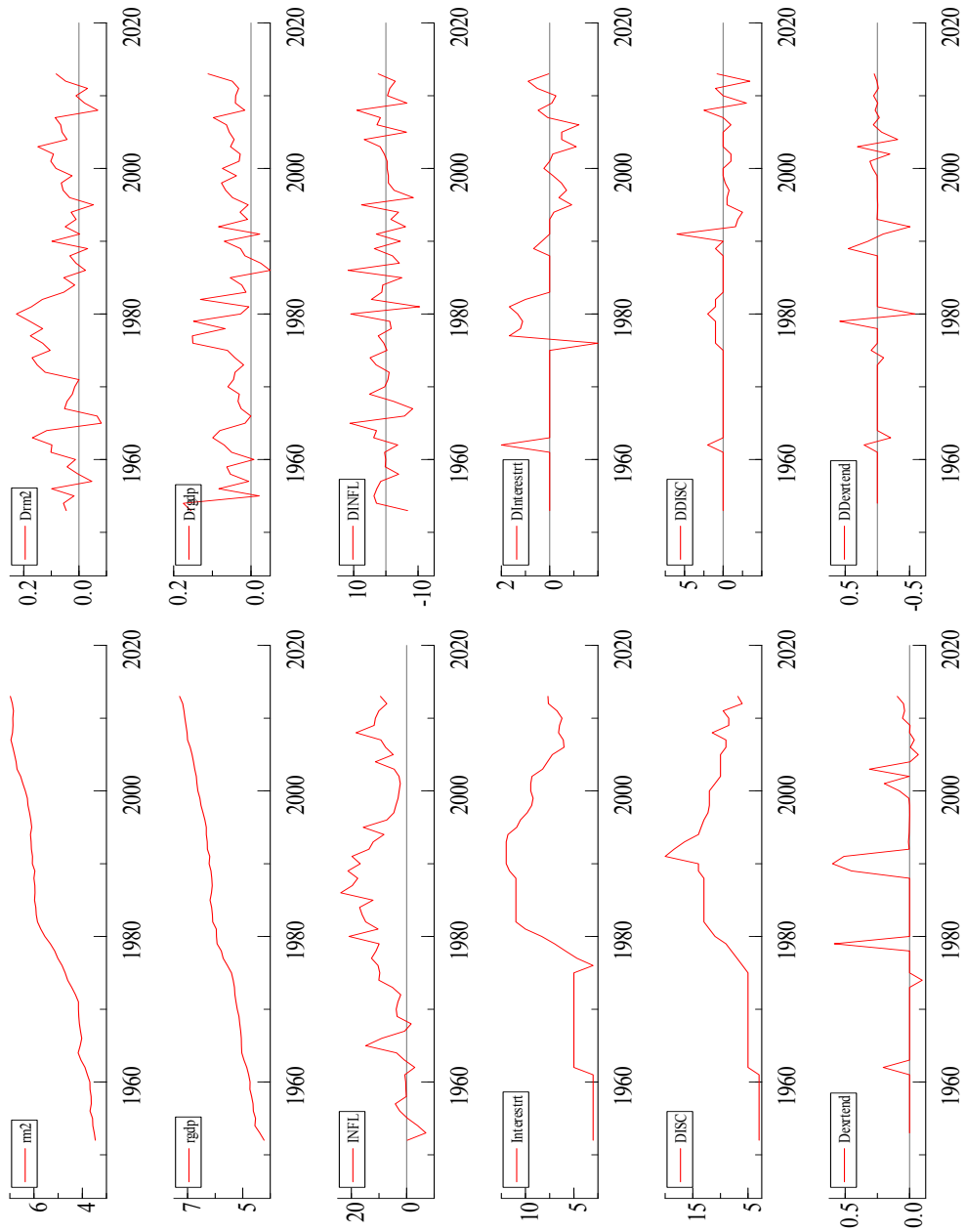
real	imag	modulus
-1.000	0.0000	1.000
-1.000	0.0000	1.000
-0.4205	0.0000	0.4205
-0.006870	0.0000	0.006870

I(2) matrix Gamma:

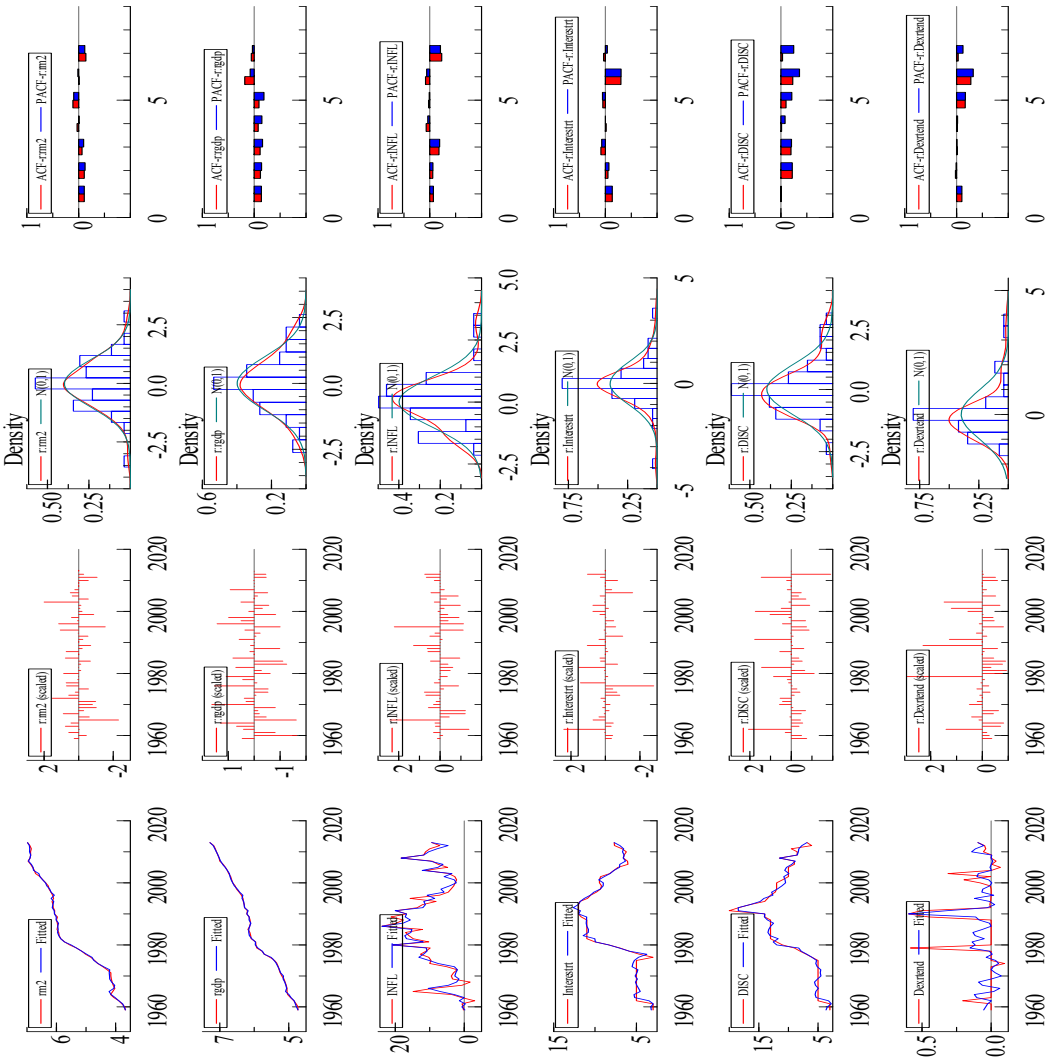
	Drm2	Drgdp	DDISC	CIa
Drm2	1.0000	0.00000	0.00000	0.00000
Drgdp	0.44943	1.0000	0.00000	0.00000
DDISC	0.00000	0.00000	1.0000	0.00000
CIa	-0.58382	0.00000	0.00000	1.0000

Annex V: Graphical Representation and Diagnostics for Open Economy Formulation

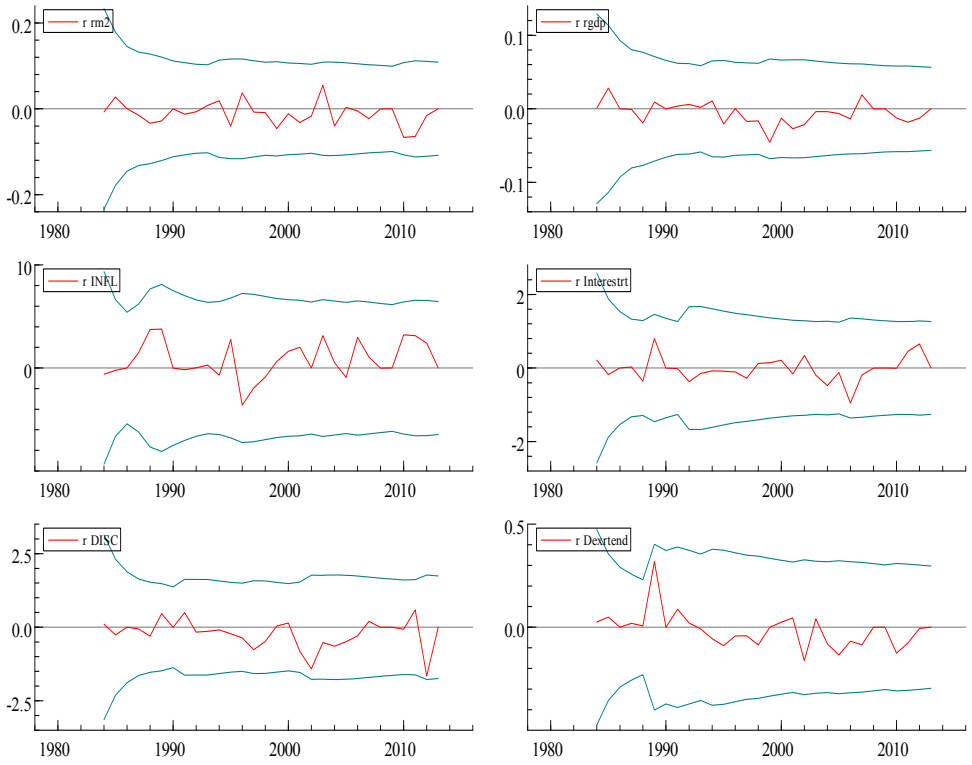
Graph (11): Plot of Levels and First Differences of Variables for Open Economy VAR



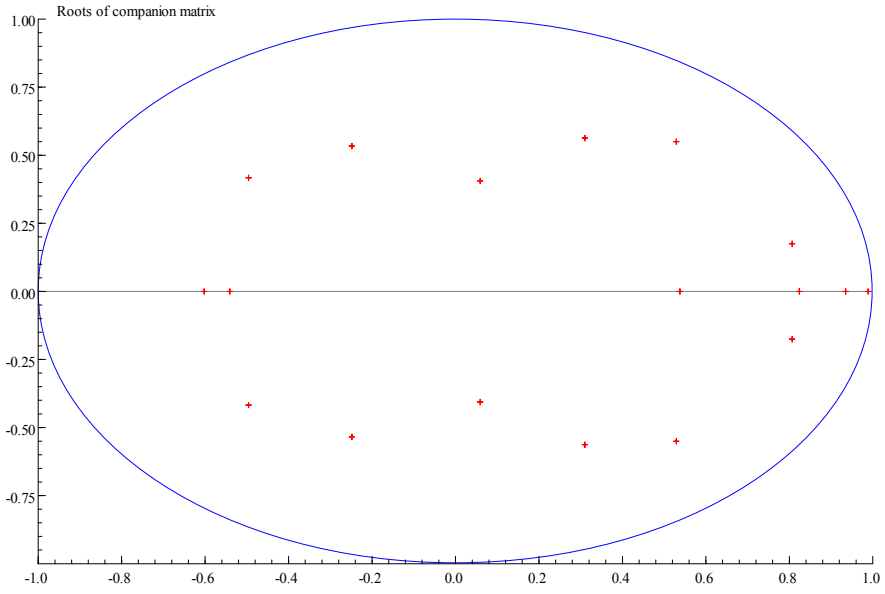
Graph (12): Diagnostic Graphs of - 3 Lags - Closed Economy VAR



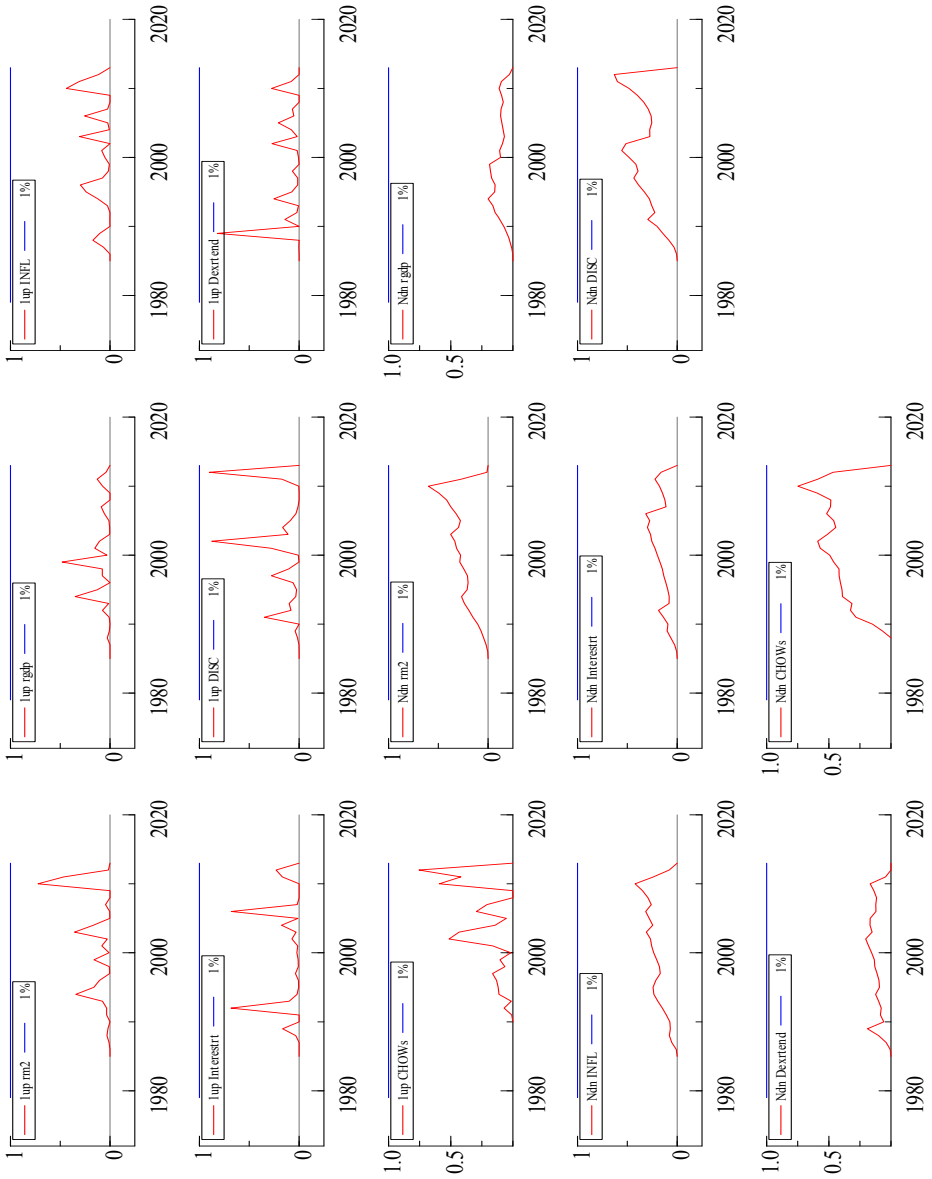
Graph (13a): Scaled Residuals - 3 Lags - Open Economy VAR



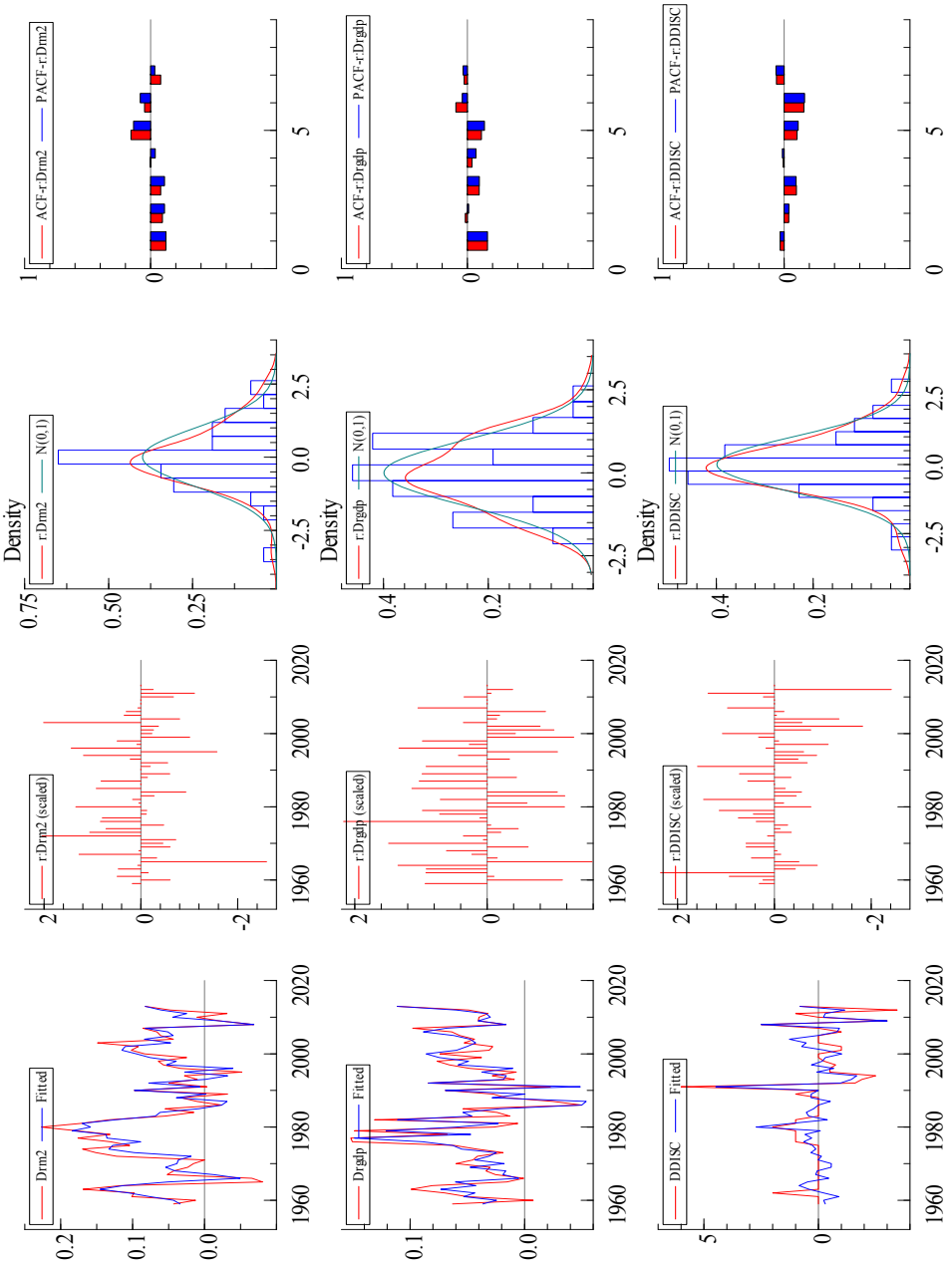
Graph (13b): Long Run Stability Test of - 3 Lags - Open Economy VAR



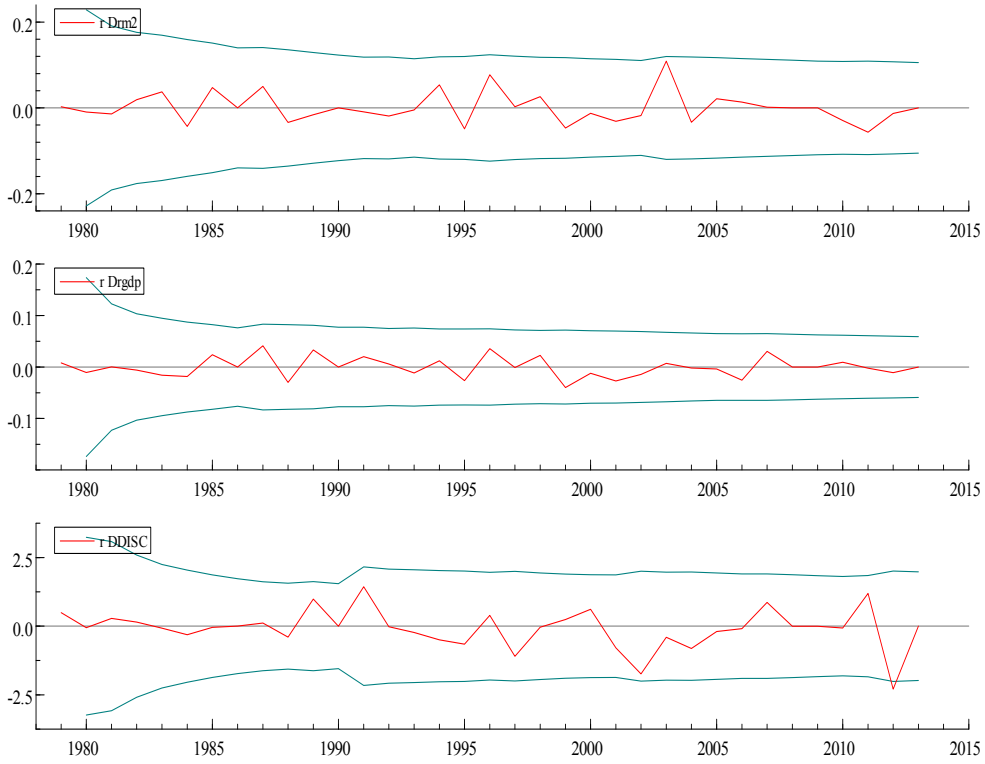
Graph (14): Stability (One Step and N Down Chow Test) Test of - 3 Lags - Open Economy VAR:



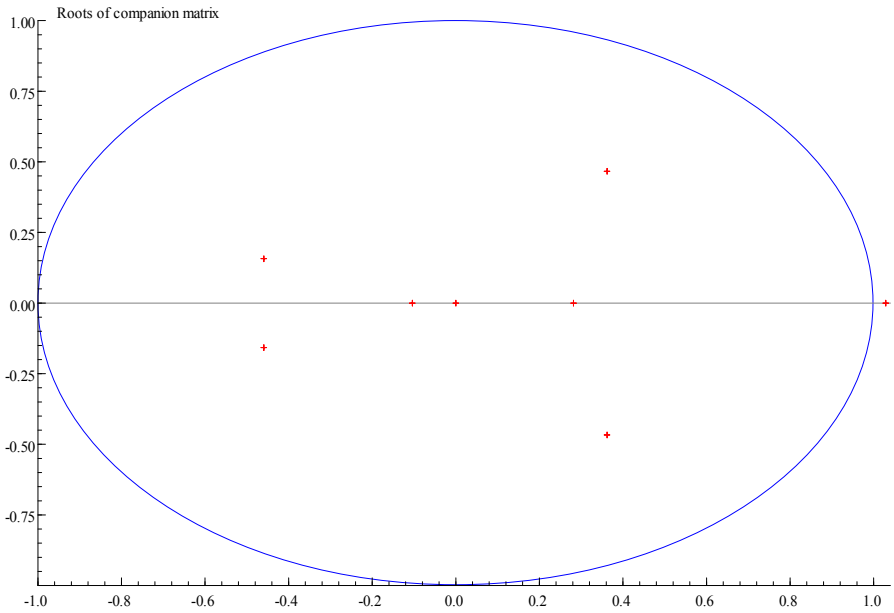
Graph (15): Diagnostic Graphs of Unrestricted Open Economy VECM:



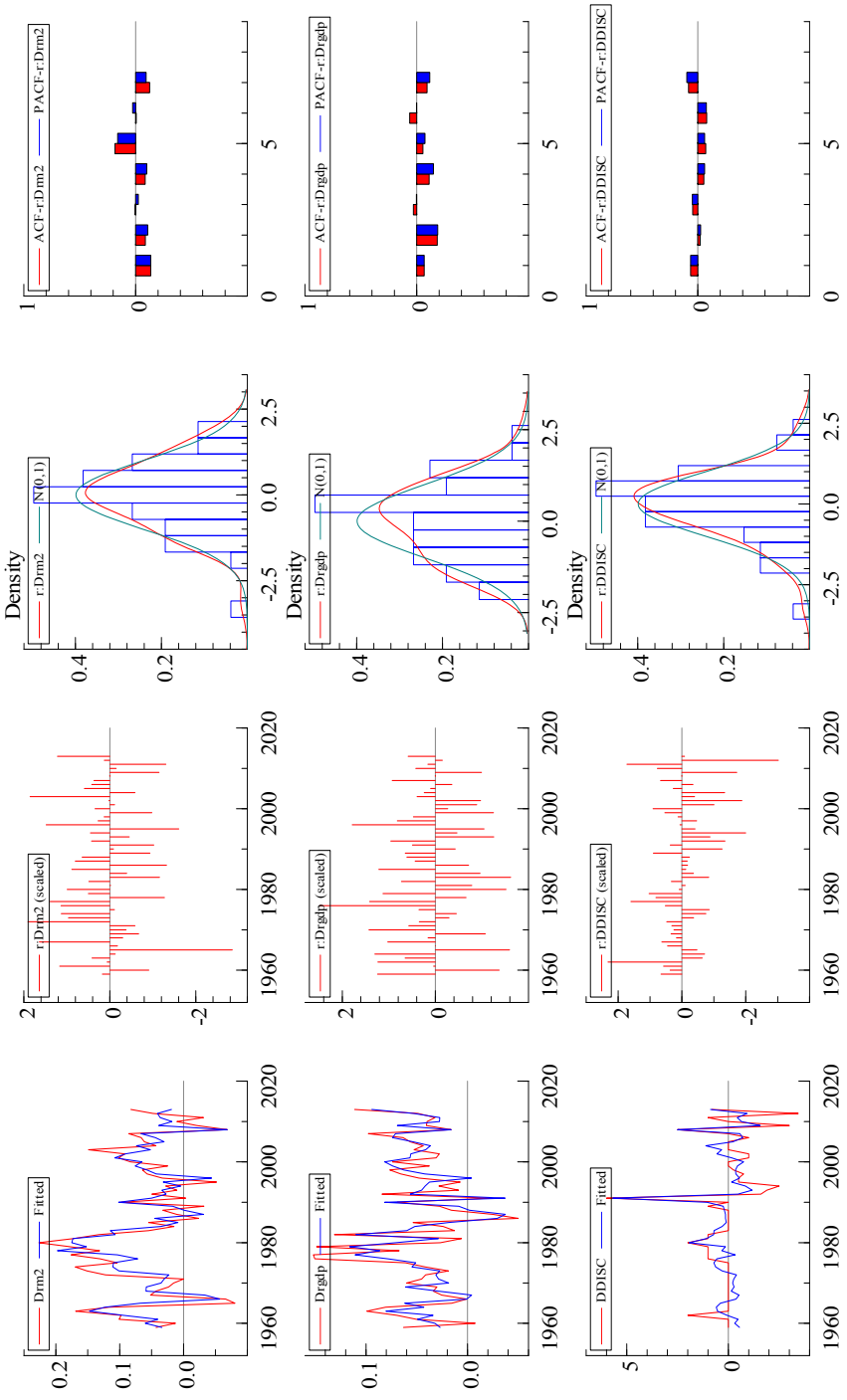
Graph (16a): Scaled Residuals of Unrestricted Open Economy VECM:



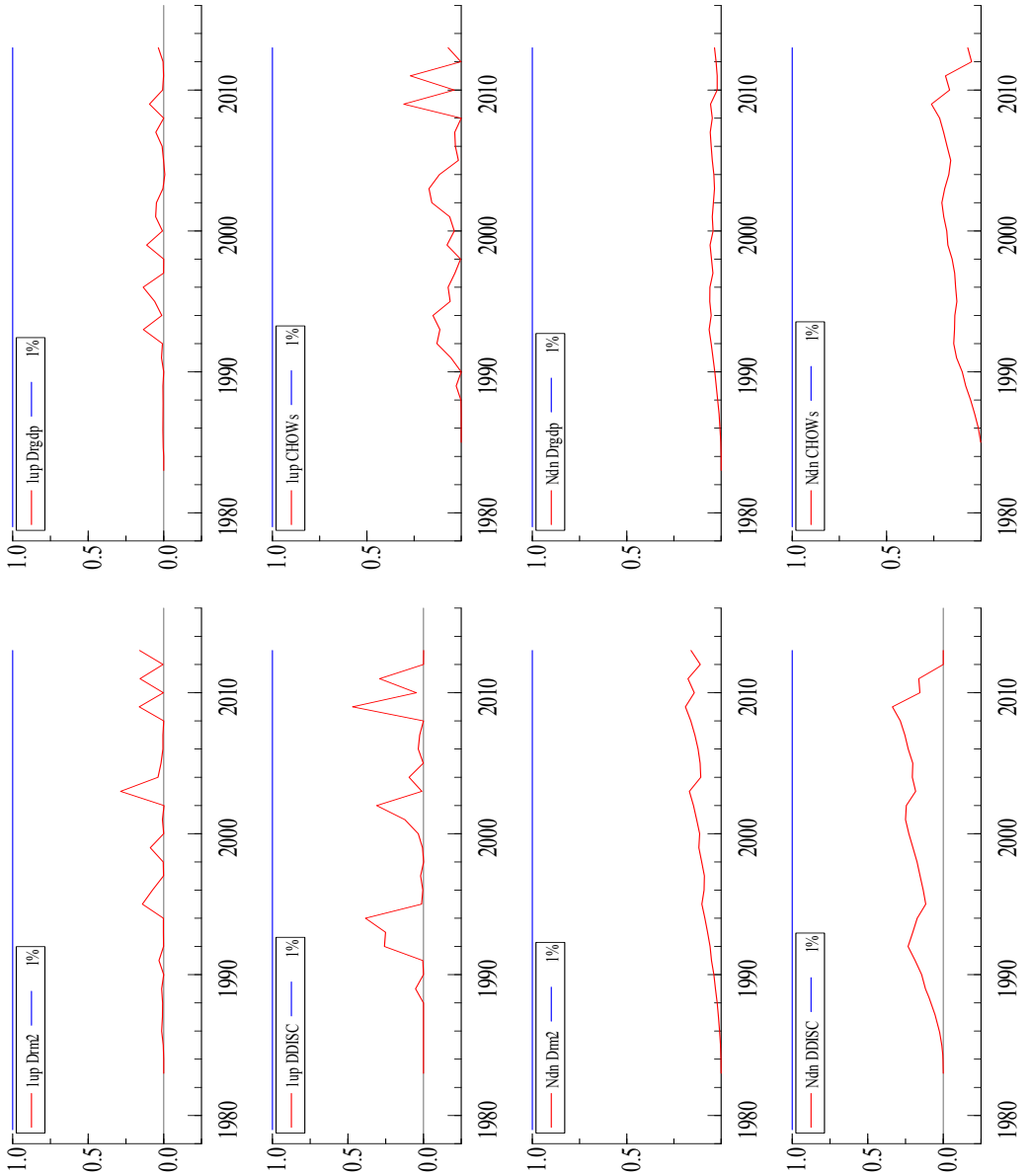
Graph (16b): Long Run Stability Test of Unrestricted Open Economy VECM:



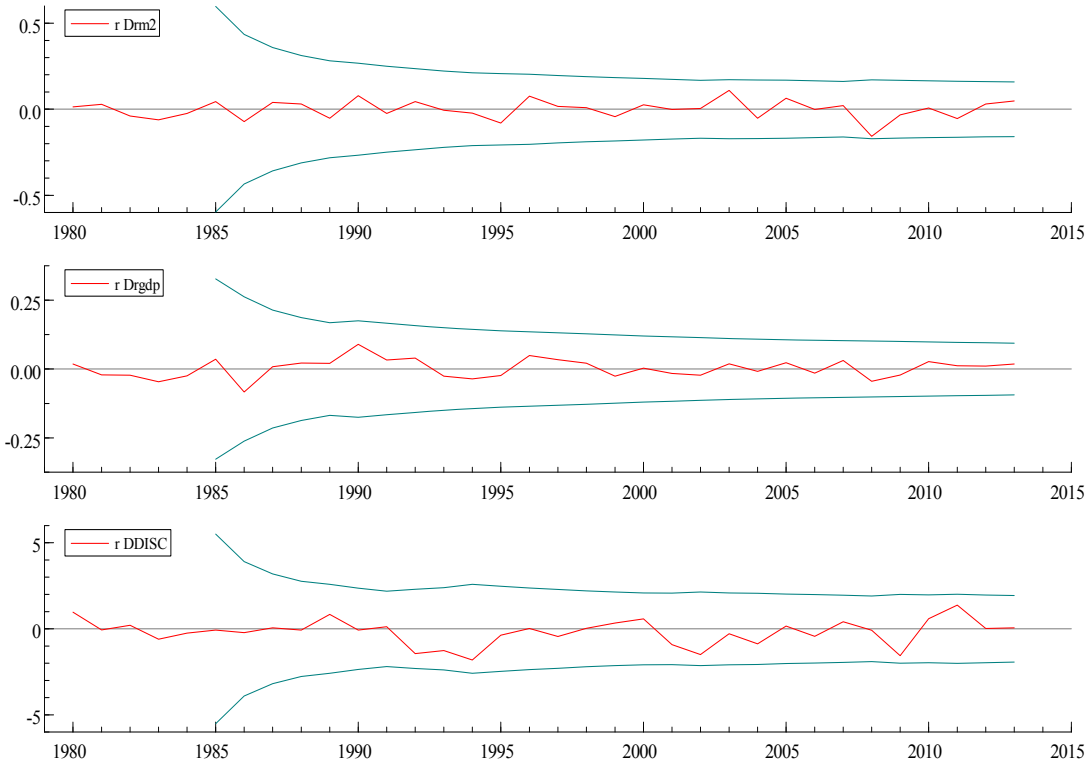
Graph (17): Diagnostic Graphs of Parsimonious Open Economy VECM:



Graph (18): Stability (One Step and N Down Chow Test) of Parsimonious Open Economy VECM:



Graph (19): Scaled Residuals of Parsimonious Open Economy VECM:



Annex VI: Key Historical Development of the Egyptian Economy:

During the past five decades, the Egyptian economy surfed through many economic and political events that reflected on monetary aggregates, output and, accordingly, demand for money. What follows is a brief account on the key events that were captured by the model:

1976: Huge foreign capital inflows between 1974 and 1985 due to number of factors; the rise in oil prices which had a positive impact on Egypt because of the increase in oil production, the reopening of Suez Canal, the surge in workers' remittances, and the inflow of foreign aid. The 1975 banking law, interest rates were fully determined by the Central Bank during this period and the lending and borrowing rates were negative.

1986: The exchange rate was devalued by almost 60 percent, and a flexible exchange rate system was announced for commercial banks to pool foreign exchange resources. Security trouble due to security soldiers' assaults pushed inflation to almost 23 percent which established a 14-year record.

1991 and 1992: Egypt signed a standby agreement with the IMF in 1990 that called for economic reform and structural adjustment known as the Economic Reform and Structural Adjustment Program (ERSAP). The set of reforms that was endorsed and implemented included:

- Removal of interest ceilings on lending
- Liberalization of the exchange rate; foreign exchange bureaus were licensed to operate freely, and the official rate devalued by around 25 percent.
- CBE adopted domestic liquidity (M2) as an intermediate target, while the operational target became banks' excess reserves.
- CBE also reduced the reserve ratio to 15 percent and introduced some changes to its method of calculation

2008: The global food crises erupted coupled with a sharp outflow of capital, as foreign investors pulled out of equity and government debt markets. This created pressures on the exchange rate market. This coupled with an increase in headline inflation was driven largely by fruit and vegetable prices. Monetary authorities allowed some additional nominal exchange rate flexibility, with the Egyptian pound depreciating by about 6 percent during this year.

2009: The global financial crisis sparked in the US and spread to Europe and the rest of the world. As a result, Egypt witnessed a setback in the growth rate of real GDP from 7 percent in 2007/08 to 4.7 percent in 2008/09. The financial crisis hit the revenues from tourism, exports, workers' remittances, and the Suez Canal. In addition, foreign direct investments declined. Nevertheless, sustained and wide-ranging reforms since 2004 reduced fiscal, monetary, and external vulnerabilities and in addition to limited direct exposure to structured products and low levels of international financial integration. Government undertook additional (mainly infrastructure) expenditure of about 1 percent of GDP.

2010: Egypt weathered the financial crisis relatively well. The economy started to recover as a result of prompt fiscal and monetary responses to the financial crisis. Real GDP growth rate stood at 5 percent.

2011: The first wave of the revolution erupted followed by the fall of the political regime and the ruling military council to govern a transition. Egypt has experienced a drastic fall in both foreign investment and tourism revenues, followed by a 60 percent drop in foreign exchange reserves, a 3 percent drop in growth, and a rapid devaluation of the Egyptian pound. All of which led to increasing food prices, worsening unemployment rates, and shortage of fuel.

2012: The Muslim brotherhood leader was elected as president, political tensions continued and Egypt suffered an economic collapse. The economy suffered large fiscal deficits, rising public debt, fragility in the balance of payments and, hence, losses of foreign exchange reserves. Growth has been only 2 percent on average, and the unemployment rate has risen to over 13 percent. Exchange rate pressures were particularly strong throughout 2012 and the first half of 2013, when reserves were only supported by sizable official financing from Gulf countries, rapid depreciation, and foreign exchange rationing, which compressed imports and reactivated the parallel exchange market.

2013: The second wave of the revolution erupted and the rule of the Muslim brotherhood ended. Egypt is still suffering an economic crisis. Inflation picked up 10.1 percent on average in 2013 due to fuel and tobacco price hikes and increases in school tuition fees. The aim of the interest rate action by the CBE was to contain inflation hikes by raising its policy rates by 100 bps.

Annex VII: Details of Empirical Procedures:

Testing for Integration

The unit root tests lay the foundation for the VECM framework outlined above. This paper will adopt the ADF procedure to test for unit roots as indicated above. The test will incorporate both constant and trend to account for trend stationarity. Since the data is in annual frequency, then no seasonal adjustment is required. The lag length for the ADF test is determined based on the Schwert (1989) formula for annual data:

$$l_4 = INT\left[4\left(\frac{T}{100}^{\frac{1}{4}}\right)\right]$$

where T is the number of observations and INT stands for integer value. Since T = 54, the lag length suggested by this criteria is 4 lags.

All tests are conducted by Oxmetrics 6.1. Tables (3a), (3b), and (3c) provide summary statistics of the ADF test. Following the Dickey and Pantula (1987) sequential approach to confirm the order of integration for each variable, unit roots are tested under the assumption that the order of integration is, at most, two. The second difference for the data is employed for this purpose and as shown in table (3a), data provide strong evidence to reject the null hypothesis of non-stationarity at a 1 percent level.[19]

This is replicated for the first difference of the series. The null hypothesis of existence of a unit root is rejected for the change in inflation at 5 percent significance level, and for the change in exchange rate at 1 percent significance level. The critical values for the change in real money balances, change in real GDP, change in the interest rate and discount rate cannot reject the null of a unit root (see table 3b). This might suggest that these variables may follow an I(2) process. However, the numerical values for the coefficients of the tests that minimize the Akaike's Information Criterion (AIC) (see Akaike's (1973)) lie between 0.55 and 0.02, respectively. This

[19] While the visual inspection of the series in graphs 1 and 11 confirm the absence of structural breaks; future research would consider testing for structural breaks at unknown dates and conditioning on the most recent break for estimation following El-Shazly (2015).

is numerically far from unity and indicates that the time series are stationary in their first and second differences.

Moreover, upon replication of this procedure with levels of data, the null hypothesis cannot be rejected for all variables with the exception of the change in the nominal exchange rate. This step concludes the existence of strong evidence that all the data series robustly follow an I(1) process in levels, with the exception of the change in the exchange rate that follows an I(0). The quantitative exercise is complemented by visual inspection to double check this conclusion. As seen in graphs (1) for the closed economy specification and (12) for the open economy specification; there are no noticeable structural breaks in the series as it is trending smoothly upward and downwards. This confirms the conclusions from the unit root tests.

Co-integration Analysis- Closed Economy

The standard econometric theory concludes that regressions for non-stationary variables give spurious results. The residuals of these models will not be stationary and, accordingly, the standard OLS assumptions will not hold. This applies to the Egyptian data that was tested based on the ADF procedure for integration in the previous section and found to possess unit roots and exhibits integration of first order [I(1)]. However, some linear combination of these series has a lower order of integration. There will also be some (co-integrating) vector of coefficients that forms a stationary linear combination of these variables.

The aforementioned analysis confirmed the fact that levels of all variables are integrated of the same order (I(1)). This is considered the first necessary condition needed to investigate if there is a long run relationship between the variables. The existence of an equilibrium long run relationship between the variables would mean that the variables are co-integrated. The definition of the co-integration relationship can be explained by the fact that it is the set of linear restriction—in other words the linear relationship—by which a number of non-stationary—integrated—series is combined to produce a stationary series. This stationary series is then analyzed to show how variables move and adjust in the long run equilibrium.

The next step to identify the short and long term relations between the variable of interest (real money balances is considered for this paper) is to run a VAR in levels since the five series of the

proposed were proven to be integrated of order one (I(1)). Then, it will be plausible to investigate the presence of a long run equilibrium relation between variables. One advantage of level VAR models over alternative models is that the former are robust to the number of unit roots in the system. This robustness is one of the reasons why level VAR models are used extensively in applied macroeconomic research, including our case (Qureshi, 2008).

The linear representation of the variables in the long run is often called the Granger theorem (Granger, 1983). Moreover, (Engle and Granger, 1987) proposed a methodology to map a one-to-one relationship between co-integration and a VECM. The VECM can well define the short run and the long run relationships between variables. In other words, it estimates how changes in levels of variables are matched by a change in the level of the variable of concern. These estimations are considered consistent and highly efficient.

Selecting the Lag Length – Closed Economy

The reliability of the findings of the VAR system of equations depends on consideration of the lag length in running the system. A procedure is needed to test the optimal number of lags that maximize the efficiency of the model and ensure that the feedback information is adequately and efficiently maintained within the model. The optimal lag length is tested using several criteria including AIC, Shwartz Criteria (SC) and the Log Likelihood test. The theory proposes that with annual data the propagation of the business cycle is considered within a 5-year period (Cotis and Coppe, 2005).

Analysis starts with a VAR system using 5 lags and then a sequential reduction process is implemented to move from a general to a specific model to avoid over-parameterization and ensure parsimony. The results of the F-test statistics shown in (table 4) confirm that 3 lags reject the null of loss of information upon sequential reduction of the rank of the VAR from 5 lags to 3 lags. The SC of the 5 and 4 lags systems are much higher compared to the 3 lags. Moreover, the AIC and individual F tests for specific lags provide mixed evidence for the 5 lags system. However, evidence for the 4 lags AIC, SC, and joint significance provide strong evidence against the adoption of this lag length. The relevant systems of rank 5 and 4 either suffered from problems of serial correlation and heteroscedasticity. On another front, the set of tests calls for adopting 3 lags as optimal lag length while avoiding loss of information. Also, reduced models with 2 lags and a

single lag perform worse than the 3 lags models in terms of residuals diagnostics. Residuals consistently exhibited serial correlation that invalidated results of relevant models. Accordingly the reduced 3 lags rank model is further vetted below to validate the choice of this rank.

The residuals misspecification test of the reduced rank—3 lags—VAR is provided in (table 6) and are also graphed in graph 2. The residuals misspecification test provides evidence that the multivariate Portmanteau test's null hypothesis up to lag 3 is rejected. This test inspects whether residuals exhibit white noise independent and identically distributed (iid) white noise characteristics. The null hypothesis of the multivariate Portmanteau test states that the autocorrelation functions of all series have no significant elements for lags 1 through 3, yet the main weakness of the test is that the alternative hypothesis isn't well identified. Accordingly, while the test can identify the problem of lacking (iid), it doesn't provide further information about the nature of the problem. Moreover, the null hypothesis of (iid) failed to be rejected for all individual equations. These mixed results require looking at alternative tests to ensure that the residuals are free from serial correlation that invalidates the results of the model.

Results of the system as well as individual equations AR 1-2 test's and ARCH 1-1 test for the restricted 3 lags model null of the presence of serial autocorrelation, hence the reduced VAR doesn't suffer from serial auto correlation. Moreover, the vector ZHetero test fails to reject the null of homoskedasticity of the system's residuals. This is also the case for individual equations' Hetero test. System normality tests null hypothesis is rejected for the system as well as individual equations of discount rate and interest rate at 1 percent. This is mainly attributed to a number of outliers. Upon inspection of graph 2, it can be seen that density of the residuals i close to a robust bell shape.

The restricted VAR stability and parameter constancy can be confidently concluded upon inspection of graphs 3 and 4. Model constancy is tested by the Chow one step test and the break point test indicated in graph 3, in addition to the plot of the companion matrix of the reduced rank model. The graph of the one step residuals also confirms these findings.

In conclusion, individual equation and vector misspecification tests for the reduced rank 3 lags model residuals and model stability robustly support our proposition to proceed with modeling

long run and short run dynamics adopting 3 lags and conditioning the analysis on white type noise residuals.

Co-integration Results – Closed Economy

Moving forward to the co-integration analysis—the 3 lags system is employed—and Johansen's co-integration approach is adopted. The constant enters the model as unrestricted and the 9 dummies elaborated earlier are also unrestricted, and accordingly do not lie in the co-integrating space.

The presence of a co-integrating relationship is identified by Johansen's maximum likelihood estimator approach. This approach helps in the distinction and determination of the equilibrium vectors, and can describe the whole co-integrating relationship. The test builds on building a matrix π that defines the equilibrium correction relationship. The rank of this matrix is then identified by the number of linearly independent rows or columns that define this relationship. For the purpose of our analysis, the full rank of this matrix is 5, and the matrix is 5x5, since we have a 5 equation system and we are testing for the rank(r) of the matrix that identifies the number of co-integrating relationships through computing the likelihood for various eigen values of the matrix. The first block of (table 7a) shows the results of the test, as the null that rank (r) equals zero rejects the null of the no co-integrating relationship, yet the null that (r) $\leq$ 1 fails to reject it. This is indicated by the p-values of the trace and maximal eigen value tests for both the asymptotic case and the finite sample case.

Results of the maximal eigenvalue ($\lambda_{\max}$) provide strong evidence of a single co-integrating relationship. The null hypothesis is rejected of no co-integration at 1 percent significance level and trace eigenvalue (λ_{trace})—adjusted for the degrees of freedom—rejects the same null at 5 percent significance level. Table (7a) also reports that a maximal eigenvalue test rejects the null at 5 percent for a second co-integrating relationship. The test statistic of the trace test and the adjusted tests indicate that the null hypothesis was not rejected at all significance levels. This is complemented by the fact that the eigenvalue associated with the first co-integrating vector is certainly dominant over those corresponding to other vectors, thereby confirming the existence of a unique co-integrating vector in the model.

Co-integration Analysis- Open Economy

The open economy formulation adopts equation 4, which was detailed earlier. This specification employs the change in the exchange rate and foreign interest rate to account for interaction with the global economy. Since the United States is the largest trading partner and foreign investor in Egypt, the nominal U.S. dollar exchange rate against the Egyptian pound is considered. The change in the equivalent in Egyptian currency to 1 USD is included. On another front, the U.S. federal funds' rate is employed as the foreign interest rate to account for the foreign opportunity cost for holding domestic currency for the period of study. Since Egypt is a small economy relative to the U.S., it is therefore understood that the Egyptian monetary policy will be influenced by the stance of the U.S. monetary policy, but will not affect it reciprocally. Against this priori, the federal funds' rate enters the model as a non-modeled variable. The VAR model is formulated with 5 lags and reduced by 1 lag at a time till reaching only 1 lag. Dynamic tests for lag length confirm that 3 lags are optimal. Moreover, the 3 lags VAR is stable and free from auto correlation at a 1 percent significance level for individual equations and the system at large. The portmanteau test rejects the null that residuals are white noise at 1 percent for the system at large; yet; individual equations confirm that residuals are white noise and fail to reject this null. The vector test is annulled for the proposed formulation as the model contains unmodeled variables and lagged endogenous variables (see Doornik 2012).

Residual diagnostics show that individual VAR equations are free from heteroskedasticty, yet the system fails to reject the null of no heterskedasticy only at a 10 percent significance level. Residuals reject the null of normality driven by the outliers in the sample period that covers more than 50 years of annual data.

The VAR system is remarkably stable, as confirmed by the visual inspection of the recursive stability tests (see graphs 13, 14, and 15). Accordingly, a research decision is taken to proceed with the co-integration analysis to test for long term relationships between variables.

Co-integration Results—Open Economy

The same set of procedures adopted under the closed economy formulation is repeated while augmenting the system with the expected devaluation in domestic currency and the foreign interest rate.

The open economy model formulation in equation (4) is adopted to pursue a co-integration analysis. The Johansen (1988) and Johansen and Juselius (1990) procedure is applied to the following set of proposed endogenous variables: rgdp, Interestrt, DISC, Dexrtend, INFL whereas FFUNDSRT is included as a non-modeled exogenous variable. Pulse dummies dumm1976, dumm1986, dumm1990, dumm2008, dumm2009, and dumm2013 are also added to capture policy switches. However, many dummies that were employed under the closed economy formulation is not included here because we explicitly introduce two variables that represent the foreign influence on demand for money, mainly FFUNDSRT and Dexrtend. The estimation is started with 5 lags and is repeated by removing 1 lag at a time until the lag length reaches 1. The model progress identified the 1 with 3 lags as the most appropriate. The test identifies a single unique co-integration vector that appears to be stationary significant at a 99 percent level by both the trace and maximal eigenvalue criteria, even when they are adjusted for the degrees of freedom. However, results of the trace test show the possibility of the existence of multiple at the 95 percent significant level. A research decision was made to proceed with considering a single co-integrating relationship based on the following findings: (1) the difference between the eigenvalue of the first rank in comparison to the eigenvalues; (2) considering the adjusted test statistics for both the trace and maximal tests (see table 7a). The large difference between the eigenvalue of first rank versus other ranks (almost double), in addition to the results of the adjusted trace and maximal tests failing to reject the null of no co-integrating relationship of ranks above (1), support the proposition to proceed with the analysis considering a unique co-integrating relationship.

Annex VIII: Summary of Findings of the Research on Estimating Money Demand for Egypt:

Data Properties					**Modeling Approach**				
Author (year)	**Sample and Source**	**Frequency**	**Variables**	**Integration**	**Type**	**Specification**	**Estimates**		
Scobie 1983	1947 - 1981	annual	GNP, Money Balances and domestic price levels	NA	Structural model	LM2; LGNP_t, LGNP_t-1, LCPI_t, LCPI_t-1, LM2_t-1, LM2_t-2	LM2 = 0.1 + 0.38* LGNP_t + 0.04 LGNP_t-1 – 0.86* LCPI_t + 0.2 LCPI_t-1, 0.66* LM2_t-1 – 0.1 LM2_t-2		
Handy 1998	1973 - 1997	annual	Currency (CUR), Domestic Liquidity (M2X excluding foreign currency deposits), Total liquidity (M2), RGDP, CPI, Inflation, Interest, Offshore interest, Dummy 1985-1992	M2X, Inflation, offshore interest are all I (1)	ADL	three models, CUR, M2X, M2:	CUR	M2X	M2
						Independent variables:			
						RGDP,	1.07*	1.86*	1.69*
						CPI,	0.55*	0.625*	0.653*
						Inf,	-0.22*	-0.15*	-0.13*
						interest rate,	0.004	0.010*	0.019*
						offshore interest rate	0.012*	-0.0010	0.00394*

Data Properties					Modeling Approach		
Author (year)	**Sample and Source**	**Frequency**	**Variables**	**Integration**	**Type**	**Specification**	**Estimates**
Alami 2001	1980 I – 1993 IV IMF - IFS	Quarterly, *DP* represents a pulse dummy variable such that *DP* = 1 at 1991:II and zero otherwise, *DL* represents a level dummy variable such that *DL* = 1 for all t > 1991:II and zero otherwise, and *DT* represents a slope dummy variable such that *DT* = 1, 2,...,9 (since the number of post break observations is 9) for all t beginning 1991:II and zero otherwise if there is an increase in the slope of the trend, or *DT* would take a decreasing number	(F) Ratio of foreign currency denominated deposits to total liquidity, (X) expected change in exchange rate, (i*-i) interest rate differential, (FCD) total holdings of foreign currency deposits in local banks, (FCDA) ~ in banks abroad, M2, (LE) log of tertiary exchange rate, (LESPT) ~ to official exchange rate	F, LE, LEPST are I (1) all others were I(0)	ECM	10 models: *1) F = LE + LDIF* *2) F = LE* *3) F = DEP + LDIF* *4) F = DEP* *5) F = LE SPT + LDIF* *6) F = LESPT* *7) F = DEP + PBV* *8) F = PBV* *9) F = LESPT + PBV* *10) F = LDIF*	In this study, quarterly data for Egypt covering the period 1981:IV to 1993:IV is used to analyze the current episode of dollarization. As expected, given that foreign currency deposits in Egypt earn a competitive rate of return, using the coefficient of the expected rate of depreciation (*LE, DEP* or *LESPT*) as a measure of currency substitution, the results of the error correction models reported in The study suggest that currency substitution is essentially absent in the short-run in estimates of Egyptian foreign currency denominated deposits held in Egyptian economy

Data Properties					Modeling Approach		
Author (year)	**Sample and Source**	**Frequency**	**Variables**	**Integration**	**Type**	**Specification**	**Estimates**
		beginning at the break, (*DT* = 9, 8,...,1) if there is a decrease in the slope of the trend.					
Baliamoune-Lutz and Haughton 2004	1960 - 1999	Annual	GDP, M1, M2	I (1)	VECM	Velocity of money (v) is a function of anticipated (sam) and unanticipated (sum) money growth for either M1 or M2 Where M1(t) or M2(t) is regressed on constant and M1(t-i) and a trend, (sam) is defined as the estimated M1 or M2 and the (sum) is the difference between	Long run co-integration relationship: v M1 (t) =- 2.225 + Log v + 55 sam (t-1) – 0.004 sum (t-1) v M2 Velocity (t) = 1.3417 + Log v - 33 sam (t-1) – 0.110 sum (t-1) Parsimonious short run model: D Log (v)(M1) (t) = 0.008 – 0.047 ECM + 0.358 D Log v (t-1) - 0.064 D Log v (t-2) + 0.199 D Log v (t-3) – 0.296 D sam (t-1) + 4.807 D sam (t-2) + 2.043 D sam (t-3) + 0.0005 D sum (t-1) – 0.002 D sum (t-2) - 0.006 D sum (t-3)

Data Properties					Modeling Approach					
Author (year)	**Sample and Source**	**Frequency**	**Variables**	**Integration**	**Type**	**Specification**	**Estimates**			
						actual and estimated M1 or M2.	D Log (v)(M2) (t) = 0.047 – 0.212 ECM + 0.341 D Log v (t-1) - 0.540 D Log v (t-2) + 0.578 D Log v (t-3) + 0.778 D Log v (t-4) + 0.391 D Log v (t-5) – 1.067 D sam (t-1) - 1.802 D sam (t-2) + 1.504 D sam (t-3) + 2.979 D sam (t-4)+ 0.544 D sam (t-5) +0.016 D sum (t-1) – 0.008 D sum (t-2) - 0.003 D sum (t-3) - 0.023 D sum (t-4) - 0.025 D sum (t-5)			
CBE 2010	1997m7 - 2009m6	Monthly – GDP was interpolated based on monthly electric energy production using uni-variate Dalton method and seasonally adjusted by multiplicative X-11 technique	RGDP (as scale variable), 3 months deposit rate (return rate for holding money); opportunity cost vector includes: 3 months treasury bills rate, exchange rate depreciation, inflation rate	All are I(0) except; RGDP and RM2 are I(1)	VECM	LRM2; LRGDP_SA, LTBILL, INF	Long run co-integration relationship: LRM2 = 0.92 rgdp - 0.69 LTBILL – 3.09 INF – 5.39 Parsimonious short run model: ΔLM2t=-0.013*[LM2t-1 – 0.91 LGDP_SAt-1 + 0.69 LTBILL t-1 + 3.09 INFt-1 – 5.39] +0.026 Δ LTBILLt-4+0.022ΔINFt-2 – 0.034Δ INFt-6 –0.020Δ INFt-8+0.005			
Awad 2010		Quarterly, GDP			ADL	*(RM2)t = b1 + b2 Yt + b3*	Variable	Coefficient	t-stat	Prob.

Data Properties					Modeling Approach					
Author (year)	**Sample and Source**	**Frequency**	**Variables**	**Integration**	**Type**	**Specification**	**Estimates**			
	1995Q1-2007Q4 IMF - IFS	1995Q1-2007Q4 are not available for Egypt either in this source or any other source, we used statistical methods to extrapolate quarterly data from the annual data for the period of 1995-2007.	real money balances, (*ln_RM2t*), real GDP (*ln_Yt*), FX rate (*ln_Et*), three-month deposit rates (*Rt*) and lagged CPI-inflation rate	*ln_Yt* and *ln_Et* are integrated of order one, i.e. I~ (1), both *Rt* and *EPt* are integrated of order zero, i.e., I~ (0).		*Et+ b4 Rt + b5 CPIt-1 + et* .	C	3.3065	2.9401	0.005
							LN_Y	0.70235	8.2304	0.000
							LN_E	0.4470	11.209	0.000
							R	-0.0400	-4.4905	0.000
							EP	-0.0105	-2.3769	0.021
							AR(1)	0.2763	1.9020	0.063
							Adjusted R-squared 0.991511 Akaike info criterion -4.376875 Durbin-Watson stat. 2.031932 Schwarz criterion -4.147432 F-statistic 1145.690 Prob (F-statistic) 0.000000			

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