RESERVE ADEQUACY AND THE DEMAND FOR INTERNATIONAL RESERVES IN EGYPT

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Theme: Macroeconomics

Abstract

This paper assesses reserve adequacy and is the first to empirically investigate the determinants of demand for international reserves in Egypt. Using standard adequacy measures, the paper shows that reserves have fallen to critical levels during the 2011-2013 political crisis in Egypt. In addition, using quarterly data 2000:3 and 2013:1, the paper estimates a long-run demand function and also tests whether money market disequilibrium affects short-term reserve movements using a vector error correction model (VECM). The paper has the following preliminary findings: First, Egypt's long-term reserve demand function can be described as a function of trade level and volatility as well as the opportunity cost of holding reserves. Second, the speed of adjustment points to a rather active reserve management of the Central Bank of Egypt (CBE) in the short-term: 40% of the deviation from the long-run equilibrium is eliminated within one quarter. Finally, giving support to the monetary approach to balance of payment, results confirm that reserve demand responds to money market disequilibrium in the short-term: excess demand for money by 1% would lead to an accumulation of reserves by 0.12%. The low elasticity suggests that CBE is reluctant to allow monetary fluctuations to affect Egypt's reserve position and may be taking some measures to clear the money market to restore the equilibrium.

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RESERVE ADEQUACY AND THE DEMAND FOR INTERNATIONAL RESERVES IN EGYPT

Introduction

Between 2011 and 2013, in a general context of domestic political instability, Egypt's stock of international reserves have sharply dropped by around US$ 20 billion to U$ less than 14 billion, its lowest level in thirteen years, from much comfortable levels of US$ 36 billion. This drop reflects sustained efforts to defend a tightly managed exchange rate regime (to the US$), which had come under significant pressure following a sharp drop in foreign exchange earnings. Political uncertainty still hovers over the Egyptian economy and further losses could be incurred in coming months. However as reserves have fallen significantly, there is speculation about the adequate level of reserves Egypt should hold, especially given the lack of empirical studies on Egypt's demand for international reserves.

Against this background, this paper assesses reserve adequacy in Egypt and is the first to investigate demand for reserves. Using standard adequacy measures, the paper shows that reserves have fallen to critical levels during the 2011-2013 political crisis. Using quarterly data between 2000:3 and 2013:1, the paper follows Badinger (2004) to estimate long-run demand function and to test whether money market disequilibrium affects short-term reserve movements using a vector error correction model (VECM). The paper has the following preliminary findings: First, Egypt's long-term reserve demand function can be described as a function of trade level and volatility as well as the opportunity cost of holding reserves. Second, the speed adjustment points to a rather active reserve management of the Central Bank of Egypt (CBE) in the short-term: 40% of the deviation from the long-run equilibrium is eliminated within one quarter. Finally, giving support to the monetary approach to balance of payment, results confirm that reserve demand responds to money market disequilibrium in the short-term: excess demand for money by 1% would lead to an accumulation of reserves by 0.12%. The low elasticity suggests that CBE is reluctant to allow monetary fluctuations to affect Egypt's reserve position and may be taking some measures to clear the money market to restore the equilibrium.

This paper is organized as follows. The first section briefly explains why countries hold reserves. Section 2 presents stylized facts about trends in international reserves and their adequacy in Egypt. Section 3 presents insights from the theory on the determinants of reserve demand as well as reviews previous empirical findings. Section 4 estimates the long-run demand for money in Egypt using cointegration and an error correction models (ECM) and provides an estimate for monetary disequilibrium. Section 5 estimates the long-run demand for reserves and also another ECM for the demand for international reserves incorporating the estimated monetary disequilibrium. The final section concludes and suggests policy implications.

I. Why do countries hold reserves?

Generally, there are two main justifications for holding foreign reserves. On the one hand, the view of the precautionary motive presumes that reserves provide the necessary liquidity buffers that smooth unpredictable and temporary imbalances in international payments and thus avoid disruptive changes in the exchange rate, investment and consumption. In addition, reserves can protect the domestic banking system and more broadly domestic credit markets from outflows of domestic or external resources (Obstfeld et al., 2007). Naturally, the motive for holding reserves is stronger for countries who adopt fixed exchange rate regimes, as they are committed to maintaining a fixed parity between domestic and foreign currencies, than for those who have opted for more flexible exchange rate arrangements. In the latter case, reserves are still held as a precaution in the case that the country would return to a fixed regime. Empirically, several studies have documented the importance of precautionary motives (Wijnholds and Kapteyn, 2001 and Bastourre et al., 2010). On the other hand, the mercantilist view explains that reserve accumulation could promote exports by either depreciation or a mitigation of the appreciation of the currency. Larger stocks of reserves allow for an artificially undervalued exchange rate providing a competitive advantage vis-à-vis the target currency (Aizenman and Lee, 2007). Leblang and Pepinsky (200x) bring in a political economy dimension to the motives for holding reserves: authoritarian institutions heighten the impact of precautionary pressures while democratic institutions heighten the impact of mercantilist pressures. Finally, reserves may also be held for non-precautionary and non-mercantilist reasons (such as intergenerational savings).

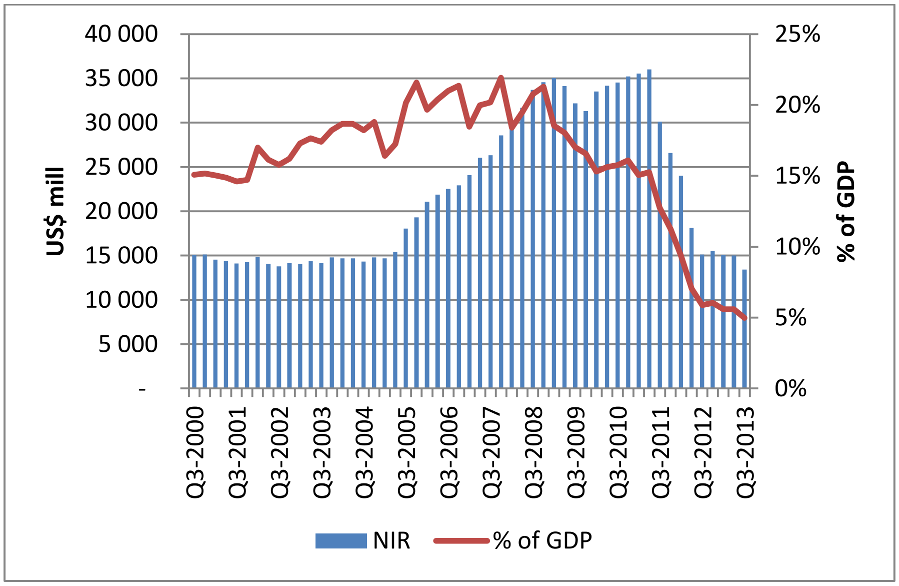
II. Reserve adequacy in Egypt

The section provides a descriptive analysis of recent trends in international reserves, interaction of reserve changes with domestic liquidity as well as assesses reserve adequacy in Egypt.

Trends in international reserves

Egypt has the same stock of net international reserves in 2013 relative to the early 2000s, around US$ 15 billion. During both instances, reserves came down from previously higher levels in order to defend the currency in a context of an unfavorable external environment. In between both dates, the level of reserve holdings stagnated between 2000 and 2005 and then like many other emerging countries, Egypt benefited from the global liquidity and was able to build-up large amounts of reserves to more precautionary levels of US$ 36 billion in Q2-FY11, more than double the low initial holdings in Q3-2000, even though as a share to GDP, reserves remained at around 15% of GDP (figure 1).

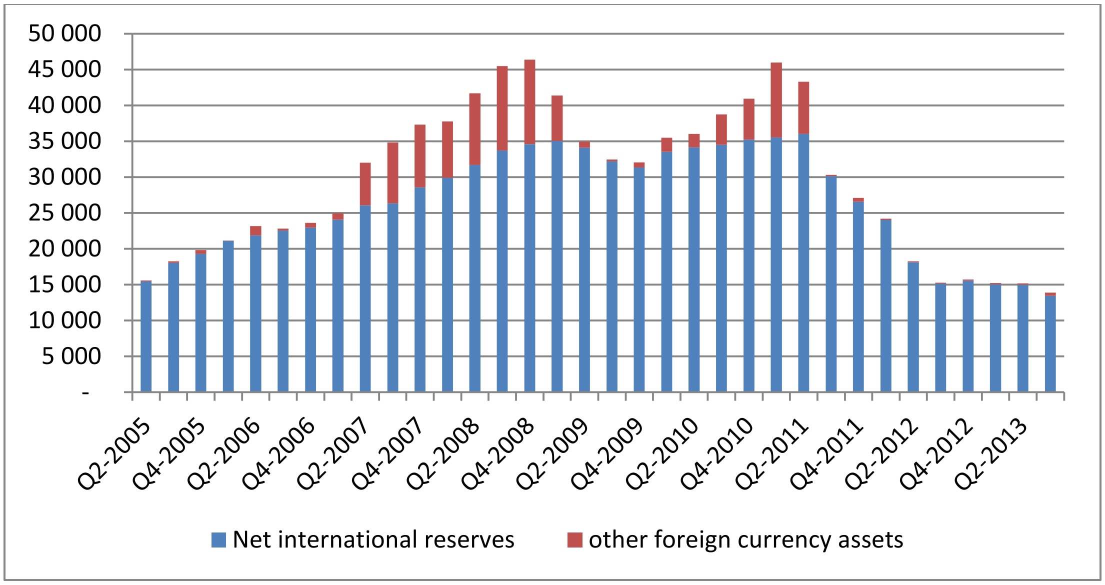
Figure 1: Level of international reserves, Q3-2000 – Q3-2013



Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

Following the significant pace of accumulation of reserves since FY05, the CBE had set up a special fund of "other foreign currency assets" which was not included the total official reserves. Reserves in this fund increased from around US$ 171 million in Q2-2005 to almost double US$ 11 billion in Q4-2008. This fund became the CBE's primary cushion to defend the pound without depleting official reserves. As a result, other currency assets exhibited much higher volatility than overall reserves. For instance, other currency assets dropped from US$ 6.3 billion in Q1-2009 to around US$ 255 million in Q3-2009. Afterwards, reserves accumulation resumed with net international reserves peaking once again to US$ 36 billion and other foreign currency assets to US$ 10.4 billion, total holdings of almost US$ 46 billion in Q1-2011 (figure 2).

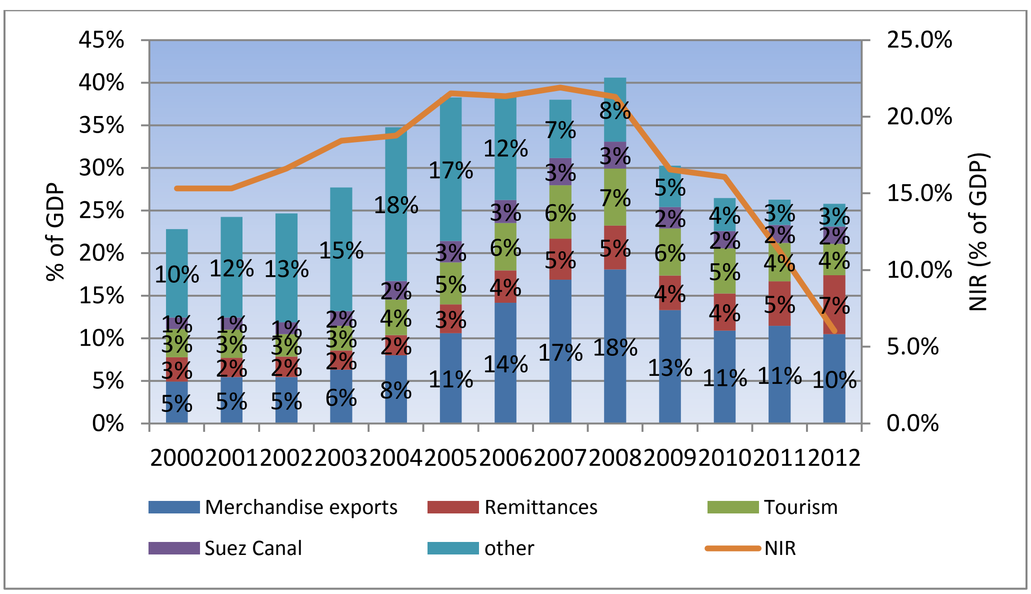
Figure 2: Official and Unofficial International reserves



Source: Central Bank of Egypt monthly statistical bulletin.

This steady accumulation in the mid-2000s reflected large inflows of foreign exchange earnings (41% of GDP in FY08 up from 22% of GDP in FY00). However, following political instability since 2011, there was a sharp drop in most foreign exchange earnings to 26% of GDP, thus putting downward pressure on the exchange rate (figure 3).

Figure 3 Foreign exchange earnings, % of GDP, FY00 - FY12

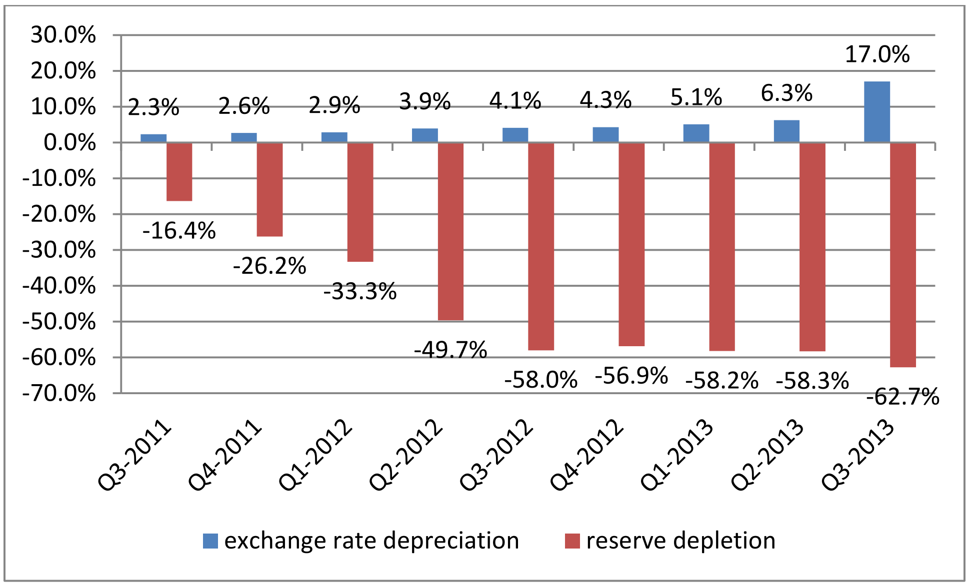


Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

To counter this pressure, the CBE initially maintained a tight management of the exchange rate, letting it only depreciate by 3% and then introducing more flexibility starting only late 2012.

To date, the exchange rate only cumulatively depreciated by around 17% between Q2-2011 and Q3-2013. This occurred at the expense an alarming depletion rate foreign exchange reserves. The first buffer, official currency assets, was entirely depleted (down by US$ 7 billion). Net international reserves have also sharply dropped to a low of US$ 13.4 billion (to around 5 percent of GDP) during that period, (by more than USD 22 billion), bringing the total loss to almost US$ 29 billion or close to two-thirds of reserves (figure 4). These losses were partly offset by sporadic deposits made by several countries including Turkey, Qatar and other Gulf states since 2011.

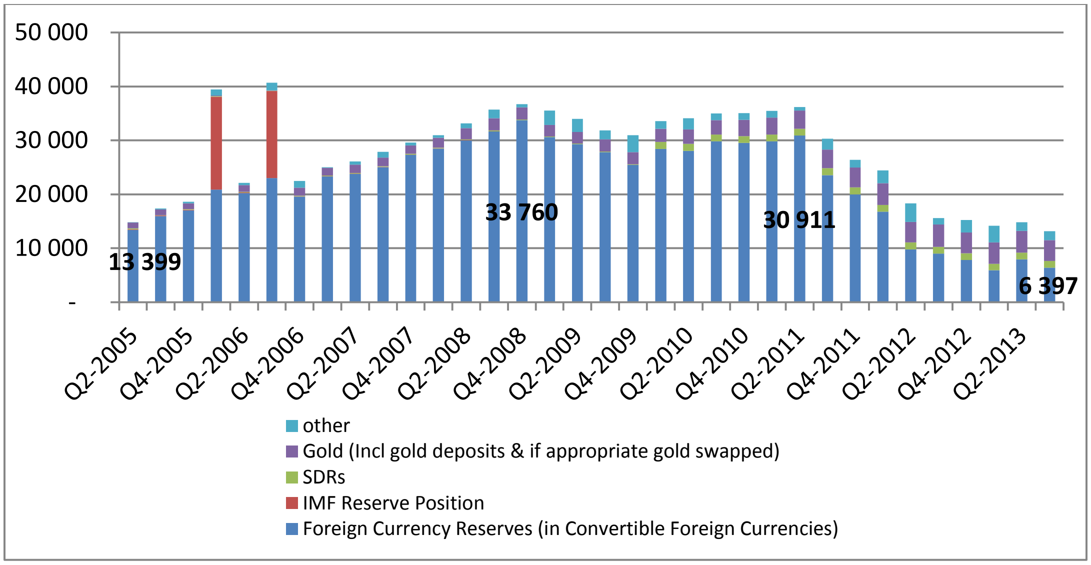
Figure 4 Cumulative change in exchange rate and net international reserves since Q2-FY11



Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

Within official reserves, the CBE has resorted to its most liquid low-risk and allocations such as securities and deposits (90% of reserve holdings) to defend the exchange rate. They currently stand at US$ 7.8 billion dollars, just above 50% of total holdings. Gold holdings have also surprisingly increased since early 2011 to 25% of total holdings, from 7% in Q1-FY05, probably reflecting a rise in the national valuation (figure 5).

Figure 5: Composition of official reserve assets



Source: Central Bank of Egypt monthly statistical bulletin.

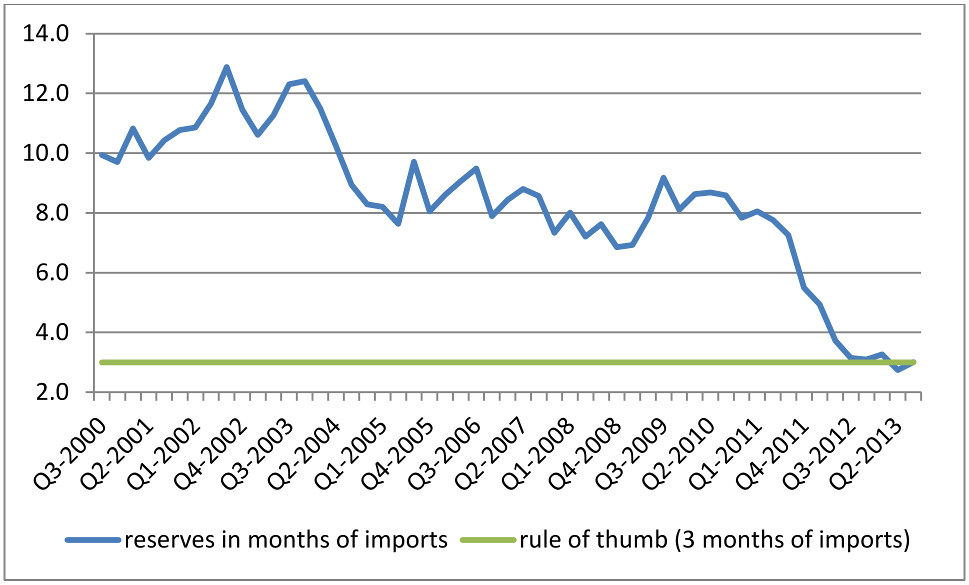
Reserve adequacy

This section provides an assessment of reserve adequacy using several popular rules of thumb indicators. These include scaling reserves against imports, short-term external debt and broad money. In general, all 3 metrics in the Egyptian context have sharply moderated since early 2011. Moreover, reserves in terms of month of imports are just and as a ratio to broad money are lower than the recommended benchmarks.

As a proxy for current account vulnerability, the most popular metric indicates that a country should hold reserves sufficient to finance the equivalent of three months of imports in the event of a sudden stop in export revenues or loss of access to external financing. This measure of reserve adequacy (though not the benchmark) which was put forward by Triffin (1961) is relevant when the balance of payments is dominated by trade and when the country has limited access to capital markets.

Egypt’s reserves sharply dropped to around 2.7 months of imports in Q2-2013, at its lowest level since 2000 and below the recommended benchmark, from higher levels of 11 months in the early 2000s (prior to the devaluation) and around 8.6 months before 2011 (figure 6).

Figure 6: Reserves in months of imports



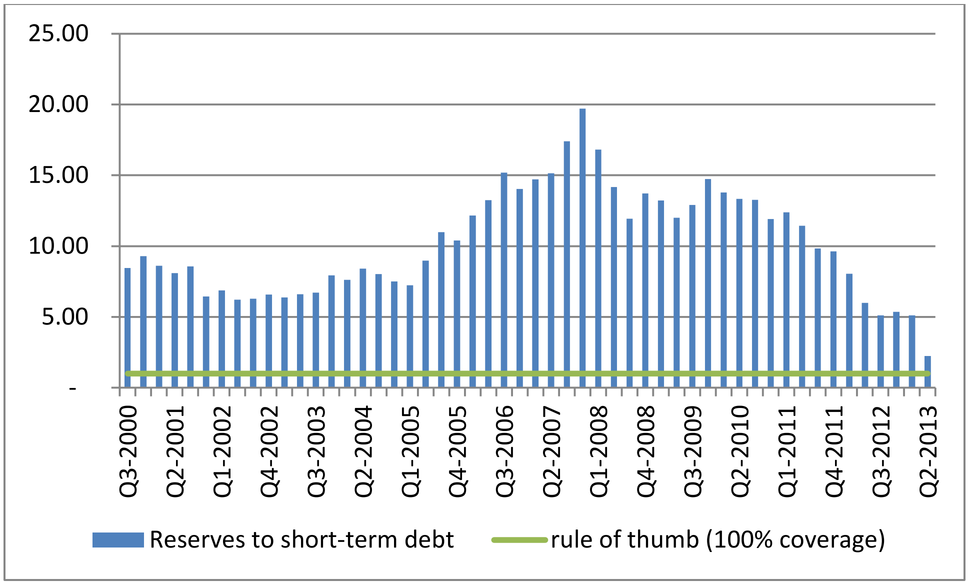
Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

As this metric does not capture capital outflows which played a destabilizing during the Asian crisis, Wjinholds and Kapteyn (2001) suggest two other measures: the ratio of reserves to short-term external debt and the reserve coverage of broad money.

The ratio of reserves to short-term external debt (less than one year) (also referred to as the Greenspan-Guidotti rule) measures the risk of a capital account crisis and should be at least equal to one. [2] The rationale is that if reserves exceed short-term debt, then a country has the capacity to service its external liabilities in the forthcoming year and thus avoid rollover problems stemming from liquidity concerns. Egypt's current level of reserves of USD 13.4 billion almost twice the required benchmark down from a ratio of 10 before the uprising (figure 7). However, in our view, even though this reserve adequacy indicator is above the benchmark, it may overstate the extent to which Egypt is insured against capital account crisis, because of its very cautious foreign borrowing policy after a small external debt crisis in the 1980s which led to it to limit external debt (16% of GDP) whether short-term or long-term ever since.

Figure 7: Reserves to short-term debt

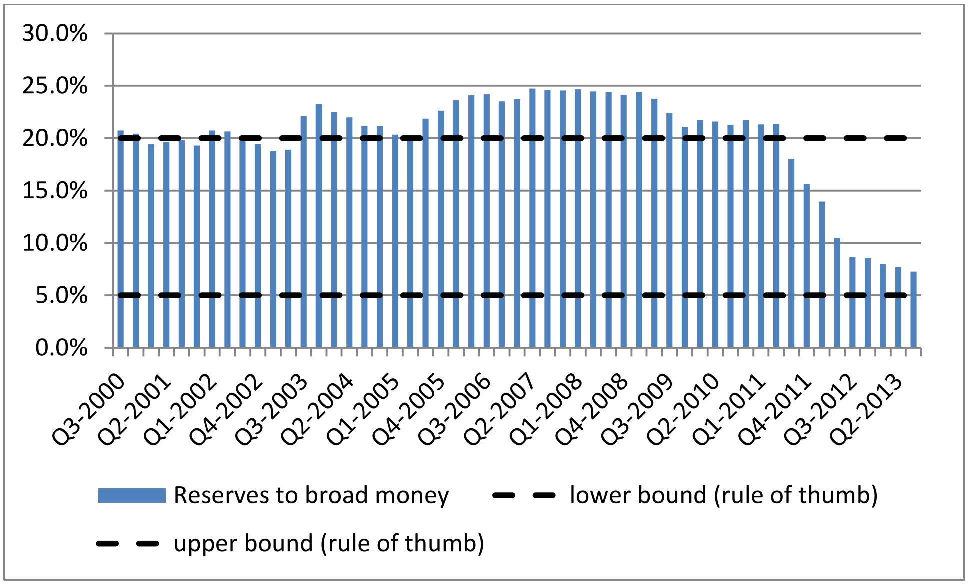
[2]Brought to the attention of the public by Greenspan (1999).



Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

The third measure, the reserve coverage of broad money measures the resilience to outflows from an economy's banking system, since many capital account crises have been accompanied by capital flight of deposits of domestic residents. In particular, Calvo (1996) and Wjinholds and Kapteyn (2001) argue that this reserve adequacy metric is most suitable for for countries with a pegged exchange rate, since it increases the risk that residents will wish to convert domestic into foreign liquidity. Wjinholds and Kapteyn (2001) recommended a minimum threshold of holdings of 5-20 percent. The lower end of the ratio is considered appropriate for flexible exchange rate regimes and the upper for fixed exchange rate regimes. On this measure, Egypt's 7.3 percent coverage is way below the upper bound, which is a more appropriate benchmark given Egypt's tightly managed peg (figure 8).

Figure 8: Reserves to broad money



Source: Author's calculation based on Central Bank of Egypt monthly statistical bulletin.

To conclude, reserves have fallen to critical levels as shown by all three metrics of reserve adequacy. These ratios have deteriorated sharply over the past two years and are very close and sometimes below the recommended benchmark. In other words, the current stock of reserves renders Egypt potentially vulnerable to a liquidity crunch and an exchange rate crisis. What then determines reserve demand in Egypt?

III. What determines reserve holdings?

Insights from the theory

Theoretical interest in international reserves received increasing attention in the aftermath of the Second World War, with the shift towards the Gold Standard rule. Bahmani-Oskooee and Brown (2002) provide an excellent and comprehensive review of the major strands of this theory and its developments over time. In general, theoretical underpinnings which have both macroeconomic and microeconomic foundations, have related the demand of international reserves to trade factors (Triffin, 1947) and to the central bank's optimizing behavior to accumulate reserves to the optimal level which balances the marginal costs and benefits of holding reserves (Heller, 1966). Another view also reconciles reserve demand with some aspects of the monetary approach to the balance of payments which postulates that a disequilibrium in the domestic money market translates into reserve changes in the short-run (Johnson, 1965).

From a macroeconomic point of view, there is consensus that demand for reserves would depend (positively) upon trade both its absolute level and variability (Triffin, 1947 and Machlup, 1966). Other strands of the theory based on microeconomic foundations. Using a microeconomic utility maximizing approach, Heller (1966) explained that the optimal level of reserves is attained when the marginal benefit of retaining an extra dollar of reserves (*adjustment costs that are reduced by reserve holdings*) is equal to the marginal opportunity cost of not keeping them. According to Heller (1966), an increase in the opportunity cost of holding reserves (defined as the net social rate of return on capital, like a government bond rate) will reduce the demand for international reserves. Meanwhile, the marginal cost of adjustment (which is equal to the inverse of the marginal propensity to import (PMI)) should negatively affect the demand for international reserves: a high PMI would imply smaller adjustment costs and will decrease a nation's demand for reserves. Heller's optimization model was developed by others over the years (for a review see Bahmani-Oskooee and Brown (2002)). One important idea introduced by Clark (1970) is the slow speed of adjustment between the optimal (or desired) and actual reserves, whereas early theoretical work assumed that adjustment to determinate desired reserve levels occurs in the same period.

Finally, Johnson (1965) relied on the monetary approach to the balance of payments to explain that changes in the demand for international reserve holdings are determined by changes in the domestic money supply in the short-run. If growth of domestic money supply exceeds that of domestic demand, then, reserves will decrease since money will flow out as people dishoard. In the opposite case when there is excess demand, the latter is satisfied by the foreign sector and reserves will increase. Edwards (1984) further explains that under a fixed exchange rate system, with other things being given, if actual reserves are below their desired level, there will be a tendency to reduce domestic credit in order to increase actual holdings of reserves.

To sum up, theory suggests that the determinants for reserves are trade variables (both level and variability), the marginal propensity to import and the opportunity cost of holding reserves. Finally, domestic money supply also explains the short-run changes in reserve demand.

Review of empirical findings

Empirical work estimating reserve demand functions dates back to prior to 1973 but renewed interest has emerged after the fall of the Bretton-Woods system. A very good survey of the empirical literature can be found in Bahmani-Oskooee and Brown (2002).

Empirical research tried to investigate the determinants of reserve demand derived from the theory being level and variability of trade, propensity to import, opportunity cost, and money supply. Estimations were initially carried out in the form of long-run equilibrium models (that included the previous list of variables) but they evolved since the 1980's into disequilibrium models, augmented with Clark's speed of adjustment term. There exists many versions of disequilibrium models but we only choose to focus on the reserve demand functions with monetary disequilibrium.

In general, there has is broad empirical support for the role of trade factors in explaining reserve demand, an exception made by Edwards (1984, 1985). Initiated by the seminal work of Kenen and Yudin (1965), empirical studies confirm that balance of payments *variability* was a main determinant of the reserve demand. Officer (1976) was also able to establish a positive and significant relationship between reserves and the *level* of imports. The recent literature has also found that imports and the volatility of real earnings to be positively correlated with reserves (Mwase, 2012; IMF, 2003, Aizenman and Marion, 2003 and Flood and Marion, 2002).

However, the early results (prior to 1973) were somewhat disappointing for other determinants derived from theory. First, contrary to what is predicted, Kelly (1970) established a positive relationship between reserve demand and the PMI, a result later confirmed by Frenkel (1974). However, later empirical studies like Heller and Khan (1978) and Landell-Mills (1989) were able to confirm the theorized negative relationship.

Second, early studies have also repeatedly failed in finding a strongly significant relation between international reserves and their opportunity cost (Kenen and Yudin 1965; Heller, 1966, Kelly 1970; Courchene and Youssef, 1967 and Frenkel and Jovanovic, 1981). This largely reflected measurement problems as the opportunity cost measure (which was usually proxied by the domestic interest rate or per capita income) or the difficulty in assigning a single interest rate for reserve holdings while accounting for their risks. However, later studies by Edwards (1985) and Landell-Mills (1989) have identified the expected significant negative relationship. Edwards (1985) used the spread between the interest rate at which countries can borrow from abroad and LIBOR is used as a proxy for the *net* opportunity cost for holding reserve. Nevertheless, the effect of the opportunity cost on reserve demand remains inconspicuous in the literature with some studies still failing to find an insignificant correlation (e.g. IMF, 2003).

Empirical support for money supply has been ambiguous with only two old studies finding support for its role in explaining international reserve changes (Machlup, 1966 and Courchene and Youssef, 1967) and many others being unsuccessful in providing significant correlation (e.g.

IMF, 2003). However, more success was made in the context of disequilibrium models. Frenkel (1983) added to the Bilson and Frenkel's (1979) model, which augments the long-term demand function with a partial adjustment equation, a monetary disequilibrium term. Later, Edwards (1984) expanded this model to include the long-term determinants of reserve demand such as income, average propensity to import and variability measure of balance of payments. Edwards' results show that a "1% excess supply of money will result in a 0.3% reduction in the level of reserves held by a particular country". Edwards also notes that the exclusion of monetary variables will yield biased coefficients. Frenkel (1984) and Lizondo and Mathieson (1987) also estimated similar models and their results emphasized the important role of monetary disequilibrium in explaining changes in demand for international reserve.

Moreover, most studies on reserve demand were carried out based on cross-country or panel data analysis. Given the recent advances in time series analysis such as cointegration and error-correction models (ECM), emphasis shifted to individual country studies using time series data. Elbadawi (1990) was among the first to refine Edwards (1984) methodology using time series analysis in the case in the case of the error correction model. He shows that there exists a stable reserve demand relationship in Sudan where remittances is a major determinant. In addition, he also validates that monetary disequilibria affects reserve demand in the *short-run*. Subsequent work carried out with this methodology includes Mishra and Sharma (2011) for India; Badinger (2004) for Austria and Ford and Huang (1994) for China.

No empirical work has addressed this issue for Egypt. The present study seeks to fill this gap in the empirical literature. We believe that this model is appropriate for the Egyptian case for the following reasons. First, Egypt is a small open economy that adopts a managed exchange rate regime vis-a-vis the US$ in our sample period. Second, there were no severe, fundamental balance of payments disequilibria in the period 2000–2013. Third, Egypt's demand for money was stable during the period of investigation (El-Shazly, 2008). Note that the two latter assumptions are particularly important for the test of the monetary approach to the balance of payments by incorporating the monetary disequilibrium.

In estimating the demand for reserve holdings in Egypt, this paper follows closely Badinger (2004). This is a two-step procedure. In a first step, a simple demand for money equation (relating money supply to income and the opportunity cost of holding money) is estimated using cointegration methodology in order to obtain a measure for the money market disequilibrium.

In the second step, the long-term reserve demand function is estimated, also using cointegration, with the traditional determinants in addition to the money market disequilibrium term (estimated from the previous step), which is included as an exogenous variable in the short-term dynamics function. International reserves are explained by: (i) real merchandise imports, (ii) the average propensity to import, (iii) the net opportunity cost of holding reserves (difference between the domestic interest rate and the yield on foreign reserves), (iv) a variability measure of the balance of payments (proxied by the standard deviation of reserves) to account for risk and uncertainty, (v) a variable capturing money market disequilibrium. A description of the data is given in Appendix I.

IV. Money demand and monetary disequilibrium

A common and simplistic empirical specification of (real) money demand typically includes (real) income and the opportunity cost of holding money (a nominal interest rate). Within this framework, numerous estimable versions can be specified, depending on the monetary aggregate used, the choice of measures of income (GDP, consumption) and the opportunity cost of holding money.

In the case of Egypt, El-Shazly (2008) provides empirical evidence that broad money (as opposed to narrow money) is the more appropriate monetary aggregate in terms of parameter constancy for forecasting and policy analysis purposes. The model used by El-Shazly postulates that money demand is determined by a number of variables such as real income, a domestic interest rate, a foreign interest rate, inflation and exchange rate change. In this paper, we opt for a simpler model to estimate the long-run money demand function as:

$$M2_t = \varphi_0 + \varphi_1\, IP_t + \varphi_2\, r_t + \varepsilon_t \qquad (1)$$

where $M2$ is the real money supply in millions of Egyptian pounds (LE), IP is real industrial production in millions of LE, a proxy for real income, r is the 3-month deposit rate in percentages per annum, and ε is the error term. Money demand is expected to be an increasing function of both real income and the domestic interest rate since the aggregate M2 includes time and savings deposits. All variables except the interest rate are in the log form. The model is estimated in quarterly, seasonally adjusted data over the period 2000:3-2013:1. As initially suggested by Edwards (1984), the effect of the monetary disequilibrium (DE) on reserves can be best captured by the term: $(M2_{t-1} - M^*_{2t})$ or M_t^{DE}, where M_t^* is the equilibrium value of money demand.

Negative (positive) values of M_t^{DE} are associated with an excess demand for (excess supply of) money. As the money demand function (1) is specified in log form, the monetary disequilibrium is expressed in relative terms.

The results of the Dicky-Fuller (DF) unit root test indicate that all variables are nonstationary at the level, but stationary at the first difference, or integrated of order one I(1) (Appendix 2). This suggests that these variables could have a long-run cointegrating relationship. From Engle and Granger (1987) theory, co-integration refers to a linear (or stationary) combination of nonstationary variables. This implies that there is a long-run equilibrium among the variables so that they never arbitrarily drift apart. According to Johansen (1988), if there are r co-integrating vectors, only these r linear combinations of these variables are stationary. Moreover, according to the Granger Representation Theorem, for any set of I(1) variables, a dynamic error-correction model also exists. The latter is an equilibrium model using the lagged residual from the cointegrating relationships in combination with short-run dynamics to adjust the model towards long-run equilibrium. This suggests that there should exist a model for the money demand function of the form:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \ \Delta z_{t-i} + \Pi \Delta z_{t-1} + u_t \qquad (2)$$

Where $z = (M2, IP, r), \Gamma_i, \Pi, \Psi$ are matrices of parameters with $\Pi = \alpha\beta', \alpha$ is a $(3xr)$ matrix with the loadings of the cointegrating vector, β is a $(3xr)$ matrix with the r cointegrating vectors. The lagged variable r_{t-1} is used because it turned out significant while the contemporaneous variable remains significant.

The money demand function was estimated with lags of the variables up to two quarters based on the sequential modified LR test statistic and the Hannan-Quinn information criteria. The computation of the other criteria yielded different lag orders: the Schwarz information criterion (SC) indicated a one-quarter lag, the Akaike information criterion (AIC) and the final prediction error (FPE) indicted a three-quarter lag order.[3] The selection of two lags of the endogenous variables was chosen as it yielded the best results while allowing for enough endogenous transmission of the shocks in the system.

[3] The lag selection tests were conducted based on a vector autoregression (VAR) using the *undifferenced* data. The computation of the different lag criteria was doen for a maximum of 4 lags.

In order to estimate the long-run model and determine the rank of Π, the Johansen test was applied with two likelihood ratio (LR) tests: the trace statistic λ_{trace} which tests the null of r cointegrating vectors against the alternative of more than r cointegrating vectors, and the maximum eignevalue statistic λ_{max}, which tests the null of r cointegrating vectors against the alternative of exactly $r+1$ cointegrating vectors. Results for the cointegration analysis of the money demand are reported in Table 1. The trace statistic indicates the existence of a single co-integrating vector.

Table 1: Johansen cointegration test: Money demand function (2000:3-2013:1)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.308532	26.05535	24.27596	0.0295
At most 1	0.166853	8.715252	12.32090	0.1864
At most 2	0.002881	0.135620	4.129906	0.7612

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.308532	17.34010	17.79730	0.0584
At most 1	0.166853	8.579632	11.22480	0.1407
At most 2	0.002881	0.135620	4.129906	0.7612

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 2: Normalized cointegrating coefficients and adjustment coefficients

Cointegrating vector

	Coefficent	Standard error	t-statistic
IP	-1.515729	0.22159	-6.84039
r	-0.287333	0.00739	-38.8632
Loading			
α_{11}	-0.049703	0.01886	-2.63537

The long-run equilibrium relationship is:

$$M2_t = 1.52IP_t + 0.29\, r_t \qquad (3)$$

All estimated coefficients the expected signs, suggesting that the level of income and the opportunity cost of holding money are significant determinants of money demand. Moreover, the speed of adjustment coefficient of the money demand function is negative and statistically significant. This also means that money supply responded to monetary disequilibrium in order to clear the market. Its size (-0.049) means that only 5 percent of the adjustment towards the long-run equilibrium takes place per quarter.

As initially suggested by Edwards (1984), the effect of the monetary disequilibrium (DE) on reserves can be best captured by the term: $(M_{t-1} - M_t^*)$ or M_t^{DE}, where M_t^* is the equilibrium value of money demand. According to the results of the parameter estimated, the monetary disequilibrium is given by

$$M_t^{DE} = (M2_{t-1} - M_t^*) = M2_{t-1} - 1.52IP_t - 0.29\, r_t \qquad (4)$$

Negative (positive) values of M_t^{DE} are associated with an excess demand for (excess supply of) money. As the money demand function (1) is specified in log form, the monetary disequilibrium is expressed in relative terms.

V. Reserve demand and the role of monetary disequilibrium

Now we proceed to estimate the long-run reserve demand function with the following form:

$$RES_t = \gamma_0 + \gamma_1 IMP_t + \gamma_2 \sigma_t + \gamma_3\, r_t^N + \gamma_4 API\sigma_t + \varepsilon_t \qquad (5)$$

Where RES is the real level of international reserves (including gold) in US$ million, IMP is real merchandise imports of in US$ million, API is the average propensity to import in percentages, σ is uncertainty defined in terms of the standard deviation of past real export earnings (defined in US$ millions) and r^N is the net opportunity cost of holding reserves, i.e. the difference between the domestic interest rate r^D (yield on government treasury bills) and r^F the yield of foreign reserves (proxied by the US treasury bills rate), in percentages per annum. All variables except the interest rate, the API and the volatility measure are in logarithms. The model is estimated in quarterly, seasonally adjusted data over the period 2000-2013.

A first look at the data reveals that there is a multicollinearity problem with the variables IMP and API (correlation 0.89). Therefore I decided to exclude the variable API from my analysis and reduced the reserve demand model to a function of scale, uncertainty and the opportunity cost of holding reserves:

$$RES_t = \gamma_0 + \gamma_1 IMP_t + \gamma_2 \sigma_t + \gamma_3\ r_t^N + \varepsilon_t \ (6)$$

As in Edwards (1984), the reserve demand equation is specified in real terms to account for the fact that reserves are held to finance real transactions or to face real shocks. While data on the exact currency composition of international reserves are kept in confidentiality by central banks, it is reasonable to assume that a large share of the Egyptian reserves were held in US$ because of the US$ peg and the fact that the US is one of Egypt's main trading partner, accounting for some x per cent of Egypt's total trade. Therefore I denominate the reserve demand equation in US$ and use the US t-bills as proxy for the yield on reserves.

Of the variables in equation (6) and following the discussion in section II, one would expect a positive sign for both trade variables IMP and σ_t. Finally, the interest rate differential r_t^N is expected to enter with a negative sign. The domestic interest rate r^D measures the gross opportunity cost, i.e. the yield forgone by binding resources to foreign reserves instead of other assets. However, as reserves are generally interest-bearing (except gold holdings), a proxy for the yield earned on reserves r^F has to be deducted in order to obtain the net opportunity cost of holding reserves r^N.

The results of the Dicky-Fuller (DF) unit root test indicate that all variables are nonstationary at the level, but stationary at the first difference, or integrated of order one I(1) (Appendix 2). This suggests that these variables could have a long-run cointegrating relationship. The results of the cointegration analysis of the reserve demand model are shown in table 3 using both the trace statistic λ_{trace} and the maximum eignevalue statistic λ_{max},. The latter indicates the existence of a single co-integrating vector.

Table 3: Johansen cointegration test: Reserve demand function (2000:3-2013:1)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.619475	79.59604	54.07904	0.0001
At most 1 *	0.325004	37.08310	35.19275	0.0309
At most 2	0.224021	19.78894	20.26184	0.0580
At most 3	0.178086	8.629235	9.164546	0.0631

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.619475	42.51294	28.58808	0.0005
At most 1	0.325004	17.29416	22.29962	0.2160
At most 2	0.224021	11.15970	15.89210	0.2402
At most 3	0.178086	8.629235	9.164546	0.0631

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The equation of the long run demand for international reserves is

$$RES_t = 2.54 + 0.55IMP_t - 0.01r_t^N + 1.01\sigma_t$$

All variables have the correct signs and are significant. In the long-term, reserve movements respond positively to trade variables (imports and volatility of export earnings) and negatively to the opportunity cost of holding reserves, even though the influence of the latter is rather small.

Table 2: Normalized cointegrating coefficients and adjustment coefficients

Cointegrating vector			
	Coefficent	Standard error	t-statistic
IMP	-0.547665	0.05376	-10.1872
r^n	0.011098	0.00603	1.84111
σ	-1.005243	0.26245	-3.83017
Constant	-2.545239	0.21982	-11.5790
Loading			
α_{11}	-0.398423	0.12845	-3.10176

It is to be noted that the monetary disequilibrium term is not included in the long-term reserve demand function as according to the monetary approach to the balance of payments, this term should only influence demand in the short term. Therefore, the short-run VEC is similar to equation (6) but in addition includes the term M^{DE} as an exogenous variable.

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \ \Delta z_{t-i} + \Pi \Delta z_{t-1} + \Psi M^{DE} + u_t \qquad (7)$$

The vector z now amounts to $z = (RES, IMP, \sigma, r^N\ )'$. The error correction model was estimated with lags up to four quarters as indicated by the LR and AIC criteria. The monetary disequilibrium term, given by equation 4, is assumed to affect only the short-run . The lagged variable M_{t-5}^{DE} is used because it turned out significant while the contemporaneous and shorter lagged values were not. If both lagged and contemporaneous variants are included, only the lagged variable M_{t-5}^{DE} remains significant. This means that money disequilibrium affects reserve demand with a one year lag.

The results of the error-correction model are reported in table 5. The speed of adjustment implied by the coefficient of the error correction term in the reserve demand equation (is negative and statistically significant) points to a rather active reserve management of the Central Bank of Egypt: 40 percent of the deviation from the long-run equilibrium is eliminated within one quarter., meaning that it takes up to three quarters for reserves to adjust to their desired level. With respect to short-run dynamics, reserve movements are explained only by lagged reserves, however none of the other dependent variables nor their lags are significant, even though the long-run relationship was validated. However, the lagged monetary disequilibrium term enters the equation significantly. This suggests that changes in the money market affect reserve holdings after a year and in the opposite direction. Excess demand for (supply of) money leads to a lagged increase (decrease) in reserves with an elasticity of only 0.12. For reserve changes to eliminate the disequilibrium completely, one would expect a coefficient equal to unity. The small coefficient could mean that the central bank is reluctant to allow monetary fluctuations to affect Egypt's reserve position. To this effect, the CBE may be taking some measures to clear the money market to restore the equilibrium. However, eventually when the monetary disequilibrium accumulates to a particular level, the authorities would use the foreign reserves either to supplement the money supply or absorb excess demand.

Table 4: Results from the VECM

Error Correction:	D(LNRES)	D(LNIMP)	D(IRDIFF)	D(VOLAT3)
CointEq1	-0.398423	0.488684	1.802599	0.045740
	(0.12845)	(0.15122)	(5.24050)	(0.04071)
	[-3.10176]	[3.23155]	[0.34397]	[1.12364]
D(LNRES(-1))	0.566292	-0.084141	-9.048435	0.021141
	(0.18010)	(0.21203)	(7.34770)	(0.05707)
	[3.14432]	[-0.39684]	[-1.23147]	[0.37042]
D(LNRES(-2))	0.117452	-0.319661	-7.506171	-0.023754
	(0.21670)	(0.25512)	(8.84105)	(0.06867)
	[0.54199]	[-1.25297]	[-0.84901]	[-0.34589]
D(LNRES(-3))	0.819731	-0.829768	2.914294	0.039382
	(0.23770)	(0.27984)	(9.69766)	(0.07533)
	[3.44859]	[-2.96514]	[0.30052]	[0.52280]
D(LNRES(-4))	0.263263	-0.739284	5.377601	-0.037901
	(0.31140)	(0.36661)	(12.7045)	(0.09868)
	[0.84541]	[-2.01656]	[0.42328]	[-0.38406]
D(LNIMP(-1))	0.026758	-0.013658	2.230957	-0.008967
	(0.14133)	(0.16638)	(5.76581)	(0.04479)
	[0.18933]	[-0.08209]	[0.38693]	[-0.20021]
D(LNIMP(-2))	-0.107365	0.227769	3.561975	-0.015815
	(0.12530)	(0.14751)	(5.11199)	(0.03971)
	[-0.85686]	[1.54405]	[0.69679]	[-0.39827]
D(LNIMP(-3))	0.023372	0.404674	3.378824	-0.001169
	(0.12899)	(0.15185)	(5.26237)	(0.04088)
	[0.18120]	[2.66489]	[0.64207]	[-0.02861]
D(LNIMP(-4))	-0.097093	0.167410	-3.559433	0.000933
	(0.13505)	(0.15899)	(5.50971)	(0.04280)

	[-0.71895]	[1.05295]	[-0.64603]	[0.02181]
D(IRDIFF(-1))	0.007599	-0.018676	-0.376177	0.000622
	(0.00525)	(0.00618)	(0.21411)	(0.00166)
	[1.44799]	[-3.02275]	[-1.75693]	[0.37369]
D(IRDIFF(-2))	0.002096	-0.025943	-0.133093	0.001938
	(0.00653)	(0.00769)	(0.26640)	(0.00207)
	[0.32102]	[-3.37473]	[-0.49960]	[0.93651]
D(IRDIFF(-3))	0.005117	-0.018003	-0.086520	0.000633
	(0.00585)	(0.00689)	(0.23861)	(0.00185)
	[0.87499]	[-2.61470]	[-0.36261]	[0.34159]
D(IRDIFF(-4))	0.001254	-0.000664	-0.057610	0.000571
	(0.00516)	(0.00608)	(0.21071)	(0.00164)
	[0.24286]	[-0.10919]	[-0.27341]	[0.34891]
D(VOLAT3(-1))	0.519775	0.545218	-36.57424	0.566379
	(0.60517)	(0.71246)	(24.6898)	(0.19178)
	[0.85888]	[0.76526]	[-1.48135]	[2.95323]
D(VOLAT3(-2))	0.521884	-1.762367	57.84731	0.005762
	(0.69524)	(0.81849)	(28.3641)	(0.22032)
	[0.75066]	[-2.15319]	[2.03945]	[0.02615]
D(VOLAT3(-3))	0.789092	0.040028	4.979472	-0.053682
	(0.75516)	(0.88904)	(30.8088)	(0.23931)
	[1.04494]	[0.04502]	[0.16162]	[-0.22432]
D(VOLAT3(-4))	0.350081	0.373790	-13.90140	-0.282483
	(0.67070)	(0.78961)	(27.3633)	(0.21255)
	[0.52196]	[0.47339]	[-0.50803]	[-1.32902]
MDE(-5)	-0.116719	-0.029157	-0.262843	0.016998
	(0.03884)	(0.04573)	(1.58468)	(0.01231)
	[-3.00493]	[-0.63762]	[-0.16586]	[1.38091]
R-squared	0.696507	0.507989	0.347926	0.528879
Adj. R-squared	0.498070	0.186290	-0.078430	0.220838
Sum sq. resids	0.078515	0.108821	130.6852	0.007885
S.E. equation	0.054953	0.064695	2.241953	0.017415
F-statistic	3.509956	1.579082	0.816046	1.716910
Log likelihood	76.79713	69.61592	-86.38254	127.3599
Akaike AIC	-2.672597	-2.346178	4.744661	-4.970905
Schwarz SC	-1.942701	-1.616283	5.474557	-4.241009
Mean dependent	-0.003804	0.024578	0.205000	-0.002977
S.D. dependent	0.077565	0.071719	2.158891	0.019729

Determinant resid covariance (dof adj.)	1.18E-08
Determinant resid covariance	1.44E-09
Log likelihood	198.0902
Akaike information criterion	-5.504099
Schwarz criterion	-2.381767

VI. Conclusion and Policy Implications

This paper has shown that reserves have fallen to critical levels in Egypt, based on several reserve adequacy ratios. This is the first paper to investigate reserve demand in Egypt. It does so for the the period 2000:3–2013:1 and considered the role of imbalances on the national money market for short-run reserve movements. The paper has the following preliminary findings: First, Egypt's long-term reserve demand function can be described as a function of the import level and the volatility of export earnings (as a proxy for trade volatility) as well as the opportunity cost of holding reserves. Second, the speed adjustment points to a rather active reserve management of the Central Bank of Egypt (CBE) in the short-term: 40% of the deviation from the long-run equilibrium is eliminated within one quarter. Finally, giving support to the monetary approach to balance of payment, results confirm that reserve demand responds to money market disequilibrium in the short-term: an increase in excess demand for money by 1% would lead to an accumulation of reserves by only 0.13%. The low elasticity suggests that CBE is reluctant to allow monetary fluctuations to affect Egypt's reserve position and may be taking some measures to clear the money market to restore the equilibrium.

The outcome of this research has important implications for monetary authorities in Egypt. First, the Central Bank of Egypt's foreign exchange policy adopted since January 2011 and which primarily relies on reserve depletion to support the exchange rate has reached its limit. Monetary authorities should explore other options including introducing more flexibility in the exchange rate regime and/or resort to foreign borrowing in order to bridge the external financing gap. Needless to say, all these policy options would only fully reap their intended benefits with a stable political environment. Second, Egypt is a large importer (merchandise imports account for 25% of GDP) and is considered to be the largest wheat importer. Imports are an important determinant of long-run reserve demand and it is crucial for monetary authorities to better manage their holdings in order to avoid any disruption in import financing in coming years. Third. as domestic interest rates have soared during the political crisis reflecting a high sovereign risk premia and as US tbills rate is maintained near the zero bound, the opportunity cost for holding reserves has risen significantly over the past two years, reaching more than 14 basis points and almost 1% of annual GDP in Q4:2012. Having said that, as reserves have reached very low levels in Egypt, monetary authorities need to increase their reserve holdings to more precautionary levels, despite the high opportunity cost. Three, the small and lagged response of reserves to changes in excess money demand suggests that CBE is reluctant to let monetary fluctuations affect Egypt's reserve position and may be taking some measures to restore equilibrium in the money market.

References to be completed

Appendix 1

Description of the Data

M2= real money supply (LE mn): Central Bank of Egypt. Calculated as sum of "M1 (being currency in circulation and demand deposits in local currency) and quasi-money (time and saving deposits in domestic and foreign currency). Nominal series were seasonally adjusted and deflated with Egypt's CPI.

IP=Real industrial production (LE mn): Central Agency for Public Mobilization and Statistics. Nominal series were seasonally adjusted and deflated with Egypt's CPI.

r = 3-month deposit rate in percentages per annum: Central Bank of Egypt.

RES= real international reserves (US$ mn): Central Bank of Egypt. The nominal series were deflated with the US CPI.

IMP= real merchandise imports (US% mn): Central Bank of Egypt. Nominal series were seasonally adjusted and deflated with US CPI.

σ = standard deviation of past real merchandise export earnings over the previous 12 quarters.

$r^N = r^D - r^F$ is the difference between the domestic interest rate r^D and r^F a foreign interest rate, in percentages per annum.

r^D = 3-month t-bills rate in Egypt, in percentages per annum: Central Bank of Egypt.

r^F= 3-month t-bills rate in the US, in percentages per annum: Federal Reserve.

API= 100*IMP/GDP = average propensity to import (%).

Appendix 2

The Dicky-Fuller (DF) unit root test was carried out for a lag of 10 quarters based on the Schwartz Criterion (SC). The following variables: M2, IP, r and σ include a constant term whereas the following ones include a constant term in addition to a linear trend: RES, IMP, r^N and API.

Table x: The Augmented Dicky-Fuller test

Variable	ADF statistic	Order of integration	McKinnon critical values for rejection of hypothesis of a unit root		
			1 percent	5 percent	10 percent
Log levels (except interest rates ,σ and API)					
M2	-2.961610	I(1)	-3.568308	-2.921175	-2.598551
IP	-2.041645	I(1)	-3.571310	-2.922449	-2.599224
r	-1.651031	I(1)	-3.571310	-2.922449	-2.599224
RES	-0.329544	I(1)	-4.156734	-3.504330	-3.181826
IMP	-2.010470	I(1)	-4.152511	-3.502373	-3.180699
σ	-2.447894	I(1)	-3.574446	-2.923780	-2.599925
r^N	-2.591149	I(1)	-4.152511	-3.502373	-3.180699
API	-2.400781	I(1)	-4.186481	-3.518090	-3.189732
First differences					
Δ*M2*	-5.618592	I(0)	-3.571310	-2.922449	-2.599224
ΔIP	-11.00377	I(0)	-3.571310	-2.922449	-2.599224
Δr	-4.687341	I(0)	-3.571310	-2.922449	-2.599224
ΔRES*	-3.863741	I(0)	-4.156734	-3.504330	-3.181826
ΔIMP	-5.666615	I(0)	-4.156734	-3.504330	-3.181826
$\Delta\sigma$	-3.613382	I(0)	-3.574446	-2.923780	-2.599925
Δr^N	-8.118175	I(0)	-4.156734	-3.504330	-3.181826
Δ *API*	-6.306748	I(0)	-4.192337	-3.520787	-3.191277

- Significance at the 5% level. The null hypothesis of a unit root is rejected if the t-statistic is greater than the critical values.