Title: Exploring the Role of the Exchange Rate in Monetary Policy in Egypt

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Abstract:

Recent reforms have enhanced the monetary policy framework in Egypt in order to pave the way for inflation targeting. Yet, there is not yet full transparency with respect to other policy objectives besides inflation, namely the stabilization of the exchange rate, which was officially abandoned as a nominal anchor in 2003.

Against this backdrop, this paper seeks to characterize the systematic behaviour of Egyptian monetary policy. It follows Clarida, Galí and Gertler (CGG) (1998) to estimate a forward-looking interest rate rule for Egypt using monthly data between 2000 and 2008.The results of a baseline model in which the central bank does not take into account the exchange rate allows us to examine whether interest rate setting responds to inflation, the output gap and a lagged interest rate. The results are then compared with those of a model in which the exchange rate is added as an explanatory variable. The empirical analysis shows that monetary policy has accommodated inflation and has not been forward-looking and that it systematically reacted to changes in the exchange rate.

Keywords: monetary policy rule, exchange rate, inflation targeting, GMM, Egypt.

JEL classification: E4, E5, F3.

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EXPLORING THE ROLE OF THE REAL EXCHANGE RATE IN MONETARY POLICY IN EGYPT

INTRODUCTION

Recent reforms have improved the monetary policy framework in Egypt in order to pave the way for inflation targeting (Selim, 2011). Yet, there is not yet full transparency with respect to other policy objectives besides inflation, namely the stabilization of the exchange rate, which was officially abandoned as a nominal anchor in 2003. Moreover, while there has been a marked reduction in global inflation over the past two decades (at least prior to the 2008 food price shock), Egypt did not take part in this era of “Great Moderation.”

In this context, it is important to assess how policy was conducted and to determine whether the exchange rate continues to serve as a constraint to policy or, in other words, whether interest rates are being used to respond to exchange rate movements. To do so, this paper seeks to characterize the *systematic* behaviour of Egyptian monetary policy to answer the following questions:

- Has the monetary stance been accommodative of inflationary pressures?
- Could the CBE be characterized as an implicit flexible inflation targeter?
- Does it modify its monetary policy stance to respond to the exchange rate?

The paper follows Clarida, Galí and Gertler (CGG) (1998) to estimate a forward-looking policy reaction function for the Central Bank of Egypt (CBE) using monthly data between 2000 and 2008. A baseline model is first estimated allowing the central bank to respond to expected inflation, the output gap and a lagged interest rate. And since the official exchange rate regime shifted to a *float* in 2003, the analysis introduces real exchange rate fluctuations in the alternative specification of the monetary policy rule to examine whether interest rates react to such movements. This is particularly important since monetary authorities have not been very clear with respect to the role of the exchange rate in the new monetary policy framework.

The main conclusions of the empirical analysis are as follows. First, monetary policy has accommodated inflation and has not been forward-looking. Second, the CBE has shown concern for minimizing deviations of output from its potential level. Yet, because the coefficient of inflation was not significant, monetary policy cannot be described as (implicit) inflation targeting (IT). Third, there is also evidence that monetary authorities strongly reacted to changes in the exchange rate. Fourth, there is considerable evidence of interest rate smoothing.

The paper proceeds as follows. The first section presents an overview of monetary policy rules with a particular focus on the exchange rate issue in emerging market economies (EMEs). The second section summarizes empirical findings of previous work. The third analyses the main characteristics of monetary policy in Egypt. The fourth describes model set-up and the GMM estimation techniques.

The fifth section deals with data issues and the sixth presents and discusses the results. The final section concludes.

I. AN OVERVIEW OF MONETARY POLICY RULES

This section addresses two issues. The first is a brief review of the role of monetary policy rules. The second is discussing formulations of rules for closed economies.

1. The role of monetary policy rules

The literature on monetary policy rules dates back to the late 1940s with Friedman's monetary growth rule. Yet, two important developments occurring as of the late 1970s gave renewed attention to the topic. The first was the idea that policy rules are superior to pure discretion, the latter leading to an inflationary bias. According to Kydkand and Prescott (1977), the existence of a binding rule would reduce the policymakers' short-run incentive to adopt an expansionary monetary policy to increase output and employment. This is because economic agents have rational expectations, and thus account for the incentive of policymakers to do so and adjust their behaviour accordingly, thus creating an inflationary bias. Alternatively, Barro and Gordon (1983) explain that in the presence of a rule, the central bank chooses a path of the interest rates that it sticks to indefinitely, irrelevant of current conditions. Under discretion, the interest rate is chosen by re-optimizing every period taking into account current conditions and treating past experiences as irrelevant. In this setting, if actual output exceeds potential output, then the equilibrium outcome will yield an inflationary bias. On the other hand, supporters of discretionary policy claim that it gives policymaking the flexibility to deal with unforeseen shocks or changes in the structure of the economy.

The second factor that led to renewed attention in the monetary policy rules literature was the emergence of the neo-classical thinking, incorporating nominal price rigidities, which showed that monetary policy can be used effectively to moderate short-term fluctuations of employment and output (CGG, 1999 and McCallum, 1999a). More recently, the emergence of the Taylor rule (and subsequently the IT rule) and the reliance on simple quantitative macroeconomic models led to a rapprochement between academic thinking and central banking practice (McCallum, 1999a and Woodford, 2006).

Most research tends to argue against the adoption of purely discretionary frameworks in EMEs. Calvo and Mishkin (2003) explain that they require greater monetary discipline in the conduct of monetary policy as a result of low policy credibility (because of weak fiscal, financial and monetary institutions, a higher risk of currency substitution[1] and liability dollarization[2]). Taylor (2000) further explains that rules can provide them with a good overall framework for making monetary policy

[1] This means that firms and individuals in EMEs turn to use a foreign currency for transactions instead of the local currency Calvo and Mishkin (2003).

[2] This means that the obligations of banks, the private sector and the government are denominated in foreign currency while their revenues are denominated in local currency Calvo and Mishkin (2003).

decisions because they make policy intentions become more transparent to the public and thus make it easier for the private sector to form expectations. This predictability in policy behaviour should also improve the transmission and effectiveness of monetary policy.

The analysis of monetary policy rules has developed along two lines. A first strand of research has sought to assess the optimality of rules and analyze their performance in models with optimizing agents as well as test for their robustness across a spectrum of macro-models. This work includes for instance (Isard, Laxton and Eliasson, 1999; Rudebusch and Svensson, 1998; Levin, Wieland and Williams, 2003; and Woodford, 2001). The second approach consists in the empirical estimation of reaction functions as a means of characterizing monetary policy and interpreting policy developments (Taylor, 1993 and CGG, 1998). This paper adopts the second approach.

2. *Alternative formulations of monetary policy rules*

a) Closed economies

The initial research on monetary policy rules was based on the case of a closed economy. The Taylor rule (1993) suggests that the central bank changes its policy rate i_t according to the equilibrium real interest rate r^* the current period inflation rate π_t relative to an "implicit" target π^* and the output gap x_t. It has the following form:

$$i_t = r^* + \pi^* + \beta(\pi_{t-1} - \pi^*) + \gamma x_t \qquad (1)$$

Several extensions have been made to the initial Taylor rule formulation, most notably the one suggested by CGG (1998) which has the following form:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_t + \rho i_{t-1} + \varepsilon_t \qquad (2)$$

where π_{t+n} is the expected inflation rate between periods t and t+n and i_{t-1} is the lagged interest rate. [3]

According to CGG (1998), this rule is a generalization of the Taylor rule and could be reduced to a simple Taylor rule if either lagged inflation or a linear combination of lagged inflation and the output gap were to provide a sufficient statistic for inflation. According to the authors, this more general specification has several advantages. First, it explicitly incorporates expected inflation in the reaction function, thus making it easier to dissociate between the estimated coefficients and central bank objectives. Second, it assumes a forward-looking representation of the economy, since the central bank reacts to expected inflation and considers a broad array of information (about inflation and output) in their decision. Third, the reaction function captures the desire of central banks to smooth interest rate changes, ie it introduces small steps in the policy rate in order to achieve the

[3] The derivation of this rule is presented in details in section C.

required change in the long-term rate (Sack and Wieland, 1999). Various motivations for smoothing interest rates are reviewed in Sack and Wieland (1999) and CGG (1999). First, it increases the impact of policy decision on current output and inflation without requiring large changes in the interest rate. In fact, as market participants expect a small policy change to be followed by additional moves in the same direction, they price their expectations into forward rates (Sack and Wieland, 1999). Second, interest rate smoothing avoids excessive interest rate volatility and thus limits the disruption of financial markets and mitigates capital losses for financial institutions exposed to interest rate risk (CGG, 1999). Third, moderate interest rate responses accommodate the uncertainty of parameters of the economic structure (as a result of imperfect information) as well as some degree of data measurement error (Sack and Wieland, 1999). Other reasons could include avoiding reputation risks to central banks from sudden reversals of interest rate directions (Mohanty and Klau, 2004). From an empirical point of view, reaction functions of the main industrial countries estimated by CGG (1998) and Seyfried and Bremmer (2003) confirm that the interest smoothing hypothesis is valid.

Both Taylor (1993) and CGG (1998) show that the coefficient of inflation in the reaction function (β) should be above unity in order to reduce inflation. This implies that the central bank should adjust the nominal short-term rate more than one-for-one with the inflation gap. Otherwise, it would fail to increase the real interest rate. In this case, monetary policy would be accommodating rather than fighting increases in expected inflation.

b) Open economies

Later on, policy rules were augmented with an exchange rate term to take into account the impact of the latter on the domestic economy. Adding the exchange rate in the policy rule means that it is one source of information to be considered when setting interest rates. This is different from targeting the exchange rate which becomes a policy goal (Dennis, 2001).

In open economies, Svensson (2000) explains that the exchange rate, depending on how open the economy is, allows for several transmission channels in addition to the standard aggregate demand and expectations channels in closed economies. A direct channel to CPI inflation (exchange rate pass-through) implies that a reduction in short-term interest rates will depreciate both the nominal and real exchange rates, which passes through into higher (import and consumer) prices. Also, the exchange rate depreciation increases demand for export and other import competing goods which also increases aggregate demand. The depreciation is translated into higher production costs of imported intermediate inputs as well as imported final goods and reduced purchasing power of wages and lower wage demands (the production costs channel to inflation).

The theoretical debate on whether central banks should respond to exchange rate movements when setting short-term nominal interest rates remains unsettled (Taylor, 2001). On the one hand, some argue in favour of including it on the basis that it provides timely and relevant information for inflation (Svensson, 2000 and Dennis, 2001). On the other hand, others argue that large interest rate movements to defend exchange rate depreciation may have balance sheet contractionary effects and could also generate inflation (Bernanke and Gertler, 2000) and Taylor, 2001). In the case of open economies, research based on simulations of calibrated macroeconomic models does not provide conclusive evidence that rules including the exchange rate produce better economic outcomes (Ball, 1998, Svensson, 2000, Senay, 2001, vs. CGG, 2001 and Batini, Harrison and Millard, 2001). In the context of EMEs, the empirical literature concluded that the inclusion of the exchange rate in central banks' reaction functions may be justified in financially vulnerable economies, provided that the weight attached to it is low (Morón and Winkelried, 2005; Céspedes et al., 2004; Cavoli and Rajan, 2006; and Roger et al., 2009).

II. REVIEW OF EMPIRICAL FINDINGS

Empirical work on monetary policy rules was instigated by the seminal work of Taylor (1993). Ever since, it has become common practice to describe monetary policy using reaction functions. This work estimated the weights of inflation, output and the exchange rate to provide a characterisation of ex-post policy. The empirical literature, in the industrial country context and to a lesser extent for EMEs, has thus thrived with the aim of comparing the ex-post the actual setting of policy rates by central banks with what would have been predicted by the rule. This chapter adopts the second approach. This section briefly illustrates some of the recent studies that estimated open-economy reaction functions.

Initially, work focused on the United States (Taylor, 1993; CGG, 2000; and Judd and Rudebusch, 1998). In essence, these authors provide evidence that during the Great Inflation, the Federal Reserve pursued a policy that accommodated inflation (the β coefficient was estimated at 0.5 by Taylor (1993)). Subsequent empirical work sought to estimate interest rate rules for other economies. CGG (1998) find evidence of flexible implicit IT in a number of OECD countries (i.e. they have raised real interest rates when expected inflation was above target) between 1979 and the early 1990s. In the case of the euro area, similar results were achieved by Peersman and Smets (1999), Gerlach and Schnabel (1998), Chortareas (2008), Fendel and Frenkel (2006), Nelson (2003), Gerlach-Kristen (2003) and Verdelhan (1999).

In the case open-economy industrial economies, some empirical work suggests that the interest rate was used to stabilize the real exchange rate (Clarida and Gertler, 1997, CGG, 1998, Kim, 2002, Chadha et al., 2004), or its deviations from fundamental value (Kharel, Martin and Milas, 2010). Results of many multi-country studies are mixed with the finding that some central banks use their policy instrument to respond to the exchange rate (Gerlach and Smets, 2000); and Lubik and Schorfheide, 2007) while others do not (Gerdesmeier and Roffia, 2003). In the context of IT, Sgherri (2005) and Hüfner (2004) find that the central banks in most industrialized economies have ignored real exchange rate misalignments. However, Bjørnland and Halvorsen (2008) find evidence of systematic policy responses to exchange rate depreciations in Australia, Canada, New Zealand, Norway, Sweden and the United Kingdom.

In the case of EMEs, empirical work confirms that central banks respond very strongly to exchange rates and that this response is even greater that to either inflation or the output gap (Aizenman, Hutchinson and Noy, 2008; Mohanty and Klau, 2004; Ades et al., 2002; and Filosa, 2001). Moreover, the reponse tends to be stronger in: (i) non-IT economies, suggesting that IT places a constraint on the pursuit of an exchange rate target (Aizenman et al., 2008), (ii) economies with a history of high inflation and with historically high real exchange rate volatility (Edwards, 2007), (iii) in commodity-exporting economies (Aizenman et al., 2008). Other cross-country studies are unable to generalize these findings to all the countries (Hsing, 2009; de Carvalho and Moura, 2008; Schmidt-Hebbel and Werner, 2002) and some work finds no evidence of an interest rate response to the exchange rate (Osawa, 2006; and Yazgana and Yilmazkuday, 2007). On individual country studies, empirical evidence confirm the existence of a systematic response to the exchange rate (Caputo, 2004; Schmidt-Hebbel and Tapia, 2002; Parsley and Popper, 2009; and Eichengreen, 2004) but not in others (Berument and Taşçi, 2004; and Chang, 2005).

In the case of Egypt, four studies estimated reaction functions for the monetary authorities and did so in Taylor rule formulations. In a multi-country study including Egypt, Jordan, Kuwait, Saudi Arabi and Tunisia, El-Erian and El-Gamal (2002) estimate Taylor closed and open-economy rules during the 1990's. For Egypt, they report a feedback parameter of -0.63 on inflation and 0.34 on the output gap. In its augmented-form, the Taylor-rule had the following coefficients: -0.81 for current inflation, 0.21 for the output gap and 9.69 for the real exchange rate. In both forms, the interest rate responded negatively to current inflation. It also responded positively to the output gap but the coefficient was not significant. The inclusion of the exchange rate yields a significant positive coefficient. Moursi et al. (2007) calibrate a simple closed economy Taylor rule in an optimization macroeconomic framework for the period 2001-2006. They report a coefficient of the inflation gap in the reaction function that is slightly below unity (0.93). The last one by Al-Mashat (2011) relies on a modified reduced-from New Keynesian model to show that the policy rule containing an exchange rate target generates the highest output and inflation variability. The latter decline as greater exchange rate flexibility is allowed.

In sum, no study estimated a forward-looking rule (with expected inflation) with interest smoothing along the lines proposed by CGG (1998) using GMM, which is the aim of this paper. The CGG rule specification is believed to provide a good description of monetary policy, particularly since 2003 for several reasons. First, the estimation of this rule requires ex-post data, including the measure for expected inflation, which is useful in the Egyptian case since there is no published inflation forecast. CGG (1998) considers that the year-ahead forecast to be a good indicator of the medium-term trend of inflation. Moreover, the estimation of this rule also provides an estimate for the inflation target. Second, the alternative specification also permits a test of the forward-looking versus the backward-looking specifications of the reaction function. Third, it allows to test whether additional policy variables may explain the interest rate setting behaviour of the monetary authorities. Namely, the inclusion of the exchange rate term in the rule is believed to be pertinent in the case of Egypt since it may still be acting as an external constraint on monetary policy.

III. MONETARY AND EXCHANGE RATE POLICIES AND INFLATION IN EGYPT

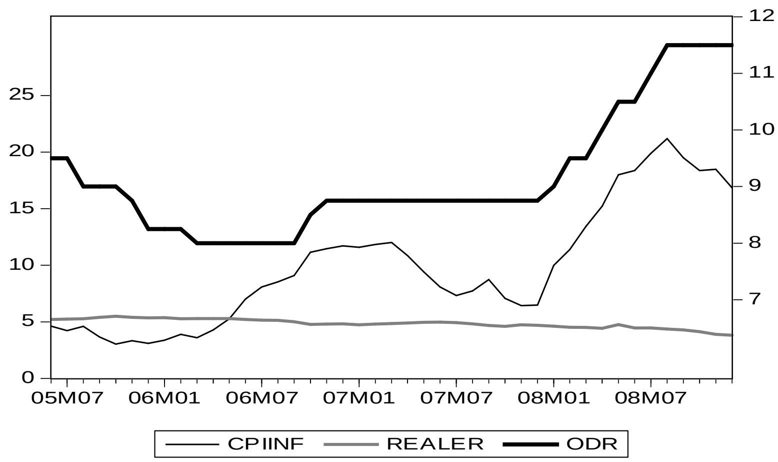
This section briefly describes the institutional framework in which the CBE operates.

There has been a first shift in the conduct of monetary policy in the early 1990s in the context of an Economic Reform and Structural Adjustment Program. Key elements of the reform included a large fiscal adjustment, an exchange rate anchor and some price liberalisation. These reforms, aided by a credible nominal anchor (an exchange rate peg), helped refocus (albeit implicitly) monetary policy towards disinflation (Selim, 2011). Monetary policy has benefited from further improvements in its underlying framework since 2003. In particular, price stability was formally declared (through the 2003 Banking Law and other CBE statements) to be the overriding medium-term objective of monetary policy (CBE, 2005). The CBE also announced its intention to move to IT in 2005.

Yet, these improvements did not allow monetary policy to achieve price stability, especially that the framework still lacks an official nominal anchor since 2003 (Selim, 2011).[4] More specifically, there has not been a redefinition of the role of the exchange rate under this new framework. The *de jure* float, *announced* in January 2003, allows the CBE to intervene in the foreign exchange market only to counter major imbalances and sharp swings in the exchange rate. Yet, the exchange rate only exhibited limited movements despite several external shocks (strong capital inflows during the 2005-2008 period and some outflow in the aftermath of the 2008 crisis) (figure 1). In this context, it is not clear to the public if and how monetary policy manages the exchange rate. However, it would seem that monetary policy tightening, which was necessary to control rising inflation since 2007, continued to attract foreign inflows, thus exerting upward pressure on the exchange rate (figure 1).

Figure 1: Real exchange rate, overnight deposit rate and inflation

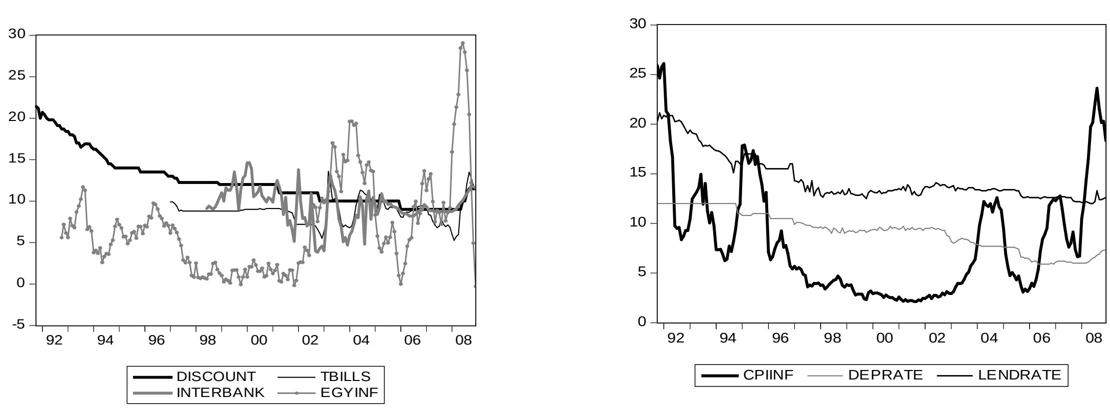
[4] For more information on the monetary policy framework in Egypt, please see Selim (2011).



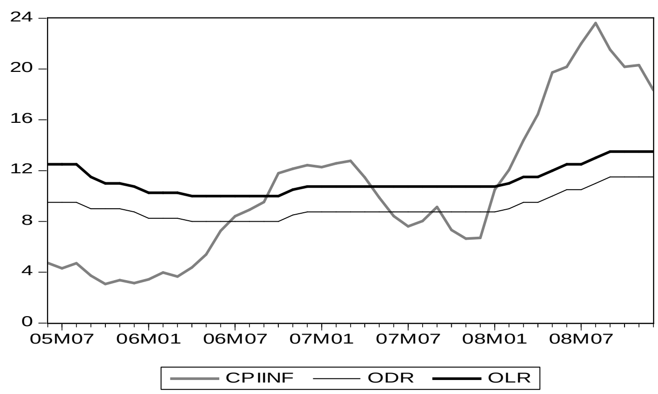
Even though the liberalisation of interest rates occurred in the early 1990's, the CBE did not rely on interest rates to conduct monetary policy, prior to 2005. However, since the exchange rate was largely fixed, there was relatively limited scope for the interest rate to independently respond to exchange rate fluctuations. However, there was no policy rate to identify the monetary policy stance. A discount rate existed and an effort was made to link it to the t-bills rate but it had ceased to respond to it since 1995 (Abou El-Eyoun, 2003). An overnight domestic currency interbank market was created in 2001 but it was thin and shallow, which rendered the inter-bank rate volatile (figure 2a). In general, the monetary authorities were not transparent about interested decisions. Other short-term rates such as the three-month t-bills rate, the three-month deposit rate and the one-year lending rate also existed but they were not responsive to the discount rate (Abou El-Eyoun, 2003) (figure 2b)..

Figure 2: Interest rates and inflation

(a) (b)

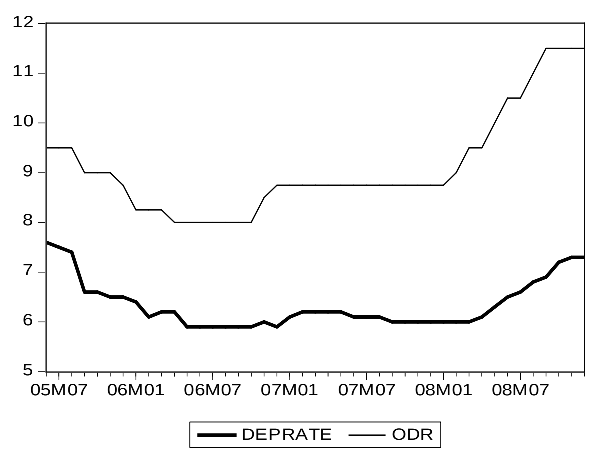


In order to prepare the implementation of IT, an attempt to conduct a systematic or rule-based monetary policy has been introduced. The launch of the new policy rates as the main operating target in June 2005 had the objective of helping the CBE meet an "implicit" inflation target. Figure (3) suggests that the central bank systematically raised nominal short-term rates in periods of high inflation. Yet, it would seem that in many cases policy decisions often lacked a forward-looking vision, reacting to developments only after they occur (Selim, 2011). Policy tightening was often also insufficient to curb rising inflation. For instance, the acceleration of inflation since March 2006 was only met with policy tightening in November 2006 and December 2006. And as inflation surged again from January 2008, the CBE tightened monetary policy six consecutive times between February and September 2008. In both cases, the CBE maintained an expansionary stance since real overnight deposit rates remained negative and declined. More generally, starting mid-2007 (except for a few months in end-2007), the CBE kept short-term rates below inflation rate. Real short-term rates accordingly hovered around zero or below.



While it has been often claimed that the pass-through of policy rates is low, the 3-month deposit rate seems more responsive to the changes in the new policy rate (figure 4).

Figure 4: New policy rate and the 3-month deposit rate



In summary, the framework that guides the conduct of monetary policy in Egypt has formally improved since 2003. It has the medium-term objective of maintaining price stability and relies on an interest rate instrument to reach an implicit inflation target. Yet, the exchange rate management policy has not been clear since the official *announcement* of the float. It would thus be useful to assess whether the policy rate is influenced by exchange rate considerations. No work has however empirically addressed this issue during the *post-float* era.

IV. MODEL SET-UP AND ESTIMATION TECHNIQUE

This section presents the model set-up and then presents the GMM technique estimation and justification for the choice to use it.

1. *Model set-up*

This section presents the specifications of the rule to be estimated first for the baseline case in which the central bank adjusts its short-term interest rate in response to expected inflation, the output gap and a lagged interest rate term. It then presents the alternative specification that allows the central bank to respond to other variables, namely the exchange rate.

a) Baseline model

The baseline case assumes that the central bank has some degree of autonomy over monetary policy and that the latter is not subject to an external constraint (an exchange rate target). The framework also assumes some degree of nominal rigidity in wages and prices so that monetary policy can affect real variables in the short-term. It also assumes that the central bank has a target for the short-term nominal interest rate (i_t^*), which is the main operating policy instrument. The central bank aims at maintaining the inflation rate equal to a pre-specified target level and keeping the economy as close as possible to a neutral cyclical position. More specifically, the central bank sets the target short-term interest rate conditional on the state of the economy and the short-term interest rate, on the deviation of expected inflation and output from their respective targets:

$$i_t^* = \bar{i} + \beta(E[\pi_{t+n}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^*) \tag{3}$$

where $\bar{i}$ is the long-run equilibrium nominal interest rate, π_{t+n} is the rate of inflation between periods t and t+n, y_t is real output, π^* is the inflation target and y_t^* is the potential output, defined as the level that would arise if wages and prices were perfectly flexible. In addition, E is the expectation operator and Ω_t is the information set available to the central bank at the time it sets the interest rate. The implied target for the ex-ante real interest rate could be written as follows:

$$r_t \equiv i_t - E[\pi_{t+n}|\Omega_t] \tag{4}$$

Rearranging equation 3, we obtain:

$$r_t^* = \bar{r} + (\beta - 1)(E[\pi_{t+n} | \Omega_t] - \pi^*) + \gamma(E[y_t | \Omega_t] - y_t^*) \tag{5}$$

According to this equation, the target real rate adjusts relative to its natural rate in response to departures of either expected inflation or output from their respective targets. As mentioned above, β must be greater than unity so that changes in the nominal rate induce changes in the real interest rate and therefore reduce inflation. If $\gamma \succ 0$, the real interest rate is also changed to stabilise output.

To capture the central bank's desire to smooth interest rate, it is assumed that the actual interest rate set by the central bank adjusts only partially to the target, as follows

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + \upsilon_t \tag{6}$$

where the parameter $\rho \in [0,1]$ captures the degree of interest rate smoothing, and υ_t is an exogenous random shock to the interest rate. It is assumed that υ_t is i.i.d. To derive an estimable equation, we define $\alpha \equiv \bar{i} - \beta\pi^*$ and $x_t \equiv y_t - y_t^*$. Equation (3) becomes:

$$i_t^* = \alpha + \beta E[\pi_{t+n} | \Omega_t] + \gamma E[x_t | \Omega_t] \tag{7}$$

From equations (3) and (4), we obtain:

$$i_t = (1-\rho)\{\alpha + \beta E[\pi_{t+n} | \Omega_t] + \gamma E[x_t | \Omega_t]\} i_t^* + \rho i_{t-1} + \upsilon_t \tag{8}$$

Finally, by eliminating the unobserved forecast variables from the expression by rewriting the policy variables in terms of the realized variables:

$$i_t = (1-\rho)(\alpha + \beta\pi_{t+n} + \gamma x_t) + \rho i_{t-1} + \varepsilon_t \tag{9}$$

where the error term $\varepsilon_t \equiv -(1-\rho)\{\beta((\pi_{t+n} - E[\pi_{t+n} | \Omega_t]) + \gamma(x_t - E[x_t | \Omega_t])\} + \upsilon_t$ is a linear combination of the forecast errors of inflation and output and the exogenous disturbance υ_t.

Equation (9) is the reaction function to be estimated that contains all the parameters of interest $[\beta, \gamma, \rho, \alpha]$. One advantage of this formulation is that all the dependent variables are future and current realizations of observable variables. Therefore, we avoid the problem of modelling, explicitly, the agents' expectations. The intuition behind this equation is fairly straightforward. If current inflation is above its target level, then the central bank should raise the domestic interest rate to dampen demand. If current output exceeds its long-run trend, then the interest rate should rise to offset inflationary pressure.

Moreover, as CGG (1998) point out, it is possible to use the parameter estimates β and α to recover an estimate of the central bank's inflation target π^*. While the empirical model does not separately identify π^* and $\bar{r}$, the long-run equilibrium real interest rate, it does provide a relation between the two variables that is conditional on β and α. Specifically, given that $\alpha \equiv \bar{r} - \beta\pi^*$, and $\bar{i} \equiv \bar{r} + \pi^*$, $\alpha \equiv \bar{r} + (1-\beta)\pi^*$, which implies that :

V. $$\pi^* = \frac{\bar{r} - \alpha}{\beta - 1} \qquad (10)$$

b) Alternative Specification

As discussed above, it is possible to test the role other potential explanatory variables in interest rate setting. Equation (3) of the baseline model is thus altered as follows:

$$i_t^* = \bar{i} + \beta\left(E\left[\pi_{t+n}\middle|\Omega_t\right] - \pi^*\right) + \gamma\left(E\left[x_t\middle|\Omega_t\right] - y^*\right) + \xi\left(E\left[z_t\middle|\Omega_t\right]\right) \qquad (11)$$

Where z_t is the set of alternative variables including lagged inflation to test the backward-looking direction of policy and the real exchange rate change. Equation (9) becomes:

$$r_t = (1-\rho)(\alpha + \beta\pi_{t+n} + \gamma x_t + \xi z_t) + \rho r_{t-1} + \varepsilon_t \qquad (12)$$

2. The Estimation Technique

This section very briefly reviews the different approaches that could be used in modelling monetary policy and presents justification for the choice of using GMM.

In general, three different approaches have been used in modelling monetary policy behaviour. A first approach is to use fully calibrated models derived from intertemporal optimization behaviours (Rotemberg and Woodford, 1998 and Svensson, 2000). This approach relies on model calibration is outside the scope of this work and has already been explored by Moursi et al. (2007).

Second, VARs have been generally used to analyze the transmission mechanisms of monetary policy shocks to key macroeconomic variables (Bernanke and Blinder, 1992, Christiano et al., 1996 and Bernanke and Mihov, 1998). Since, VAR estimations include among other dynamic relationships an equation for the monetary policy instrument, Clarida and Gertler (1997), Kim (2002), Filosa (2002), Schmidt-Hebbel and Werner (2002) and Bjǿrnland and Halvorsen (2008) have thus been able to estimate the parameters of the reaction function. These models have the advantage of being able to identify the effects of shocks without a complete structural model of the economy (Rudebush, 1998). They also allow the joint modelling of both the endogenous policy response and the transmission mechanism by making only minimal assumptions about their causal links. Yet, this approach identifies unsystematic monetary policy shocks (which are the components that are not due to the state of the economy as explained by McCallum (1999b)) and their effects on macroeconomic variables. This has led Clarida (2001) to argue that evidence from VAR estimations does not describe the systematic behaviour of the central bank. Moreover, McCallum (1999b) argues that the unsystematic component of policy is quite small compared to the systematic component. In fact, as shown by CGG (1998), the fraction of monthly instrument variability that is unexplained by the systematic component is only 1.9, 3 and 1.6 percent for the Bundesbank, Japan and the Federal Reserve respectively. Moreover, the monetary policy response to the exchange rate does not have a clear interpretation because it can either be an explicit response to exchange rate misalignments, a response to expected inflation (that is affected by the current level of the exchange rate) or a combination of the two (Clarida, 2001).

The third approach consists of the direct estimation of single-equation reaction functions for monetary policy instruments either using either with two-stage-least squared and GMM. The GMM was first used by CGG (1998). It is evident that because of the endogeneity problem or the correlation between the error term and some of the explanatory variables (namely future inflation as derived from equation 9), the use of ordinary least squares to estimate the equation will generate biased estimators. The GMM technique is mainly chosen in order to avoid this problem and provide consistent estimators under weak distributional assumptions (Wooldridge, 2001).[5] Work carried out using this methodology includes Gerlach and Schnabl (1999), Verdelhan (1999), Ades et al. (2002), Schmidt-Hebbel and Tapia (2002), Gerdesmeier and Roffia (2003), Berument and Taşçi (2004), Caputo (2004), Eichengreen (2004) and Mohanty and Klau (2004).

To apply GMM, it is necessary to impose an orthogonality condition between the error term ε_t in equation (9) and a vector of instrument variables u_t that contain central bank's information at the time it chooses to set the interest rate (i.e. $u_t \in \Omega_t$). Possible elements of u_t include any lagged variables that help forecast inflation and output as well as any contemporaneous variables that are uncorrelated with the current interest shock υ_t.[6] Then, since $E[\varepsilon_t | u_t] = 0$, equation (9) implies the following set of orthogonality conditions:

$$E\left[i_t - (1-\rho)\alpha - (1-\rho)\beta\pi_{t+n} - (1-\rho)\gamma x_t - \rho i_{t-1} | u_t\right] = 0 \tag{13}$$

In order to assess whether a particular set of instruments is valid, a *J-test* of over-identifying restrictions is implemented. The *J-statistic* minimizes the GMM objective function. Under the null hypothesis that the overidentifying restrictions are satisfied, the *J-statistic* times the number of regression observations is asymtptotically χ^2 distributed with *m-k* degrees of freedom, where *m* is the number of instruments used and *k* is the number of explanatory variables (Hansen (1982)). The

[5] Wooldridge (2001) explains that GMM are best suited for time series (as well as panel) analysis.

[6] Wooldridge (2001) indicates that the use of lagged values of dependent and dependent variables makes more sense in the context of models estimated under rational expectations. The error term is uncorrelated with all the variables dated at earlier time.

acceptance of the null hypothesis implies that there are values for the estimated parameters $[\beta, \gamma, \rho, \alpha]$ so that the implied residual ε_t is orthogonal to the variables in the information set Ω_t. Otherwise, some relevant "explanatory variables" are being omitted from the interest rate equation. To the extent that some of these variables are correlated with u_t, the set of orthogonality conditions will be violated, which would lead to a statistical rejection of the model.

VI. DATA ISSUES

The sample period consists of monthly observations between 2000 and 2008. As mentioned before, Egypt adopted a *de jure* more flexible exchange rate arrangement in early 2003 and hence regained some autonomy in the domestic conduct of monetary policy. Over this period, inflation rose since late 2004 and experienced three double-digit spikes, suggesting that monetary policy may have been accommodative or may have been hampered by other targets. A short description of the variables follows:

(i) Since there was no relevant policy rate before June 2005, the short-term interest rate is the 3-month deposit rate *(deprate)* is used as a measure of the stance of monetary policy.

(ii) Data on consumer price index (PPI) (2005=100) was used to measure inflation. Inflation is then calculated as the log difference over a 12-month period *(egyinf)*. For the estimation, the horizon of the inflation forecast (π_{t+n}) is chosen to be 12 months. This implies that the ending point of the ex-post inflation data is 12 months prior to the latest data available.

(iii) Due to the absence of monthly real GDP series for Egypt, this variable was interpolated using six high frequency indicator variables.[7] The output gap *(ygap)* is constructed by applying the Hodrick-Prescott (HP) filter under the assumption that output fluctuates around its potential level. The HP filter decomposes output into permanent and transitory components generating a smoothed trend of output. These generated series are the estimated potential output. The *ygap* is calculated as the difference between actual and potential output as a percentage to potential output.

(iv) Data on a commodity price index, being the IMF's Index of Fuel and Non Fuel Commodities (2005=100) is used as an instrument variable that is uncorrelated with the interest rate shock. The change in the index is calculated as the log difference over a 12-month period (*dlcomm)*.

(v) The real exchange rate (LE/US$) *(q)* is defined as the number of domestic currency units per US$. The exchange rate change is calculated as the log difference over a 12-month period.

Data on prices (including the 3-month deposit rate, the PPI, commodity price index and the nominal exchange rate) are from the IFS data base. To calculate the real exchange rate, the author

[7]A temporal disaggregation procedure, namely, oil price (UK Brent) and the real exchange rate (for US CPI) series as well as the real value series for exports, imports, money balances (M1) and real quasi-money. The CPI was used to deflate the nominal exports, imports, M1 and quasi-money series. The calculation of this variable was performed by Dr. Tarek Moursi and colleagues, whom we thank for sharing this data.

used the formula: $q = e\ *(\frac{ppi_{us}}{cpi_{eg}})$, where *(q)* is the real exchange rate, *(e)* is the nominal exchange rate, (ppi_{us}) is the foreign price level, proxied by the US producer price index for all commodities, and (cpi_{eg}) is the domestic price level, proxied by the consumer price level in Egypt. Data on the US PPI is from the US Bureau of Labor Statistics.[8] The real GDP, PPI time series and commodity price index were seasonally adjusted using e-views

In order to implement GMM, the time series should be stationary. The results of the Dicky-Fuller (DF) and Phillip-Perron (PP) unit root tests are reported in appendix (1). They show that the interest rate and exchange rate change variables are non-stationary at the level, but stationary at the first difference. However, several empirical work on reaction functions ignore the non-stationarity of the data in short samples on the assumption that the DF test has a lower power in short samples and that the time series would be stationary in a larger sample (Ades et. al (2002)). Gerlach-Kristen (2003) suggest that over short samples (less than 20 years), it is more likely that stationarity may be rejected. In any case, a cointegration test shows that a linear combination of these variables is stationary, suggesting that these variables have a stable long-term relationship.

VII. EMPIRICAL RESULTS

This section presents the results of estimating the policy reaction function (equation 9) as well as for two alternative specifications (equation 12). For the baseline specification, the set of instruments u_t includes a constant and 3, 6, 9 and 12 lagged values of inflation π_t, the log difference of a world commodity index *(dlcomm)*, the 3-month deposit rate r_t and the log difference of the LE/US$ real exchange rate (q_t *)*. For the output gap x_t, the lags included are 3 and 6. For the alternative specifications, the parameter vector is expanded to include the coefficient (ξ) on the additional variable z_t and the instrument list is expanded to include lagged values of this variable. A simple ***t-test*** on the significance of the coefficients of expected inflation, (β) the output gap (γ) and the exchange rate (ξ) can be performed. If these coefficients are statistically different from zero, then it is not possible to reject the hypothesis that the central bank has additional objectives besides controlling inflation.

The top line of table 1 reports the results for the baseline specification. The results show that the response to expected inflation (β) has an unexpected negative sign, it is below unity but the coefficient is not statistically significant. The counterintuitive negative sign implies that instead of tightening the stance of policy, a rise in expected inflation by 1 percent induced the central bank to reduce real interest rates by 16 basis points. This makes the CBE response to inflation accommodative or at best neutral in the face of expected inflation shocks.. Initially, this finding may seem a bit

[8] http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=WPSSOP3000&output_view=pct_1mth

surprising since nominal interest rates have increased several times in tandem with higher inflation. However, the econometric result is also consistent with the descriptive analysis in chapter 4 saying that these increases were not sufficient for the real interest rates (which were already negative) to increase. And since the coefficient of expected inflation is not significant, it could also be argued that the CBE behavior was not forward-looking.

The response to output (γ) has been positive and significant. Thus, holding expected inflation constant, a 1 percent rise in the output gap induces the CBE to increase nominal (and thus real) interest rates by 582 basis points. This result indicates that the CBE had a concern for output even though it was not an explicit policy target. The *J-statistic* implies that the null hypothesis that the over-identifying restrictions are satisfied is not rejected. Finally, we obtain a plausible estimate for the inflation target. The sample average real 3-month deposit rate (taken as the estimate for the long-run real rate) is 0.72 percent. Equation (8) implies a value for the inflation target of 9.4 percent.

Table 1: GMM Estimates for Egypt's reaction functions, Estimated Coefficients *(t-statistic)**

	β	γ	ρ	α	ξ	R^2	*J-test*
Baseline estimation	-0.204496	4.968938	1.013872	10.44679	-	0.981858	0.149348
	(-2.040655)	(1.806855)	(109.8808)	(6.298083)	-		*0.824466*
Adding Lagged Inflation	-0.488016	-0.764824	0.977176	10.02489	-0.094134	0.983148	0.125904
	(-3.170137)	(-0.930679)	(98.88356)	(9.649102)	(-0.777057)		*0.70531*
Real Exchange Rate	-0.498075	0.695410	0.991102	8.377462	-0.233120	0.983489	0.121597
	(-1.090266)	(0.475881)	(85.76244)	(8.562897)	(-0.678434)		*0.70531*

*The *J-test* refers to the overidentifying restriction test. The first row reports the *J-statistic* and the second one reports *p-value.*

1. π_{t-12}. The test of overidentifying restriction for baseline specification *J=9.26, chi squared(15) with p-value=0.86*
2. Real change in the LE/US$ exchange rate. The test of overidentifying restriction for baseline specification *J=7.13, chi squared(15) with p-value=0.86*

Next, we consider several alternative specifications. First, in order to test whether the CBE was reacting to past inflation, we allow lagged inflation to enter the reaction function along with expected inflation and output. The policy response is positive but not statistically significant. Also, the policy response to the other variables decreased and/or became statistically insignificant.

Then we consider the 12-month change in the real exchange rate. This variable enters the reaction function significantly and with the right sign. Holding constant expected inflation and the output gap, a 1 percent depreciation in the exchange rate generates an increase in the 3-month deposit rate by 13.6 basis points. This result confirms the intuition that the CBE defends the exchange rate using the interest rate. It also confirms previous results obtained in chapter 6 that Egypt has a fear of floating behavior. The policy response to expected inflation is still negative and non-significant. In the case of output, the coefficient is positive and significant but lower than in the baseline specification. When the exchange rate is added to the rule, holding everything else constant, a 1 percent rise in the output gap induces the CBE to increase interest rates by 281 basis points. For both alternative specifications, the null hypothesis of the j-test is not rejected. Finally, the coefficient of the lagged interest rate (ρ) appears to be high, stable and significant across all specifications. This implies a high degree of interest rate smoothing.

It is useful to assess how the well the estimated rules fit with actual monetary policy. This should also give an idea about the with-in sample fit of the estimated equation. To this end, figures 7.3 and 7.4 plot the estimated and actual values as well as residual values for both specifications respectively. As the figure shows, except for 2002M11, 2003M01 and 2005M09, the interest rate implied by the estimated rules tracks the behavior of the observed interest rate fairly closely.

Figure 5: Actual and fitted values for the interest rate, baseline estimation

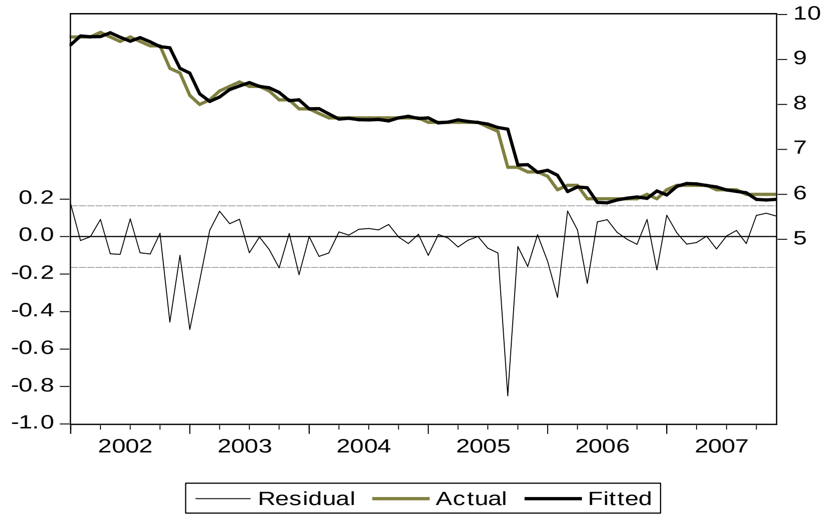


Figure 6 Actual and fitted values for the interest rate, alternative estimation (with the real exchange rate)

Source: Eviews

Taken together, the results suggest that the stance of monetary CBE has been accommodative of inflationary pressures, which could explain in large part the persistently high inflation since 2006, despite nominal tightening. The CBE did not show sufficient concern for curbing expected inflation. Instead, it showed concern for other implicit objectives, avoiding output deviations from equilibrium and limiting exchange rate fluctuations. There is also a high degree of interest rate smoothing. To conclude, the CBE's monetary policy since the early 2000's cannot be characterized by IT.

VIII. CONCLUSION

Recent monetary reforms in recent years in Egypt have enhanced the monetary policy framework in order to pave the way for IT. Yet, there is not yet full transparency with respect to other policy objectives besides inflation, namely the stabilization of the exchange rate, which was officially abandoned as a nominal anchor in 2003. In particular, this paper has investigated the impact of a number of variables on the central bank interest setting behaviour between 2000 and 2008 through the estimation of a forward-looking reaction function with interest rate smoothing.

The paper reveals the following. First, the CBE response to inflation has been rather accommodative and not forward-looking. Second, the CBE attaches importance to smoothing output deviations from equilibrium. Third, it intervenes through its interest rate policy to stabilise the exchange rate. Finally, there is a considerable degree of policy inertia across all specifications. The CBE's monetary policy since the early 2000's cannot be characterized by IT. Concern price stability has been outweighed by concern for other implicit goals.

Going forward, the CBE cannot manage two goals with one instrument. If the CBE move to a formal inflation targeting regime, it should give priority to its inflation target. This does not mean that it may not smooth exchange rate fluctuations, just that it must do so in a way that is not inconsistent with price stability and in a transparent manner in order not to confuse the public about the policy priorities. In this respect, sterilized intervention could provide an additional instrument to independently manage the exchange rate, especially if the latter is expected to have a substantial direct effect on the target within the forecast horizon, or is misaligned. It is important to ensure that intervention is not preventing the exchange rate from reaching its long-term level. IMF (2010) has already shown that the exchange rate is overvalued. The authorities must not excessively rely on intervention, turning the float into a *de facto* managed system. Over the longer-term, reforms are important to facilitate the transition to a more flexible exchange rate regime, which in turn would ensure the priority of the target. In particular, increased monetary policy independence and liquid foreign exchange markets would reduce the need to depend on intervention. In due time, credibility gains should lead to a low inflationary environment, improve the workings of the flexible exchange rate regime and be conducive to less erratic exchange rate fluctuations with adverse domestic repercussions.

Areas of future research could also be highlighted. First, the estimation could be redone using core inflation instead of headline inflation and the new ODR introduced in mid-2005 instead of the 3-month deposit rate. But this would require a longer sample. A second extension would be to take into account the CBE time-varying behaviour which allows the parameters of an interest rate rule to vary over time allowing for multiple regime shifts. One approach employed by CGG (2000) and Judd and Rudebusch (1998) is to use ad hoc structural break dates in monetary policy and assume they are directly reflected in the policy rule. Other recent work rely on sophisticated econometric seek methods to estimate structural breaks (Yilmazkuday, 2008). Another approach is to rely on Markov-switching models which are able to identify regime shifts which affect the dynamics of the central banks' instrument interest rates (Valente, 2003 and Assenmacher-Wesche, 2006). Such an approach does not require splitting the sample which shortens the available time series. Third, the estimation could be repeated using cointegration methodology to better capture the non-stationarity of some of the variables. In general, the use of this methodology has been very limited in the estimation of reaction functions (Gerlach-Kristen, 2003). Finally, the estimation of the forward-looking reaction function was not based on the preferences of the monetary authorities and these results could not indicate which possibility is preferred. Naturally, the estimated parameters may not necessarily represent the technically best outcomes for Egypt. One can evaluate the optimality of the estimated policy rules in terms of the volatility of inflation and output that would result if the rule were used by policymakers in the context of a specific macroeconomic model.

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APPENDIX 1:

Table 1 reports the ADF unit root test results for a lag of 11 months (SIC) and table 2 reports the result of the PP test. The following variables (*deprate, egyinf and ygap)* include a constant term and *(dlcomm)* does not. The results show a discrepancy between the DF and PP tests. In this case, the decision is made based on the former since it has more power (or ability) in rejecting the null hypothesis when it is false.

Table 1: 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
percent (except for q)					
Deprate	-1.114414	I(1)	-3.492523	-2.888669	-2.581313
egyinf [i]	-2.615992	I(0)	-3.501445	-2.892536	-2.583371
ygap	-3.814933	I(0)	-3.493747	-2.889200	-2.581596
Dlcomm [ii]	-2.000757	I(0)	-2.589795	-1.944286	-1.614487
erchange	-1.232088	I(1)	-3.500669	-2.892200	-2.583192
First differences					
deprate	-5.716948	I(0)	-3.493747	-2.889200	-2.581596
erchange	-9.515301	I(0)	-3.501445	-2.892536	-2.583371

The null hypothesis (H_0) of a unit root is rejected if the t-statistic is greater than the critical values.

[1] (H_0) is rejected at the 10 percent level.

[ii] (H_0) is rejected at the 5 and 10 percent levels.

Table 2: The Phillips-Perron test

Variable	PP statistic	Order of integration	McKinnon critical values for rejection of hypothesis of a unit root		
			1 percent	5 percent	10 percent
percent (except for q)					
deprate	-1.152209	I(1)	-3.492523	-2.888669	-2.581313
egyinf	-2.411825	I(1)	-3.500669	-2.892200	-2.583192
ygap	-2.565323	I(1)	-3.492523	-2.888669	-2.581313
dlcomm[i]	-1.820378	I(0)	-2.589531	-1.944248	-1.614510
erchange	-1.365294	I(1)	-3.500669	-2.892200	-2.583192
First differences					
deprate	-10.03774	I(0)	-3.493129	-2.888932	-2.581453
egyinf	-5.871851	I(0)	-3.501445	-2.892536	-2.583371
ygap	-7.348237	I(0)	-3.493129	-2.888932	-2.581453
ln(q)	-9.205437	I(0)	-3.493129	-2.888932	-2.581453
erchange	-9.525109	I(0)	-3.501445	-2.892536	-2.583371

The null hypothesis of a unit root is rejected if the t-statistic is greater than the critical values.

[i](H_0) is rejected at the 10 percent level.