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**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. 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 behavior 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 does not provide evidence of a systematic reaction to changes in the exchange rate.

JEL Classification: E4, E5, F3.

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

ملخص

قد عززت الإصلاحات الأخيرة إطار السياسة النقدية في مصر. وبالرغم من ذلك، لا يوجد حتى الآن شفافية كاملة فيما يتعلق بأهداف السياسة الأخرى إلى جانب التضخم، وخاصة تحقيق الاستقرار في أسعار الصرف والذي تم التخلي عنه رسمياً باعتباره مرتكزا اسمياً في عام 2003. وإزاء هذه الخلفية، فإن هذه الورقة تسعى لتوصيف السلوك المنهجي للسياسة النقدية المصرية. وتبنى على كلاريدا وغالي وجيرتلر (CGG) (1998) لتقدير قاعدة لمعدل فائدة تطلعي في مصر باستخدام بيانات شهرية بين عامي 2000 و 2008. تسمح لنا نتائج نموذج خط الأساس في البنك المركزي (والذي لا يأخذ في الاعتبار سعر الصرف) بدراسة ما إذا كان معدل الفائدة يستجيب للتضخم، والفجوة في الناتج ومعدل فائدة متأخر. ثم يتم مقارنة النتائج مع تلك التي في نموذج حيث يتم إضافة سعر الصرف كمتغير تفسيري. التحليل التجريبي يبين أن السياسة النقدية قد استوعبت التضخم ولكنها غير تطلعية ولا تقدم دليلاً على وجود تفاعل منهجي للتغيرات في سعر الصرف.

1. Introduction

Recent reforms have improved the monetary policy framework in Egypt. 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” (Selim 2011).

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. To do so, this 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. In addition, 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.

The main conclusions of the empirical analysis are as follows. First, monetary policy has accommodated inflation and has not been forward-looking. Therefore, monetary policy cannot be described as (implicit) inflation targeting (IT). Second, there is no evidence that monetary authorities reacted to changes in the real exchange rate. Third, 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 exchange rate augmented rules in emerging market economies (EMEs). The second section summarizes previous empirical findings. The third presents the main characteristics of monetary policy in Egypt. The fourth describes the 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.

2. 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 a discussion of formulations of rules for closed economies.

2.1 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 Kydland 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 incentives of policymakers to do so and adjust their behavior accordingly, thus creating 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 to monetary policy rules 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).

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 substitution¹ and liability dollarization²). Taylor (2000) further explains that rules make policy intentions more transparent and thus make it easier for the private sector to form expectations. This predictability in policy behavior should also improve the transmission and effectiveness of monetary policy.

2.2 Alternative formulations of monetary policy rules

2.2.1 Closed economies

The initial research on monetary policy rules was based on the case of a closed economy. The Taylor (1993) rule 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:

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

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

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

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 the Central Bank’s 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 its decision. Third, the reaction function captures the desire of central banks to smooth interest rate changes, i.e. it introduces small steps in the policy rate in order to achieve the 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, moderate interest rate response 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, it accommodates 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).

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).

³ The derivation of this rule is presented in details in section IV.

2.2.2 *Open economies*

Later on, policy rules were augmented with an exchange rate term, the latter being one source of information to be considered when setting interest rates 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 lead to depreciation in both the nominal and real exchange rates, which passes through into higher (import and consumer) prices. Also, depreciation increases demand for export and other import competing goods which also increases aggregate demand. It 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 that the exchange rate provides timely and relevant information for inflation and therefore should be included in the Central Bank's reaction function (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).

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, 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).

3. Review of Empirical Findings

Empirical work on monetary policy rules was instigated by the seminal work of Taylor (1993). This work consists in the empirical estimation of reaction functions as a means of providing a characterization of ex-post policy monetary policy. In other words, it estimated the weights of inflation, output and the exchange rate in order to compare the ex-post actual setting of policy rates by central banks with what would have been predicted by the rule. This section briefly reviews the findings of related empirical work.

Initially, work focusing on the United States (Taylor 1993; CGG 2000; and Judd and Rudebusch 1998) showed that during the Great Inflation, the Federal Reserve pursued a policy that accommodated inflation. Subsequently, CGG (1998) found evidence of flexible implicit IT in a number of OECD countries between 1979 and the early 1990s. In the case of the euro area, similar results were achieved by Peersman and Smets (1999), Chortareas (2008), Fendel and Frenkel (2006) and Gerlach-Kristen (2003).

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 from multi-country studies are mixed; with the finding that the policy instrument is sometimes used by some central banks to respond to the exchange rate (Gerlach and Smets 2000; and Lubik and Schorfheide 2007) but not by others (Gerdesmeier and Roffia 2003). In the context of IT, Sgherri (2005) and Hüfner (2004) found that the central banks have ignored real exchange rate misalignments. However, Björnland and Halvorsen (2008) found 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 than to either inflation or the output gap (Aizenman et al. 2008; and Mohanty and Klau 2004). Moreover, the response 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 for all the countries (Hsing 2009; 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 confirms the existence of a systematic response to the exchange rate (Schmidt-Hebbel and Tapia 2002; 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 Arabia and Tunisia, El-Erian and El-Gamal (2002) estimated 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, Al-Mashat (2011), relies on a modified reduced-form New Keynesian model to show that the policy rule containing an exchange rate target generates the highest output and inflation variability. The latter declines 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 testing whether additional policy variables may explain the interest rate setting behavior 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.

4. 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 liberalization. These reforms helped refocus (implicitly) monetary policy towards disinflation (Selim 2011). The monetary policy framework has benefited from improvements 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 in 2005 its intention to move to IT.

Yet, these improvements did not allow monetary policy to achieve price stability, especially that the framework still lacked 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 outflows in the aftermath of the 2008 crisis) (Figure 1). In this context, it is not clear to the public whether the monetary policy manages the exchange rate and how it does so.

Even though the liberalization of interest rates occurred in the early 1990s, the CBE did not rely on interest rates to conduct monetary policy, prior to 2005. Until 2003, the exchange rate was pegged to the US\$ and there was relatively limited scope for the interest rate to independently respond to exchange rate fluctuations. Moreover, 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-Eyouun 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 interest rate 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-Eyouun 2003) (Figure 2b).

In order to pave the way for implementing IT, new policy rates were launched in June 2005 to help 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 by policy tightening in November 2006 and December 2006. Moreover, 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 the 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 t-bills rate seemed more responsive to the changes in the new policy rate (Figure 4). Correlation between the two rates is estimated at 60%.

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. However, no work has yet empirically addressed this issue during the *post-float* era.

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

5. 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.

5.1 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.

5.1.1 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, it is assumed that the Central Bank has a target for the short-term interest rate that is conditional on the state of the economy and on the deviation of expected inflation and output from their respective targets:

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

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:

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

Rearranging equation 3, we obtain:

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

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 $\gamma > 0$, the real interest rate is also changed to stabilize 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

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

where the parameter $\rho \in [0,1]$ captures the degree of interest rate smoothing, and v_t is an exogenous random shock to the interest rate. It is assumed that v_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:

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

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

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

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

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

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

Equation (9) is the reaction function to be estimated that contains all the parameters of interest $[\beta, \gamma, \rho, \alpha]$.

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.

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 modeling, 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 :

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

5.1.2 Alternative Specification

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

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

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:

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

5.2 The Estimation Technique

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

In general, two different approaches have been used in modeling monetary policy behavior. First, VAR models 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). 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 modeling of both the endogenous policy response and the transmission mechanism by making only minimal assumptions about their causal links. Since VAR estimations include among other dynamic relationships an equation for the monetary policy instrument, Clarida and Gertler (1997), Kim (2002), Schmidt-Hebbel and Werner (2002) and Bjørnland and Halvorsen (2008) have thus been able to estimate the parameters of the reaction function.

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 behavior 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 second approach consists of the direct estimation of single-equation reaction functions for monetary policy instruments either using two-stage-least squared (both). 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 Schmidt-Hebbel and Tapia (2002), Gerdesmeier and Roffia (2003) 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 the 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 v_t .⁶ Then, since $E[\varepsilon_t | u_t] = 0$, equation (9) implies the following set of orthogonality conditions:

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

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 asymptotically 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 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

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 independent 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.

correlated with u_t , the set of orthogonality conditions will be violated, which would lead to a statistical rejection of the model.

6. Data Issues

The sample period consists of monthly observations between 2000 and 2008. As mentioned before, Egypt adopted a more flexible *de jure* 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 accommodating or may have alternatively been constrained by other targets. A short description of the variables follows:

1. Since there was no relevant policy rate before June 2005, the short-term interest rate, the 3-month t-bills rate (*tbills*), is used as a measure of the stance of monetary policy.
2. Data on consumer price index (CPI) (2005=100) was used to measure inflation. Inflation is then calculated as the annualized month-over-month log difference (*cpinfn*). 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.
3. 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.
4. 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 month-over-month log difference (*dlcomm2*).
5. 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 annualized month-over-month log difference.
6. Alternatively, the real effective exchange rate (REER) is also used instead of the real exchange rate. The REER change is obtained in the same manner.

Data on prices (including the 3-month t-bills rate, the CPI, the commodity price index and the nominal exchange rate) are from the IFS data base. To calculate the real exchange rate, the author used the formula: $q = e * \left(\frac{ppi_{us}}{cpi_{eg}}\right)$, 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

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.

⁸

http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=WSSOP3000&output_view=pc_t_1mth

In order to implement GMM, the time series should be stationary. The results of the Dicky-Fuller (DF) unit root test are reported in appendix (1). They show that all variables are stationary at least at the 5% level.

7. 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_i includes a constant and 3, 6, and 9 lagged values of inflation π_t , 3, 6, 9 and 12 the annualized log difference of a world commodity index ($dcomm2$), the 3-month t-bills rate r_t and the annualized log difference of the REER (q_t). For the output gap x_t , the lags included are 3 and 6.⁹ 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 coefficient of expected inflation (β) has a positive sign but is below unity and also not statistically significant. This means that the CBE's response to inflation is accommodative in the face of expected inflation shocks. Initially, this finding may seem a bit 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 showing that nominal policy rate hikes were insufficient 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's behavior was not forward-looking.

The response to output (γ) has been negative and not statistically significant. The *J-statistic* implies that the null hypothesis—that the over-identifying restrictions are satisfied—is not rejected.

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 negative and not statistically significant.

Then we consider the change in the real exchange rate. The coefficient of this variable, whether it is the change in the bilateral exchange rate or the REER, enters the reaction function with the right sign but is not statistically significant.

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.

Taken together, the results suggest that the monetary stance of the 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. There is also a high degree of interest rate smoothing. To conclude, the CBE's monetary policy since the early 2000s cannot be categorized as IT.

8. Conclusion

In Egypt, recent monetary reforms have enhanced the monetary policy framework in order to pave the way for IT. Yet, other policy objectives besides inflation are not fully transparent,

⁹ Except for the specification where the real LE/US\$ enters the equation as an explanatory variable. In this case, lagged values of the annualized log differences of the bilateral exchange rate are used as instruments.

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's interest setting behavior between 2000 and 2008 through estimating a forward-looking reaction function with interest rate smoothing.

The paper reveals the following. First, the CBE's response to inflation has been rather accommodative and not forward-looking. This means that the CBE's monetary policy since the early 2000s cannot be categorized as IT. Second, it does not appear to be systematically using the interest rate to stabilize fluctuations in the real exchange rate. Finally, there is a considerable degree of policy inertia.

Several areas of future research can be highlighted here. First, the estimation could be repeated using core inflation instead of headline inflation and the new overnight deposit rate introduced in mid-2005 instead of the 3-month t-bills rate. But this would require a longer sample. A second extension would be to take into account the CBE's time-varying behavior 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 studies rely on sophisticated econometric methods to estimate structural breaks (Yilmazkuday 2008). Another approach is to rely on Markov-switching models which are able to identify regime shifts that affect the dynamics of 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 weak stationarity of some of the variables, as in Gerlach-Kristen (2003). Finally, the estimation of the forward-looking reaction function was not based on the preferences of monetary authorities and thus results could not indicate which possibility is preferred. Naturally, the estimated parameters may not necessarily represent the best outcomes for Egypt technically. 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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Figure 1: Real Exchange Rate, Overnight Deposit Rate and Inflation

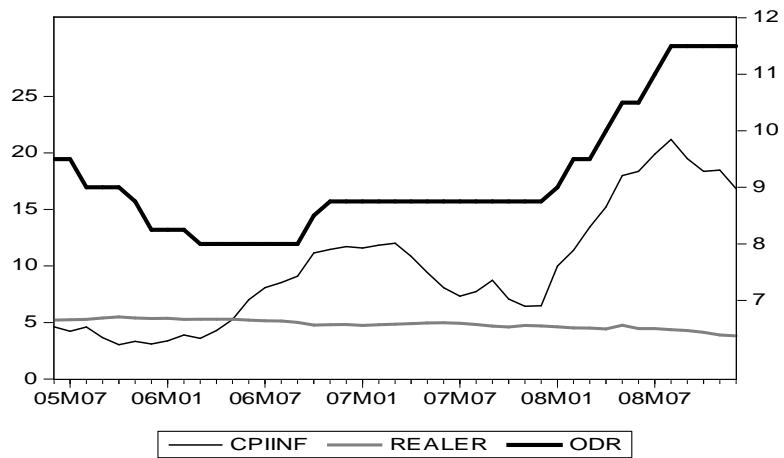
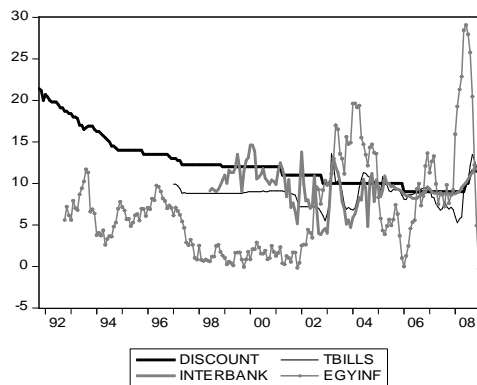


Figure 2: Interest Rates and Inflation

(A)



(B)

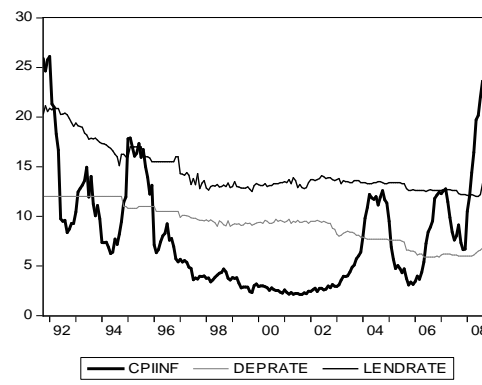


Figure 3: New Policy Rates and Inflation

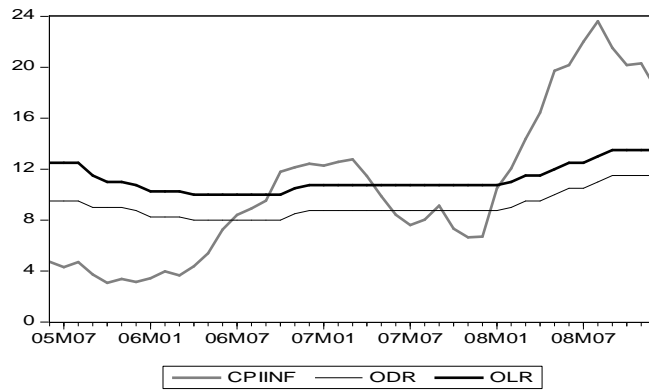


Figure 4: New Policy Rate and the 3-Month T-Bills Rate

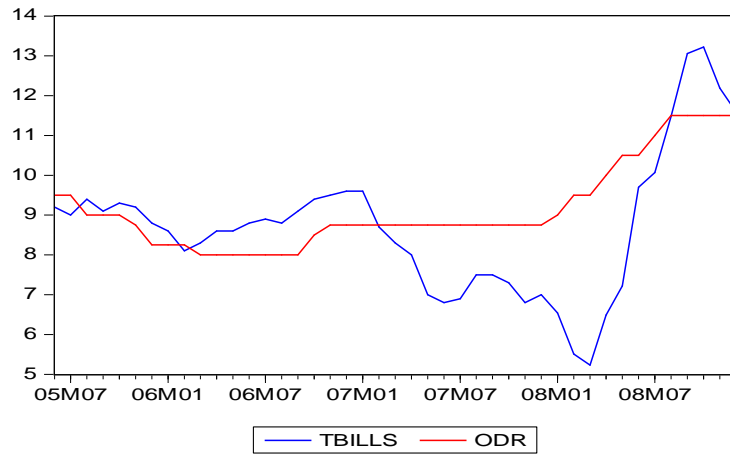


Table 1: GMM Estimates for Egypt's reaction functions, Estimated Coefficients (*t*-*statistic*)*

	B	γ	P	α	ξ	R^2	<i>J</i> -test
Baseline estimation	0.825724 (0.715308)	0.035915 (0.452638)	0.967774 (21.5053)	0.007963 (0.074626)	- -	0.672544	9.618612899 0.7895
<i>Adding</i>							
<i>Lagged Inflation</i>	-1.393492 (-0.104139)	0.123165 (0.098673)	1.003301 (34.76522)	0.323219 (0.146612)	-0.485273 (-0.096188)	0.668967	10.772234 0.54856
<i>Real Exchange Rate</i>	-0.462704 (-0.513007)	-0.045610 (-0.603289)	1.017166 (37.11689)	0.150551 (1.331341)	0.304319 (0.636284)	0.646038	9.842203 0.6298
<i>REER</i>	1.925432 (0.111932)	-0.050117 (-0.122232)	0.996904 (33.69979)	-0.120556 (-0.06617)	1.197731 (0.107732)	0.654858 0.5305	10.9811

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

Appendix 1

Table 1 reports the ADF unit root test results for a lag of 12 months (SIC). All variables except *ygap* include a constant term.

Table A1: The Augmented Dicky-Fuller Test

Variable (annualized log differences, except the interest rate and output gap)	ADF statistic	McKinnon critical values for rejection of hypothesis of a unit root		
		1 percent	5 percent	10 percent
tbills ¹	-3.802090	-4.046925	-3.452764	-3.151911
Cpiinf	-5.656545	-4.046925	-3.452764	-3.151911
ygap ¹	-3.814933	-3.493747	-2.889200	-2.581596
dlcomm2	-6.318510	-4.046925	-3.452764	-3.151911
RERchange	-9.832028	-4.046925	-3.452764	-3.151911
REERchange	-7.858347	-4.048682	-3.453601	-3.152400

Notes: 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 5 percent level.