



The Cabinet
Information and Decision Support Center

***Effect of Some Recent Changes in Egyptian Monetary Policy:
Measurement and Evaluation***

Tarek Abdelfattah Moursi
Cairo University and IDSC

Unabridged Version

*First Draft: December, 2006
Second Version: January, 2007
Final Version: April, 2007*

Table of Contents

Abstract.....	1
1. Introduction.....	2
2. Monetary policy in Egypt 1990-2005: A narrative.....	4
3. Measuring stance and the impact of monetary policy shocks	8
3.1 Theoretical underpinnings	8
3.2 Data.....	10
3.3 Estimation of monetary stance and dynamic responses to policy shocks.....	12
4. Effect of monetary policy on output.....	19
5. Monetary policymaking by a rule.....	23
5.1 Rules versus discretion: A cursory overview.....	24
5.2 Estimating a policy rule for Egypt.....	26
5.3 Policy rule simulations under alternative scenarios.....	30
6. Concluding remarks.....	33
References.....	34
Appendix.....	38
I. Tables.....	38
II. Graphs	42
Tables:	
Table 1: Parameter Estimates for Different Models	13
Table 2: Contribution of Structural Disturbances to the Variance of the Interest Rate Shocks.....	15
Table 3: Predicted Stationary Variances of Real Output, Inflation and Interest Rate Under Alternative Monetary Rules	32
Table A1: Monetary Policy in Egypt.....	38
Table A2: Lag Length Selection Tests	40
Table A3: Values Selected for Calibration Parameters	41
Table A4: Unrestricted Trivariate VAR Estimates: 2001:1-2006:7	41

Graphs:

Figure 1: Relation between the 3MDEP and OVERNIGHT, TBILL, Growth and M2.....	12
Figure 2: Responses of Policy and Non-Policy Variables to a Contractionary Shock for the JI (-) and Non-Structural (--) VAR Models	17
Figure 3: Total Measure and Exogenous and Endogenous Components of Monetary Stance 1985-2005	18
Figure 4: Overall Index of Monetary Stance and 3MDEP	19
Figure 5: Impulse Responses with Pure-Sign Approach for K=5	23
Figure 6: Actual and Simulated Paths with and without a Monetary Shock	31
Figure A1: Selected Monetary and Macroeconomic Indicators	42
Figure A2: Impulse Responses to a Contractionary Monetary Policy Shock Using Lower Triangular Cholesky Decomposition.....	43
Figure A3: Distribution of the Impact Impulse Response	44
Figure A4: Impulse Responses Ranges with Pure-Sign Approach for Real GDP.....	44
Figure A5: Impulse Responses Ranges for Real GDP with Pure-Sign Approach.....	45
Figure A6: Impulse Responses with Penalty-Function Approach for K=5	45
Figure A7: Actual and Theoretical Responses to a Monetary Policy Shock.....	46
Figure A8: Cross-Correlation Functions for the Theoretical and Empirical VAR Models	46

Effect of Some Recent Changes in Egyptian Monetary Policy: Measurement and Evaluation

Tarek Abdelfattah Moursi, Mai El Mossallamy and Enas Zakareya*

Abstract

The paper focuses on examining the salient features and developments in the structure of monetary policy and on describing their implications for the Egyptian economy mainly during the period 1990 through 2005. The analysis is based on a set of policy oriented models that measure the stance of monetary policy and evaluate the responses of key policy (total and nonborrowed reserves and the interest rate) and non-policy (commodity prices, GDP deflator and real output) variables to policy shocks. We also shed light on the prospects for policymaking by a policy rule in lieu of the current discretionary monetary decision making regime. Accordingly, we examine whether the current discretionary policymaking process may have resulted in rule-like decisions via estimating a variant of the Taylor-type interest rate feedback rule à la Rotemberg and Woodford (1998). The results show that recently monetary policy shocks virtually had no real effect on output thereby providing evidence in support of the long-run neutrality of money. We conclude that the effect of monetary policy on the level and on the growth rate of real output in the long run is limited by its capacity to achieve long-run price stability. Moreover, we argue in favor of implementing the constrained discretion framework as a basis for monetary policymaking in Egypt. That framework is consistent with the inflation-targeting approach, which the Central Bank of Egypt (CBE) is currently considering to adopt as the principle monetary policy objective. Employing an estimated interest rate targeting rule, historical and counterfactual policy simulations indicate that during 2001-2006, the CBE has given precedence to reducing the interest rate variance rather than to the stabilization of inflation. Simulation scenarios suggest that it is possible to stabilize inflation via policy intervention measures.

* Tarek Abdelfattah Moursi: Department of Economics, Faculty of Economics and Political Science, Cairo University and consultant, Information and Decision Support Center (IDSC); Mai El Mossallamy and Enas Zakareya: economists, IDSC. This study was conducted as a joint project between the IDSC and the Egyptian Center for Economic Studies (ECES). We are extremely indebted to Hanaa Kheir El Din for suggesting the topic and for valuable comments and to Magued Osman and his staff at IDSC, especially Wafik Younan, Ahmed El Tawanssy and Keity George, for offering an exquisite environment to conduct our research. We are also grateful to Ahmed Abdel Tawab for writing the Matlab optimization code used in section 5. Sultan Abu Ali and participants at the 2006 Annual ECES Conference suggested important comments on an earlier draft of this paper. Heidy Aly, Enas Ali and Dina Rofael provided research assistance. Address correspondence regarding this paper to Moursi: tmoursi@cics.feps.eun.eg.

1. Introduction

Since the beginning of the 1990s through 2005, frequent changes have occurred in the conduct and management of the monetary policy in Egypt. The changes have been implemented as part of the reform endeavors by the government and the Central Bank of Egypt (CBE) to stimulate the short-term growth of the real economy. They involved modifications in the operational and intermediate targets of the CBE as well as in the choice of the monetary instruments that were selected to achieve the operating targets. Nevertheless, the principal objectives of monetary policy remained more or less unchanged throughout almost all of that period, focusing essentially on price stability and on the stabilization of the exchange rate. Besides, the CBE principal monetary objectives included several other goals such as increasing the level of output, controlling liquidity growth, raising foreign competitiveness, promoting exports and establishing confidence in the national currency.

The high inflation rates that came about in the aftermath of the floatation of the Egyptian pound- at the end of January 2003- presumably prompted the CBE to espouse price stability and low inflation rates (along with banking system soundness) as the main monetary objective. The importance of realizing price stability as an intervening principal objective of monetary policy was further accentuated with the recent structural reforms, which encompassed the establishment of the Coordinating Council, under the leadership of the Prime Minister, in January 2005 and the Monetary Policy Committee affiliated to the CBE Board of Directors in mid-2005.

Within this setting, the CBE recently restructured the monetary policy framework through the adoption of the overnight interest rate on interbank transactions in lieu of the excess bank reserves as the main operational target. To manage the interest rates (including the overnight interbank rate) and implement its monetary policy, the CBE established a new operational framework early in June 2005, known as the corridor system, with a ceiling and a floor for the overnight interest rates on lending from and deposits at the CBE, respectively.

The new system of policy management is based on conventional macroeconomic theorization, which predicates that it would be possible to stabilize prices and control inflationary pressures via monetary tightening¹. In practice, there are no assurances that the actual results obtained from a monetary contraction would match the theorized facts. In particular instances, an increase in interest rate could lead to a rise in the price and/or output levels. Such *puzzles* are likely to jeopardize the effectiveness of the CBE monetary policy and its capacity to check inflation and achieve the price stabilization objective. Consequently, a dire need transpires for understanding the dynamic behavior of prices and output in response to different monetary policy shocks. Discerning the structure of those responses should also be useful to investigate the prospects of pursuing a monetary policymaking framework based on a formal inflation-targeting approach as proposed recently by the CBE (2004/2005)².

¹Standard macroeconomic theory a priori suggests that a contractionary (expansionary) monetary shock raises (decreases) the interest rate, reduces (increases) the level of prices and lowers (raises) real output.

²Inflation-targeting is a monetary policy framework, which assumes that the primary objective of monetary policy is to achieve and maintain price stability. Hence, it commits the central bank to

The main object of this paper is to examine the effect of recent changes in the structure of the monetary policy in Egypt on the monetary system and on the performance of the economy. We begin by measuring the stance of monetary policy in a way that reflects the CBE operating procedure. The stance is constructed based on an analytical framework that allows the extraction of information about monetary policy from the data on variables of interest. We concentrate on two key policy variables, the bank reserves and the interest rates, which appear to be the main CBE operational policy targets since the end of the 1980s. To maintain the focus on the monetary sector, we avoid imposing any unwarranted restrictions on the relationships between the other macroeconomic variables in the economy. In the process of measuring the stance, we are also able to estimate the size and the direction of the responses to policy shocks of real output, of prices and of the policy variables themselves. Finally, against the backdrop of the estimated responses, we explore the viability of policymaking by rules rather than by discretion. We construct a theoretical structural model that simulates, as closely as possible, empirically estimated responses of output, interest rate and inflation to the policy shocks. The structural model is then used together with the estimated VAR to identify the shocks to the structural equations. Based on the estimated shock processes and VAR parameters, we derive various simulation paths, which correspond to different historical and hypothetical interest rate policy rules for inflation-targeting. Then we examine the consequences of selecting each of those rules on real output, inflation and interest rate variability. Furthermore, we argue in favor of implementing constrained discretion, which importantly turns out to be consistent with the inflation-targeting approach, as a basic framework for monetary policymaking at the CBE.

Our empirical study takes the analytical models introduced by Bernanke and Mihov (1998), Uhlig (2005) and Rotemberg and Woodford (1997a and 1998) as templates to measure the monetary stance, to identify the effects of policy shocks on the economy and to formulate historical and counterfactual scenarios that assess the implications of different rules on policy decisions, respectively. Our replicas of the analytical models are adapted to consider the realities of the Egyptian economic system and the monetary regime.

The monetary policy in Egypt has been subjected to frequent changes in the stance. To get an idea about the frequency of change, it suffices to note that during the last 25 years, eight different Governors have presided over the CBE, each bearing his own point of view and policy perceptions. Recurrent breaks caused by the frequent structural shifts in policy emphasize the importance of analyzing short time horizons. We confine our study to a short analytical horizon covering the period 1985 to 2006. Nevertheless, we occasionally find it necessary to resort to smoothing techniques and to the use of low frequency data and a few variables in order to avoid the difficulties associated with the identification of changes in the structure of the economy and in the monetary operating procedures.

The remainder of the paper proceeds as follows. Section 2 presents a brief historical overview that delineates the main objectives, targets and instruments of the CBE policy since the beginning of the 1990s. In section 3, we evaluate the existing

conduct policy to reach a publicly announced inflation rate within a particular time horizon (Khalid, 2006).

measures and direction of monetary policy from the mid-1980s to 2005 using a structural vector autoregression (VAR) that is chosen from a model that nests different possible descriptions of the CBE operating procedures. The selected VAR model is employed for measuring the changes in the stance during the period under investigation. Section 4 considers that model as a point of departure to describe the effect of monetary policy shocks on real output subject to different stylized structural restrictions. Section 5 attempts to identify an underlying monetary policy rule for the CBE and to predict how real output, interest rate and inflation respond to stochastic disturbances in that rule using a structural VAR model. Section 6 concludes. An Appendix includes additional tables and graphs related to the analysis.

2. Monetary policy in Egypt 1990-2005: A narrative

This section presents a brief review of the evolution of the main components of monetary policy in Egypt. The review considers the recent developments in the ultimate objective of the CBE monetary policy, the intermediate and operational targets that were selected to achieve that objective and the monetary instruments adopted to affect those targets. Table A1 summarizes those developments from 1990 to 2005.

During 1990 through 2005, with the exception of 1996/1997, the CBE has continually focused on achieving two principal objectives, namely, price stability and exchange rate stability. The monetary policy, however, exhibited overt inconsistencies, particularly during 1992/1993-1996/1997. In 1992/1993, besides price and exchange rate stability, the CBE planned to achieve ostensibly conflicting objectives. While the CBE aimed at controlling the monetary expansion thereby implying a contractionary policy, it also called for a reduction of the interest rate on the Egyptian pound to encourage investment and promote economic growth thereby implying an expansionary stance (CBE, 1992/1993). With the onset of the second stage of the economic reform program in the following year 1993/1994, the thrust of the monetary policy shifted to the promotion of growth in the productive sectors as a means of stimulating aggregate productivity (CBE, 1993/1994). The CBE primary objective swayed back to the expansionary monetary control/output growth recipe during the 2-year period 1994/1995 to 1995/1996. In 1996/1997, the CBE reverted once more to the objective of economic growth via monetary stabilization.

Alternatively, throughout the period 1990/1991 until 2004/2005, the different proximate targets of monetary policy seemed fairly consistent. Table A1 discloses that the CBE intermediate target entailed the control of the annual growth rate of domestic liquidity measured in terms of the broad money supply, M_2 . Similarly, during the entire period under consideration, save 2004/2005, the two operational target components, management of nominal interest rates and the control of banks' excess reserves in local currency at the CBE, remained unchanged. Starting in 2005, the overnight interest rate on interbank transactions was designated as the operational target.

To achieve its targets, the CBE depended mostly on a number of indirect, market-based instruments such as the required reserve ratio, reserve money and open market operations along with a host of interest rates including the discount rate, Treasury Bill

rate³, 3-month deposit rate and loan and deposit interest rates (Table A1). The choice of indirect instead of direct instruments was motivated by the initiation of the monetary policy reform act as part of the country's overall economic reform program. Direct instruments (e.g. quantitative and administrative determination of interest rates using credit and interest rate ceilings) were abolished for the private and the public sectors starting 1992 and 1993, respectively. Consequently, public enterprises were allowed to deal with all banks without prior permission from a lending public bank (Hussein and Nos'hy, 2000). The remainder of this section presents a brief overview of the main developments in the use of the monetary instruments since the 1990s.

The CBE relied on the *discount rate* as a monetary policy instrument during 1990 to 2005. During that period, the discount rate was lowered gradually from 19.8% in 1992 to approximately 9% by the beginning of 2006 with the hope of promoting investment⁴. To reduce the rigidity in the discount rate, the CBE linked it to the interest rate on *Treasury Bills*. This resulted in a steady decline in the interest rate on Treasury Bills, which decreased starting 1992 through 1998. The interest rate on Treasury Bills began to recover once again in 2002 only to attain a maximum in the following year (Table A1).

By January 1991, the CBE had liberalized the *interest rates on loans and on deposits*. Banks were given the freedom to set their loan and deposit interest rates subject to the restriction that the *3-month interest rate on deposits* should not fall below 12% per annum. This restriction was cancelled thereafter in 1993/1994. Because of the continuous decrease in the discount rate, interest rates on loans (one year or less) also fell during the period 1995 to 1999 before they started to rise again in 2000. The decline in the interest rate on loans led to a reduction in the returns on deposits held in local currency. The local currency deposits, however, were not significantly affected by the fall in the interest rate since the interest rate on the Egyptian pound deposits remained relatively higher than the equivalent rates paid on foreign currencies (El-Asrag, 2003).

Open market operations are an important instrument that affects the short run nominal interest rate through their capacity to absorb and manage excess liquidity in the economy and to sterilize the effect of increases in international reserves. Open market operations in Egypt depend on a number of tools including, repurchasing of Treasury bonds, final purchase of Treasury Bills and government bonds, foreign exchange swaps and debt certificates (Abu El Eyoum, 2003). The use of open market operations became consistent with the liberalization of the interest rates once the CBE resorted to the market as a means of financing government debt⁵. The primary dealers system,

³The monetary reforms required the use of an axial instrument to link the monetary and the fiscal policy. Treasury Bills were chosen to play that role. They were first issued as a monetary instrument by the CBE at the beginning of the 1990s at weekly auctions to create a market mechanism for interest rate determination and to absorb excess liquidity (Abu El Eyoum, 2003).

⁴The discount rate is typically considered a poor operational monetary policy instrument because it is usually subjected to strong administrative control. Thus, shocks in the discount rate do not always account for variation in the monetary stance (Bernanke and Mihov, 1998).

⁵Since the beginning of the 1990s, the CBE began using Treasury Bills to control liquidity in the money market.

which became effective in July 2004, increased the importance of the open market operations as an instrument of monetary policy⁶.

In 1997/1998, the CBE increased its dependence on an alternative instrument, the *repurchasing operations of Treasury Bills (repos)*, to provide liquidity and to stimulate economic growth. The value of these operations increased reaching LE 209 billion in 1999/2000. The reliance on repos, however, started to decrease in 2000/2001 reaching a minimum in 2002/2003. In 2003/2004, the CBE introduced the *reverse repos of Treasury Bills* and permitted *outright sales of Treasury Bills* between the CBE and banks through the market mechanism. In August 2005, the CBE notes were introduced instead of the Treasury Bills reverse repos as an instrument for the management of the monetary policy.

The *domestic and foreign currency required reserve ratios* represented another key instrument of monetary policy. During the period 1990-2005, the domestic and foreign required reserve ratios ranged between approximately 14%-15% and 10%-15%, respectively. The changes in the required reserve ratios alone have not been sufficient to determine the variance in the reserves as the formula employed in the calculation of the reserve ratio was subjected to several revisions during 1990-2005⁷.

Apart from the modifications in the structure of the indirect monetary policy instruments, the CBE undertook a number of notable reforms in the *exchange rate* system. At the beginning of the 1990s, Egypt officially implemented a managed float regime, with the exchange rate acting as a nominal anchor for monetary policy. Yet, in reality, the country had adopted a fixed exchange rate regime with the authorities setting the official exchange rate without regard for market forces. This resulted in a highly stable exchange rate for the Egyptian pound against the US dollar and a black market for foreign exchange (El-Asrag, 2003). In February 1991, a dual exchange rate regime, which included a primary restricted market and a secondary free market, was introduced to raise foreign competitiveness and to simplify the exchange rate system. The two markets were unified in October 1991. Since then up until 1998, the Egyptian pound was freely traded in a single exchange market with limited intervention by the authorities to keep the exchange rate against the US dollar within the boundaries of an implicit band (ERF and IM, 2004).

The second half of the 1990s was characterized by a tight monetary stance. El-Refaay (2000) detects that tightness based on the observed slowdown in the growth rate of M2 and of reserve money. By 1997, the Egyptian economy had started to feel the crunch of a liquidity crisis owing to internal and external shocks that led to a shortage in both domestic and foreign (i.e. US dollar) currencies. The internal shocks were prompted by a large increase in bank lending, particularly to the private sector. A significant part of the bank credit extended to the private sector in the 1990s was directed to real estate investments. In the absence of matching demand, the relative increase in the supply of housing units made it difficult for the real estate investors to

⁶The system allows 13 financial institutions (listed with the Ministry of Finance) that include banks and bond dealers to act as primary dealers. These institutions are permitted to underwrite primary issues of government securities and activate trading in the secondary market through the sale, purchase and repurchase of government securities based on a multiple-price auction system (BUYUSA, 2006).

⁷For example, in July 2002, the CBE decided to increase the reference period for calculating the ratio from one to two weeks (including week ends and official holidays) and to exclude the Treasury Bills' stocks with less than 16 days maturity from the numerator of the reserve ratio (CBE, 2002/2003).

repay their bank loans. The supply-demand mismatch raised the rates of loan default and instigated a liquidity shortage in the banking system. The liquidity crisis was intensified by the large fiscal debt, which was sparked by the government's initiation of several huge projects at the same time including Toshka Project, Al-Salam Canal, North West Gulf of Suez Development Project and East of Port Said Project (Hussein and Nos'hy, 2000). The financing of these projects greatly depended on bank deposits. The strain on bank deposits increased with the accumulation of a large government debt to public and private construction firms. Moreover, external shocks, including the fall in oil, tourism and Suez Canal revenues and the decrease of workers' remittances from abroad by the end of the 1990s exacerbated the liquidity problem.

The appreciation of the real exchange rate during the 1990s was probably the key factor behind the liquidity shortage. Following the liberalization and unification of the foreign exchange rate in 1991, the nominal exchange rate remained within excessively tight bounds (between LE 3.2-3.4 per dollar). The nominal exchange rate rigidity in conjunction with high real interest rates caused a real appreciation in the value of the Egyptian pound that not only depleted the economy's foreign competitiveness but also triggered significant market speculation. The foreign exchange market instability and the increase in the importation bill- financed through bank loans- created a shortage of US dollars in the economy (Hussein and Nos'hy, 2000).

The move to an exchange rate peg during the 1990s was accompanied by accommodating changes in the monetary policy. It was not possible, however, to pursue an active monetary policy with a fixed exchange rate regime. In January 2001, Egypt replaced the de facto Egyptian pound to US dollar peg with an adjustable currency band. The band had a central rate determined according to the weighted average of the prevailing exchange rates during the previous three weeks. The central rate had a bandwidth spanning the range $\pm 1\%$; that range was later increased to $\pm 3\%$ (Table A1). Despite those reforms, the Egyptian pound gradually lost about 48% of its value against the US dollar over the period 2001-2003 (ERF and IM, 2004).

On January 29, 2003, the adjustable peg was swapped with a floating exchange rate regime. Under the free float, banks were permitted to determine the buy and sell prices of exchange rates. The CBE was barred from intervention in setting the foreign exchange rate, except to correct for major imbalances and sharp swings (El-Asrag, 2003). The move from the managed float system to a flexible exchange rate regime denotes a transformation from an implicit policy rule to a non-committal absence of a monetary policy rule (Bartley, 2001 and Mundell, 2000). Accordingly, the liberalization of the pound marks the demise of an implicit dual-component monetary rule system with intricate price stability and exchange rate stability rules.

Despite the liberalization of the pound in 2003, the CBE has continued to maintain exchange rate stability as one of its key objectives during the following years, 2004 and 2005 (Table A1). It is rather difficult now to construe how the CBE plans to bring about exchange rate stability without frequently resorting to direct controls. We suspect that in the coming months, the CBE might still choose to keep a tight grip on the foreign exchange market. In theory, efficient monetary policymaking, however, tolerates intervention in the foreign exchange market only by means of policy measures. Hitherto, the CBE has a good record on that account. For instance, the fears

of dollarization that followed the liberalization of the pound, prompted the CBE to tighten monetary policy through an increase in the rate of interest (CBE, 2004/2005).

During the last year, the main objective of the CBE has been to keep inflation low and stable. That objective was cast within the context of a general program to move eventually toward anchoring monetary policy by inflation-targeting once the fundamental machinery needed for its implementation is installed (CBE, 2005). Meanwhile, in the transition period, the CBE intends to meet its inflation stabilization objective through the management of the short-term interest rates and the control of other factors that affect the inflation rate including shocks to credit and to money supply (CBE, 2005). In view of the recent changes in policymaking initiated by the CBE, we anticipate that the upcoming period shall witness important endeavors to conduct monetary policy on objective and methodical bases. We believe that good measurement of monetary policy and of the stance within the last 15 years or so should provide a suitable inferential point of departure en route toward the support of those endeavors.

To summarize, the above narrative establishes the importance of price stability as the prime objective of the CBE. We show that since the beginning of the 1990s short-run interest rates and reserves have played a key role as monetary instruments under the control of the CBE for achieving that objective. In the following sections, we select appropriate models to measure monetary policy and stance in Egypt since the late 1980s and to examine the effects of changes in the policy instruments on real economic performance as well as on the monetary system.

3. Measuring stance and the impact of monetary policy shocks

This section focuses on measuring the direction of monetary policy to find out whether it has been expansionary or contractionary in the last two decades. Measuring the stance requires the identification of the monetary instruments that can best describe the policy shocks and the selection of a suitable model that can illustrate the behavioral dynamics that explain the structural responses to those shocks. We use the historical information about the CBE operating procedure presented in section 2 and the Bernanke and Mihov (1998) VAR methodology to measure monetary policy in Egypt and to assess its impact on the economy.

3.1 Theoretical underpinnings

Contemporary macroeconomic literature draws attention to the drawbacks of intermediate targeting of monetary aggregates. In addition, the monetary aggregates (e.g. M0, M1 or M2) cannot be used to measure neither the stance nor the effects of variations in the central bank operating procedure since they are typically influenced by a variety of non-policy effects (e.g. money demand disturbances) and by changes in policy (Bernanke and Mihov, 1998). Consequently, different measures have been proposed for the evaluation of monetary policy.

Strongin (1995) proposes measuring policy by the changes in that portion of nonborrowed reserves that is orthogonal to total reserves⁸. He argues that when the

⁸Nonborrowed reserves are defined as the difference between the total bank reserves with the monetary authority less bank borrowed reserves at the reserve discount window.

monetary authority is constrained to meet total reserve demand in the short-run, it can effectively tighten policy through reducing the nonborrowed reserves to the extent of forcing the banks to borrow from the discount window. Strongin's approach has several advantages. First, the inclusion of nonborrowed reserves as a policy variable can avoid the price puzzle and other anomalies in the behavior of non-policy variables, e.g. output (Sims, 1992, Uhlig, 2005 and Bernanke and Mihov, 1998). Second, the approach is capable of nesting alternative monetary authority operating procedures because it allows the projection of nonborrowed reserves on total reserves to vary over time (Bernanke and Mihov, 1998)⁹.

We have seen in section 2 that interest rates and reserves were regularly utilized as CBE monetary policy instruments during the period 1990-2005. In this section, we provide an analysis of the monetary policymaking process within the context of a VAR framework that includes three policy indicators: total reserves, nonborrowed reserves and short-term interest rates. Bernanke and Mihov (1998) propose a six-variable semi-structural VAR model that nests a number of quantitative monetary policy approaches within a unified milieu. An important advantage of their approach is that it facilitates the computation of an optimal overall measure of policy stance, which is consistent with the estimated parameters describing the monetary authority's operating procedure and the market for bank reserves. Beside the three policy variables, the VAR model incorporates three main non-policy variables. Real GDP and the GDP deflator are chosen as indicators of broad macroeconomic activity together with an index of commodity prices. Like nonborrowed reserves, the exclusion of commodity prices may lead to a price or an output puzzle (Sims (1992), Eichenbaum (1992), Gordon and Leeper (1994), Bernanke and Mihov (1998) and Kim (1999)).

The structure in the VAR model proposed by Bernanke and Mihov (1998) depends on a simple description of the market for bank reserves that is represented in innovation form by the following equations¹⁰:

$$u_{TR} = -\alpha u_{IR} + v^d \quad (1)$$

$$u_{BR} = \beta u_{IR} + v^b \quad (2)$$

$$u_{NBR} = \phi^d v^d + \phi^b v^b + v^s \quad (3)$$

where u_{TR} , u_{IR} and u_{NBR} are observable VAR residuals representing the shocks to the banks' total demand for reserves (TR), to the interest rate (IR) and to the nonborrowed reserves (NBR), respectively, and α , β , ϕ^b and ϕ^d are positive parameters. Equation (1) implies that the innovation in the demand for total reserves depends negatively on the shock in the interest rate (u_{IR}) and on an unobservable VAR residual, v^d , that measures the demand disturbance in the system. Equation (2) shows that the shock to borrowed reserves (BR), u_{BR} , depends positively on the innovation in the interest rate and on an unobservable VAR residual, v^b , which represents the disturbance in the portion of reserves that the commercial banks choose to borrow¹¹. Finally, equation

⁹For instance, a policy targeting nonborrowed reserves presumes that they do not respond to changes in total reserves (Christiano and Eichenbaum, 1992a) while an interest rate targeting strategy assumes that nonborrowed reserves respond one to one to shocks in total reserves (Bernanke and Blinder, 1992).

¹⁰Equation 2 is slightly different from the one presented by Bernanke and Mihov (1998) to comply with the structure of the estimated VAR model for Egypt.

¹¹Consequently, we ignore shocks in the discount rate, which negatively affects u_{BR} .

(3) describes the behavioral response of the monetary authority to shocks in the demand for total and for borrowed reserves and to policy innovations (v^s). The coefficients ϕ^d and ϕ^b determine the relative importance of the response of the central bank to the different shocks.

Bernanke and Mihov (1998) stipulate that the disturbance term v^s represents the policy shock that needs to be identified. It can be easily shown that the class of solutions for the vector of observable shocks $\mathbf{u}=[u_{TR} \ u_{BR} \ u_{NBR}]'$ in the system of equations (1)-(3) is given by $[\alpha(\beta+\alpha)^{-1} \ v^s \ -(\beta+\alpha)^{-1}]'$ such that

$$v^s = -(\phi^d + \phi^b)u_{TR} + (1 + \phi^b)u_{NBR} - (\alpha\phi^d - \beta\phi^b)u_{IR}. \quad (4)$$

With seven unknown variables, α , β , ϕ^d , ϕ^b , v^d , v^b and v^s , the system is underidentified by one restriction. Bernanke and Mihov also show that the solution of this system nests at least five different models for measuring monetary policy shocks including Bernanke and Blinder (1992) *IR* model, Christiano and Eichenbaum (1992a) *NBR* model, Strongin (1995) *NBR/TR* model, Cosimano and Sheehan (1994) *BR* model and the Bernanke and Mihov (1998) just identification (*JJ*) model. All those models can be determined through imposing a variety of parametric restrictions on the equation coefficients in the solution for \mathbf{u} .

First, targeting the interest rate so that the monetary authority can fully offset changes in total and in borrowed demand for reserves is equivalent to the parametric restriction $\phi^b=-1$ and $\phi^d=1$ (Bernanke and Blinder, 1992). Second, imposing the constraint $\phi^b=\phi^d=0$ implies that nonborrowed reserve shocks depend only on monetary policy innovations (Christiano and Eichenbaum, 1992a). Third, Strongin (1995) assumes that all disturbances in total reserves are attributable to demand shocks (i.e. $\alpha=0$), which are accommodated by the monetary authority in the short-run through open-market operations and/or the discount window and that the monetary authority does not respond to shocks in commercial bank borrowing ($\phi^b=0$). Fourth, targeting borrowed reserves implies the parametric restrictions $\phi^d=1$ and $\phi^b=\alpha/\beta$. Since each of those four models imposes two parametric constraints, the resulting solutions are overidentified by one restriction. Finally, Bernanke and Mihov (1998) present an alternative model with the single identifying restriction $\alpha=0$, thus implying that the shocks in total reserves are exclusively attributable to demand disturbances.

3.2 Data

Equations (1)-(3) and the relevant parametric restrictions were employed to estimate the parameters of a 6-variable semi-structural VAR for each of the five models described above. The VAR estimates are obtained using monthly data for Egypt during the period 1985-2005.

Time series data on real GDP and the GDP deflator were not available at monthly frequency. Following Bernanke and Mihov (1998), the two monthly series were constructed from annual IMF-IFS (2006) data for the period 1981-2005 by state-space methods using the Litterman (1983) temporal disaggregation procedure (Quilis, 2004)¹². The consumer price index (CPI) was chosen as a proxy for commodity prices

¹²Bernanke and Mihov (1998) employ the Chow and Lin (1971) temporal disaggregation procedure. We took advantage, however, of Litterman's (1983) method for distributing the low frequency real

to capture the CBE perceptions about the future behavioral dynamics of inflation. The monthly frequency CPI series as well as the data for total reserves were obtained from the IMF-IFS (2006). The nonborrowed reserves series was computed as the difference between the total reserves less the credit to commercial banks from the CBE, which was also available in the IMF-IFS database. Both the total and the nonborrowed reserves were seasonally adjusted using an autoregression integrated moving average (ARIMA) model of the order $ARIMA(3,1,0)$ ¹³. The total and the nonborrowed reserves series were normalized by a 36-month moving average of total reserves to induce stationarity.

From 1985 to 2005, the CBE used at least four different rates of interest as policy instruments. They include the discount rate, the 3-month deposit rate, the Treasury Bills rate and the interbank overnight rate. To maintain a sufficient number of degrees of freedom, it would not be practically feasible to take account of all these interest rates concurrently in a VAR model. We picked the 3-month deposit rate to represent the interest rate component of the CBE operating procedure¹⁴. Although our choice involves some degree of subjectivity, it is not totally without objective merit.

Figure 1 Panels A and B juxtapose the movements in the 3-month deposit rate with the interbank overnight rate and the Treasury Bills rate from 2002-2005 and from 1997-2005, respectively. The shading in the diagrams indicates the periods characterized by co-movement of the 3-month deposit rate and each of the two other rates. It appears that the movements of the Treasury Bills and the interbank overnight rates are fairly captured by the variation in the 3-month deposit rate. These eyeball findings are confirmed by Ljung-Box Q -statistics estimates (results not reported), which could not reject at the usual levels of significance the correlation between the 3-month deposit rate and each of those rates for different lags and leads. We conclude that, apart from its importance as a key instrument of monetary policy since the mid-1980s, the 3-month deposit rate is a good proxy for other short-term interest rates.

Having the expected correlations with economic growth and M2 provides additional evidence that supports proxying the interest rate disturbances by shocks in the 3-month deposit rate. Panel C in Figure 1 contrasts the standardized movement of the 3-month deposit rate with real output growth from 1991-2005. In concurrence with the conventional wisdom, the diagram illustrates that unlike the first half of the 1990s, an inverse relation between the 3-month interest rate and the economic rate of growth generally characterized the period 1997-2005. Alternatively, the expected (negative)

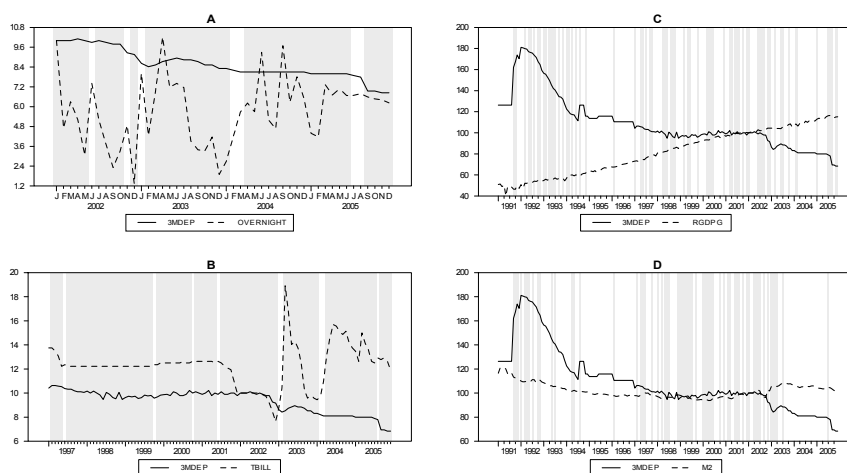
GDP and GDP deflator series. Besides the trend, seven high frequency indicator variables (oil price (UK Brent), real exports and imports, real Suez Canal dues, real M1, real quasi-money and real exchange rate with respect to the US CPI) were utilized in the disaggregation of the real GDP series. The series real exports and imports, real Suez Canal dues, real M1 and real quasi-money were deflated using the wholesale price index (WPI) (IMF-IFS, 2006). The annual GDP deflator was distributed using two high frequency (monthly) interpolator variables: CPI and WPI.

¹³We employed the Tramo and Seats method (Caporello and Maravall, 2004) for the seasonal adjustment. Alternatively, the series were seasonally adjusted with the Ratio-to-Moving-Average (RTMA) method (Wichern and Reitsch, 2001). Both seasonal adjustment methods rendered qualitatively similar VAR estimates.

¹⁴The monthly data for the 3-month deposit rate were obtained from the CBE database CBE (2006). These data are consistent with the IMF-IFS (2006) data during January 1985 to December 2005, except for the period September 1991 to July 1994. During the latter period, we believe that the IMF-IFS (2006) dataset unintentionally cites the post-office savings interest rate rather than the 3-month deposit rate.

correlation between the 3-month deposit rate and M2 prevailed from 1997 to mid-2003 as depicted by the shading in Figure 1-Panel D. The anomalous relation between M2 and the 3-month deposit rate, observed since the beginning of mid-2003, emphasizes the limited capacity of the CBE to absorb excess liquidity by means of open market operations without resorting to an increase of the 3-month deposit rate (Table A1)¹⁵.

Figure 1
Relation between the 3MDEP and
OVERNIGHT, TBILL, Growth and M2



Note:

- Panel A: The overnight interbank rate (OVERNIGHT) and the 3-month deposit rate (3MDEP) were standardized such that 2002:1=10. The OVERNIGHT series starting 2001:12-2006:7 was obtained from the CBE database (unpublished) and from 2001:2-2001:11 was forecasted using an ARIMA(3,1,0) process (Caporello and Maravall, 2004). The shading indicates co-movement of the two series.

- Panel B: The Treasury Bills rate (TBILL) and the 3MDEP were standardized such that 2002:1=10. Shading indicates co-movement of the two series.

- Panel C: RGDPG portrays the growth rate of (detrended) real output. The growth rate and the 3MDEP were standardized such that 2002:1=100. Shading indicates counter-movement of the two series.

- Panel D: M2 was normalized by a 36-month moving average of M2 to induce stationarity. Both M2 and 3MDEP were standardized such that 2002:1=100. Shading indicates counter-movement of the two series.

3.3 Estimation of monetary stance and dynamic responses to policy shocks

This sub-section is concerned with the measurement of monetary policy using the Bernanke and Mihov (1998) VAR model. Additionally it examines the dynamic responses of the key macroeconomic variables to policy shocks. The selected VAR process isolates the monetary shocks in a 6-variable model incorporating 3 policy variables (total bank reserves, nonborrowed reserves and the 3-month deposit rate) and 3 non-policy variables representing broad macroeconomic conditions and the

¹⁵The correlation between the 3-month deposit rate on one side and economic growth and M2 on the other, during most of the period under investigation, should not be taken as an unequivocal confirmation of the consistency of the behavior of the deposit rate with the theoretical conjectures. Many things that go on simultaneously in the economy, which are bound to influence the relation between the 3-month deposit rate and growth and M2, are not accounted for in this simple correlation analysis.

overall performance of the economy (real GDP, the GDP deflator and the commodity price index)¹⁶. To identify their model, Bernanke and Mihov (1998) assume there is no feedback from the policy variables to the economy¹⁷. Hence, the length of the estimation horizon affects the parameter estimates. To identify the influence of the time horizon effect, the VAR parameters were computed for the period 1985:1-2005:12 and for the sub-period 1990:1-2005:12. Estimating the model over different time horizons allows for the possibility of detecting shifts in the regression coefficients. The structural relations implied by equations (1)-(3) were imposed on the coefficient estimates.

Table 1
Parameter Estimates for Different Models

Sample	Model	Standard errors in parentheses					
		α	β	ϕ^d	ϕ^b	Test for OIR	LLF
1985:1-2005:12	JI (BM)	0	0.554 (0.498)	0.805 (0.033)	-0.067 (0.088)		2029.596
	IR (BB)	0.416 (0.001)	-0.019 (0.008)	1	-1	0.000	1801.266
	NBR (CE)	0.849 (0.021)	0.006 (0.007)	0	0	0.000	2005.991
	NBR/TR (S)	0	-0.989 (0.510)	0.805 (0.035)	0	0.055	2027.759
	BR (CS)	-0.016 (0.013)	0.761 (0.005)	1	α/β	0.000	2004.063
1990:1-2005:12	JI (BM)	0	1.141 (2.545)	0.822 (0.040)	-0.021 (0.066)		1575.583
	IR (BB)	0.843 (0.000)	0.083 (0.000)	1	-1	0.000	1244.835
	NBR (CE)	0.758 (0.011)	0.009 (0.009)	0	0	0.000	1559.144
	NBR/TR (S)	0	-1.227 (0.904)	0.822 (0.039)	0	0.352	1575.150
	BR (CS)	0.137 (0.000)	0.251 (0.000)	1	α/β	0.000	1500.933

Note: IR denotes the BB model assumptions (Bernanke-Blinder, 1992), NBR denotes the CE model assumptions (Christiano-Eichenbaum, 1992a), NBR/TR denotes the S model assumptions (Strongin, 1995), BR denotes the CS model assumptions (Cosimano-Sheehan, 1994) and JI denotes the BM model assumptions (Bernanke-Mihov, 1998). The imposed parameters for each model are indicated in boldface. The OIR p-values shown in boldface italics are not significant at the 0.05 level implying that the model cannot be rejected at the 5% significance level.

Table 1 reports the structural VAR parameter estimates and their standard errors obtained from the four overidentified and the just identified models for the complete (1985:1-2005:12) and the sub-sample (1990:1-2005:12) periods¹⁸. The different VAR specifications were fit with 12 lags in levels of the logs of real GDP, GDP deflator,

¹⁶The reported results use the CPI to represent commodity prices. Analogous results obtained using the WPI in general yield qualitatively comparable results.

¹⁷The assumption seems quite realistic when the economy is expected to adjust to a monetary policy shock with a time lag since the policymakers are presumed to have only contemporaneous information about the non-policy variables. If the monetary authority were to have lagged information about the non-policy variables, this assumption would not be realistic.

¹⁸The BFGS algorithm was employed in the estimation of the structural VAR models.

CPI and total and nonborrowed reserves and in 3MDEP¹⁹. The table reports a p-value corresponding to the test of the overidentifying restriction (OIR) and an estimate of the log likelihood function (LLF) for each model. We analyze statistical results portrayed in Table 1 to select the preferred model describing the CBE operating procedure and the instruments of policy intervention. We start by analyzing the statistical properties of the parameter estimates for the different models.

The estimate of the coefficient ϕ^d that describes the CBE propensity to accommodate shocks to the total demand for reserves is depicted in Table 1 for the NBR/TR and JI models²⁰. The values of the estimates of ϕ^d in the whole and the sub-sample periods for both models are very close (between 0.805-0.822), and are highly statistically significant. This implies that the CBE has usually almost fully but not perfectly aimed at offsetting reserve demand shocks during the entire and the sub-sample periods. These findings are naturally inconsistent with the IR and the BR models and the NBR model in which the estimate of ϕ^d is assumed to be restricted either to 1 (i.e. full accommodation) or 0 (no accommodation), respectively. Accordingly, there is a tendency to reject the IR, BR and NBR models in the selected sample horizons.

The negative parameter estimates for the response to borrowing shocks, ϕ^b , in the whole and the sub-sample periods predicted by the JI model disclose the CBE inclination to offset reserves market disturbances. The estimates, however, are very small in absolute terms and are statistically insignificant. Consequently, since the IR, NBR/TR and BR models are distinguished primarily by their predictions of ϕ^b , it would not be possible to single out the best one of those models to describe the behavior of the CBE (Bernanke and Mihov, 1998).

Table 1 reports the estimates of the slope coefficients, α and β , for all but the JI and the NBR/TR models wherein α is preset by assumption. With the exception of the BR model for the whole sample, the estimates of α have the correct (positive) sign and are statistically significant. The BR model estimate of α for 1985-2005 is negative yet insignificant. The estimated value of α varies considerably between the 0.14-0.85. The small magnitude of α predicted by the BR model for the sub-sample period provides support for the identifying assumption imposed by the JI and NBR/TR models ($\alpha=0$). The estimates of β are of the correct sign for all the models except the IR and the NBR/TR models for the whole sample and the NBR/TR model for the sub-sample period. Similarly, the estimates of β for the BR model are statistically significant; alternatively, the JI, NBR and NBR/TR models yield insignificant results for the whole and the sub-sample periods. The IR model predicts a significant estimate of β for the whole sample period but the absolute magnitude of the estimated coefficient is relatively very small. This implies that the shocks in the demand for borrowed reserves do depend on the unanticipated disturbances in the borrowing function rather than on the interest rate at which the borrowed reserves are relent.

¹⁹The lag length for all the models was determined using a 6-variable unrestricted VAR. The non-policy variables in the VAR were ordered prior to the policy variables as follows: real GDP, GDP deflator, CPI, total reserves, nonborrowed reserves and 3-month deposit rate. Table A2 displays the AIC and SBC coefficient estimates of lag length selection for the whole sample and the selected sub-sample period. In both cases, the AIC test selects a VAR representation with 15 lags while the SBC selects 12 lags. We chose the parsimonious lag structure.

²⁰The estimate for ϕ^d was determined freely only in the case of those two models.

The estimated VAR coefficients are not alone adequate to identify the preferred monetary instruments and operating procedure pursued by the CBE. We, therefore, complement the above analysis by resorting to an evaluation of the performance of the alternative models based on the OIR test results and the LLF estimates.

The OIR for the IR model rejects the BB assumptions with a $p=0.000$ for the sample as a whole and for the sub-period 1990-2005. Table 1 reveals that the NBR model performs poorly according to the p-value criterion. These results suggest that it could have been easier to employ nonborrowed reserves management in comparison with interest rate as an operational target. The BR model that assumes the CBE targets borrowed reserves also fails the OIR test. Unlike the IR and the NBR models that restrict the response of nonborrowed reserves and total reserves demand shocks to 1 and 0, respectively, the NBR/TR treats ϕ^d as a free parameter. The flexibility of the NBR/TR model probably explains its relatively better performance. Table 1 shows that the OIR test fails to reject the NBR/TR model for the selected time periods.

In general, the JI and the NBR/TR models yield similar results mainly since they restrict the slope of the demand curve for total reserves to be vertical ($\alpha=0$)²¹. That restriction seems to be readily pinned down by the data at hand. Hence, the JI and the NBR/TR models consistently outperform the others. The LLF estimates reported in Table 1 reinforce these findings. However, the overall performance of the JI model surpasses that of the NBR/TR model based on the LLF criterion and on the relatively poorer estimates of β obtained from the latter model.

Despite the relatively overall superior performance of the JI model, it embraces some of the behavioral features of the other models. For instance, the estimated value of ϕ^d (the policy response parameter) for the JI model approaches the theoretical value of 1 as suggested by the IR and the BR models and the estimated coefficient for ϕ^b does not statistically differ from the theoretical value of 0 imposed by the NBR and the NBR/TR models. Thus, the values of the estimated coefficients ϕ^d and ϕ^b for the JI model obviously differ. This confirms that the nonborrowed reserves and the interest rate ought to receive appreciably different weights as indicators of monetary policy with the biggest share of the weight devoted to interest rate smoothing and a minimal share dedicated to the nonborrowed reserves target (see equation 4).

Table 2
Contribution of Structural Disturbances
to the Variance of the Interest Rate Shocks

	Structural Shock		
	v^d	v^b	v^s
1985-2005	3.889	3.703	92.408
1990-2005	4.076	3.940	91.984

The variances of the structural shocks to demand for total reserves, to banks borrowings and to policy (v^d , v^b and v^s , respectively) can tell the important role that the policy variable (interest rate) may play as a monetary instrument. Bernanke and Mihov (1998) point out that these variances are not estimated in comparable units and suggest presenting the variance estimates in terms of the share in the interest rate

²¹In particular, the NBR/TR and the JI models yield identical estimates for ϕ^d for the whole and the sub-sample periods.

shocks that are attributable to each of the three structural disturbances. Table 2 reports the distribution of the variance share estimates for the whole and for the sub-sample periods.

Table 2 shows that the policy shocks account for roughly 92% of the interest rate variance in 1985-2005 and 1990-2005. This finding provides strong support for the importance of the interest rate as a good policy indicator for the CBE operating procedure. In contrast, borrowing and demand shocks had negligible impact accounting only for about 4% of the interest rate variance. During 1985-2005, the CBE apparently had aimed at offsetting the effects of demand and of borrowing shocks on the interest rate.

The estimated JI model suffers two apparent drawbacks. First, the insignificant coefficient estimates for ϕ^b and β preclude efficient prediction of the CBE response to borrowing shocks and to changes in the fraction of reserves that the banks decide to borrow at the discount window. Second, the model cannot distinguish the differences in the monetary policy regime during 1985-2005 and 1990-2005 owing to the similar estimates of ϕ^d for the whole and the sub-sample periods. These weaknesses notwithstanding, we employed the JI model to measure the monetary policy and to describe the overall operating policy, rather than the operating procedures per se, of the CBE. We start by an examination of the dynamic responses of the different variables in the VAR, including the policy measure itself, to policy shocks. Then we estimated an index for the overall monetary stance from the mid-1980s until 2005 by means of an indicator that accounts for the endogenous components of policy, which we presume is representative of an implicit policy rule.

The dynamic effects of a negative policy shock (i.e. tightening) on the variables in the VAR are depicted by means of impulse response functions (IRFs)²². The IRFs estimated using the JI model for the whole and the sub-sample periods following the interest rate shock are pictured in Figure 2 (solid line) over a 48-month response horizon. The shock was normalized to produce a 100 basis points increase in the 3-month deposit interest rate on impact²³. The IRFs from a standard non-structural VAR model are also included in the diagram (dashed line) as a benchmark for comparison.

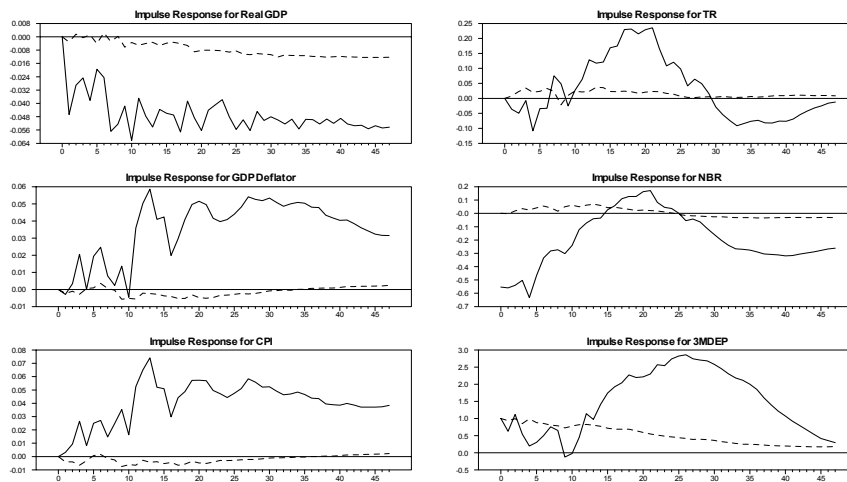
The conventional wisdom entails that a monetary policy contraction leads to a rise in the interest rate and a decrease in output, prices and total and nonborrowed reserves (Sims (1972, 1980, 1986, 1992), Eichenbaum (1992), Bernanke and Blinder (1992), Strongin (1995), Christiano and Eichenbaum (1992a, b) and Canova (1995)). The IRFs from the JI model do not show evidence of an output puzzle neither for the whole nor for the sub-sample period as real GDP appears to fall in response to monetary tightening. The standard VAR model implies very weak effects for the shock on real output in each of those periods with some anomalous responses in the first 6-12 months following the shock. In contrast, the JI model IRFs for the GDP

²²We depend solely on the results described by the IRFs without reference to variance decomposition analysis of the forecast error. Bernanke and Mihov (1998) argue first that the share of the forecast variance of the non-policy variables caused by policy shocks excludes the systematic policy component so it would not be possible to verify whether a policy is stabilizing. Second, they point out that changes in the variance decomposition in different periods may merely reflect fictitious instability proceeding from changes in the variance of the structural shocks.

²³Without loss of generality, all the dynamic experiments in this study were conducted for contractionary policy shocks.

deflator and the CPI indicate an obvious price puzzle that prevails throughout the whole sample period with both prices rising in response to the shock (Figure 2.A). It would also be difficult to rebuff the price puzzle during the sub-sample period despite the fall in prices (especially the CPI) that occurs one year after the shock. The standard VAR IRFs portray the correct responses for prices with just a trace of a price puzzle that is detected with the whole sample data. Like output, the price responses, particularly those implied by the non-structural VAR, remain relatively small owing to sticky price responses, model misspecification and/or measurement errors.

Figure 2
Responses of Policy and Non-Policy Variables to a Contractionary Shock for the JI (-) and Non-Structural (--) VAR Models
A. 1985-2005



B. 1990-2005

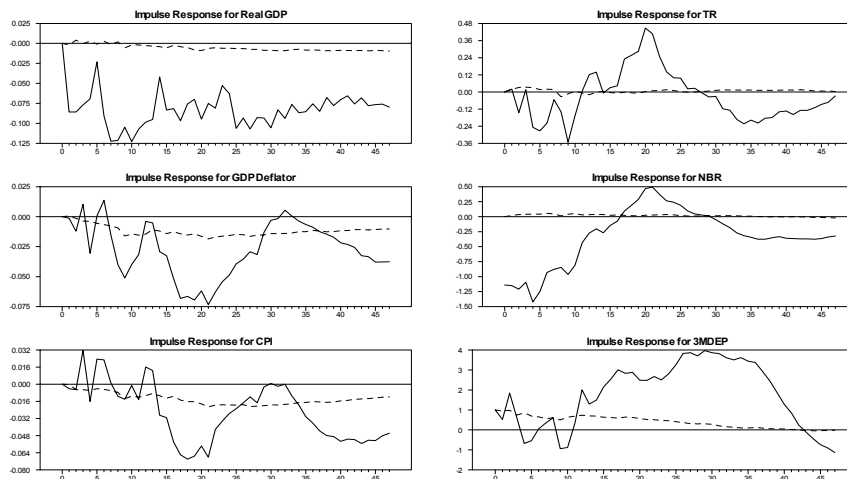
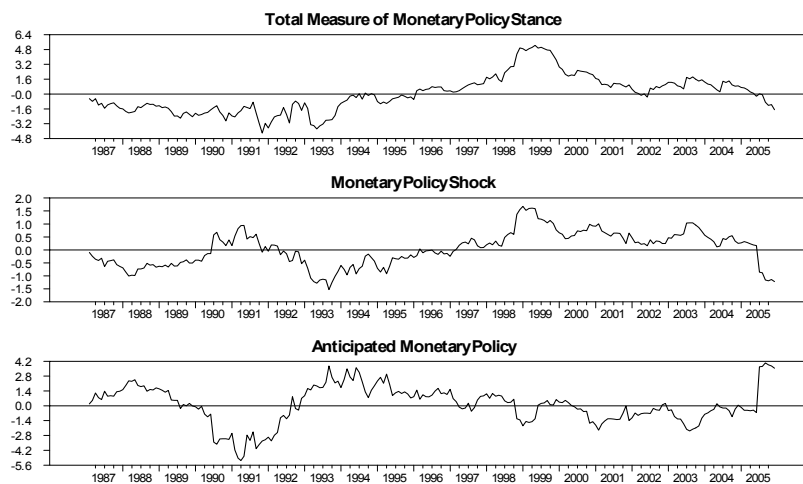


Figure 2 demonstrates that the dynamic responses of the total and of the nonborrowed reserves described by the non-structural VAR IRFs are inconsistent with the prior expectations. The IRFs for the JI model, however, depict the correct responses for these variables except from the 15th to the 30th month following the shock. Moreover, Figure 1 illustrates that the impact of the shock on the non-policy variables (real output and prices) is much smaller than its effect on the policy variables. Such a difference might exist because of misspecification errors. It may also arise owing to

the presence of propagation mechanisms that affect the reserves market relatively more than the rest of the economy.

The dynamic responses of the variables to the shock cannot alone provide information on the effects of changes in the implicit policy rule on the economy and on monetary stance²⁴. To estimate the effect of variation in that rule, we computed a simple indicator of monetary policy stance that articulates the anticipated (endogenous) and unanticipated (exogenous) components of policy. In practice, the indicator can provide a qualitative description of the overall behavior of the CBE and a measure of the general monetary conditions in the economy that allows for the detection of different episodes of monetary tightness or ease²⁵. Equation (4) specifies the index of monetary stance (Bernanke and Mihov, 1998). We employ the parameter estimates obtained using the JI VAR model in the construction of the index.

Figure 3
Total Measure and Exogenous and Endogenous Components of Monetary Stance 1985-2005



Note: The overall stance is rescaled to have 0 mean and the same variance of 3MDEP. The unanticipated and anticipated components are rescaled to have the same variance of the unanticipated and anticipated components of 3MDEP, respectively. The latter components of 3MDEP are decomposed using the Hodrick-Prescott (HP) filter.

Figure 3 sketches the overall index of the monetary stance (top panel) and its exogenous (middle panel) and endogenous (bottom panel) components graphed for the period 1985-2005. Figure 4 juxtaposes the stance index and the 3MDEP. The peaks and troughs in the index identify episodes of monetary easing and tightening, respectively. The top two panels in Figure 3 and Figure 4 show that most of the period 1987-1996 was characterized by a tight stance, especially during the fourth quarter of 1991 through 1993. The following period 1996-2004 witnessed an easier stance and a continuous decline in interest rates. Figure 4 shows, however, that the degree of easing or tightening implied by the stance index is not directly correlated with the

²⁴The monetary policy in Egypt has been carried out by discretion rather than by a policy rule. In section 5, we argue that the existing discretionary framework has often resulted in rule-like policy outcomes.

²⁵A formal analysis of the effect of shocks in the policy rule requires setting up a more elaborate structural model with stronger prior restrictions. This is done in section 5.

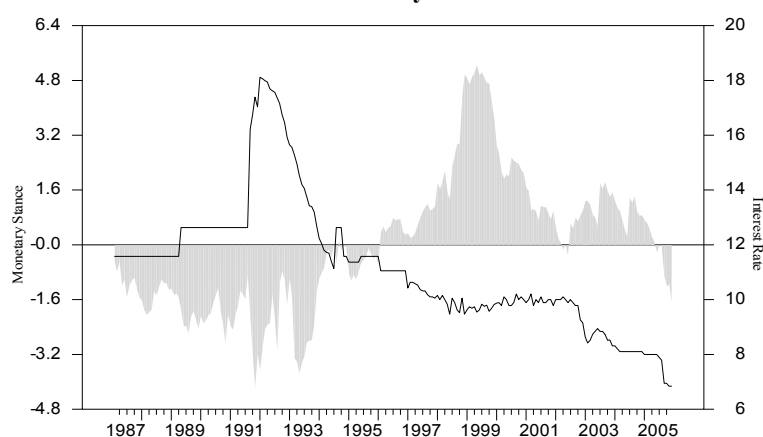
changes in interest rate because of the presence of policy disturbances in the reserves market, which, beside interest rate shocks, also affect the index.

Despite a decline in the 3MDEP, the stance index indicates an unexpected monetary tightening in 2005. We are not exactly sure what the reasons responsible for that tightening are. One possibility is that the impact of the rise in the overnight interbank interest rates in that year on shocks in the market for total and nonborrowed reserves has beset the effect induced by the fall in the 3-month deposit rate.

Figure A1 contrasts the index of monetary stance with the real output and the money (M2) series in growth rates and in levels during 1987-2005²⁶. The shading in panels A, B, C and D indicates the episodes of monetary tightening (easing) corresponding to lower (higher) economic growth, real GDP, M2 growth and M2, respectively. The pictures indicate that the behavior of the stance throughout most of the specified period was consistent with the prior expectations.

To summarize, the estimated stance index faithfully traces the episodes of monetary easing and tightening from the mid-1980s through 2005. The JI model, from which the stance was derived, however, is not capable of emulating the a priori theoretical responses of important variables, particularly real output, to policy innovations. We have found that the impact of monetary policy shocks on the size and on the direction of change in real GDP and in prices was either negligible or ambiguous. The anomalous responses of total and of nonborrowed reserves to policy shocks (Figure 2 A,B) could possibly lead to such puzzling outcome.

Figure 4
Overall Index of Monetary Stance and 3MDEP



Note: The stance index and the 3MDEP are displayed as a polygon and a solid line, respectively. The 3MDEP is normalized such that 2002:1=10.

4. Effect of monetary policy on output

This section considers the effect of policy shocks on real output responses after imposing restrictions on the IRFs of nonborrowed reserves and of prices to ensure the

²⁶These comparisons should be considered with caution since they contrast the behavior of a composite index with the movements of single variables whose simple behavioral dynamics might not take into account the additional cause-and-effect channels of interaction that emerge from the analysis of multiple time series.

consistency of their dynamic behavior with the prior expectations. We use the *pure-sign-restrictions* methodology proposed by Uhlig (2005). The restrictions are set up such that a negative monetary policy shock does not lead to decreases in the interest rate or to increases in the prices or nonborrowed reserves for a certain period following the shock. Meanwhile, no restrictions are imposed on the response of real output, which is *agnostically* identified by the model output (Uhlig, 2005). It becomes, therefore, critical to select a time horizon (K) for the sign-restrictions to hold following the shock.

Uhlig's model imposes much less structure than that implied by the VAR models introduced by Bernanke and Mihov (1998) since it focuses only on one shock (that of the interest rate) with minimal a priori assumptions about the structure of other shocks²⁷. This flexibility comes at a price. For example, imposing a non-positivity restriction on the impulse response of nonborrowed reserves precludes the possibility of money demand shocks. However, if the monetary authority opts to accommodate, at least partially, the rise in money demand by increasing nonborrowed reserves, then the money demand shocks cannot be ignored. The poor performance of the NBR model and the marginal success of the NBR/TR model compared with the JI model diminish the importance of this shortcoming since the data reveal that the CBE might not have depended on the nonborrowed reserves as a policy instrument. However, Uhlig's model remains exposed to other weaknesses. One serious inadequacy of that model arises because it ignores the complex effect of combinations of different policy shocks. While formally addressing that problem might unduly complicate the analysis, a simple way to avoid this limitation would be to identify the shock with the policy variable (i.e. the interest rate) ordered last in the VAR model. In this way, the cumulative effects of the underlying shocks in the model can be captured. Such identification may not always be very convincing because the shocks in the interest rate would have to depend linearly on a combination of several underlying disturbances in the other variables (Uhlig, 2005). And that dependency is likely to contaminate the shocks in the policy variable to the extent that it can no longer embody the main thrust and direction of monetary policy.

At the outset, we obtained a set of benchmark IRFs from our non-structural 6-variable VAR model using the standard Cholesky decomposition²⁸. The monthly data from 1981-2005 described in sub-section 3.2 were employed in the estimation²⁹. The VAR was estimated with 12 lags in levels of the logs of real GDP, the GDP deflator, the CPI and total and nonborrowed reserves and in level of 3MDEP³⁰. This ordering of the variables allows monetary policy shocks to be identified in the VAR with the innovations in the 3MDEP ordered sixth (Figure A2I). We fit the same model identifying a monetary policy shock with 3MDEP innovations reordered fourth before the nonborrowed and the total reserves as proposed by Uhlig (2005) (Figure A2II).

²⁷The main difference between Uhlig's approach and other methods that impose constraints on impulse responses (e.g. Blanchard and Quah (1989), Faust (1998) and Canova and de Nicolo (2002)) is that Uhlig's technique suggests imposing the sign restrictions only for a few periods following the shock rather than for a longer than necessary period or upon impact.

²⁸Unlike the pure-sign-restrictions approach, the Cholesky decomposition provides an exact identification.

²⁹Uhlig (1994 and 2005) suggests fitting the VAR without a constant or a time trend to improve the robustness of the results at the expense of slight misspecification. We follow suit.

³⁰The choice of lag length is based on the SBC criterion.

The IRFs and the corresponding error bands are sketched in Figures A2I,II for a 5-year period following the shock. The diagrams reveal that the endogenous behavior of the response functions to the policy shock seems qualitatively insensitive to the choice of ordering of the variables in the VAR. The response of the policy variable to its own shocks is not exactly consistent with the prior predictions. The negative monetary shock brings about an initial immediate increase in the 3MDEP by about 25 basis points, after which the interest rate starts declining very gradually. The waning effect of the shock dissipates after about 60 months. Figures A2I,II also show that the initial response of total reserves to a policy shock is unexpectedly positive for the first 4 years following the shock. The dynamic response of nonborrowed reserves is generally more realistic although it takes roughly 2 years to be consistent with the prior expectations. It is likely that the puzzling (positive) price response due to the negative monetary shock can lead to a fall in the real interest rate, which may in turn tempt the CBE to unduly accumulate rather than de-accumulate reserves.

A one standard deviation contractionary shock reduces real output nearly all through the response horizon. We detect a bit of an output puzzle in the third month after the shock with 3MDEP ordered last à la Bernanke and Mihov. The identification of the policy shock implied by that ordering might not always be appropriate. However, when the policy shock is ordered fourth the output puzzle becomes even more distinct (Figure A2I). Figure A2 panels I and II disclose that despite the relatively tight standard error bands for real output during the first 2 years following the shock, they seem to straddle the no-response line at 0. In addition, during the remainder of the response horizon, the error bands are too wide. We, therefore, conclude that the effect of a policy shock on the size and sign of the response of real output is ambiguous.

Figures A2I,II demonstrate other antinomies. We observe a persistent price puzzle that could not be mitigated by reordering the policy variable shock in the VAR. The price puzzle is not the only problem that taints the response functions for the GDP deflator and the CPI. The price movements in the commodity market are normally larger and more flexible in comparison with the aggregate price changes. Figures A2I, II indicate comparable amplitude for the responses of the GDP deflator and the CPI to the policy shock especially during the first 6 months of the response horizon. In the next 6 months, the amplitude of the IRF of the GDP deflator exceeds that of the corresponding IRF of the CPI. This unexpected relation between the IRFs of the GDP deflator and the CPI may be due to deliberate doctoring of the CPI data in order to dodge social unrest by dampening price perturbations and pinning down the official inflation rate.

We resort to the pure-sign-restrictions approach (Uhlig, 2005) to rectify the theoretically unreasonable responses of reserves and prices to monetary shocks. The 6-variable VAR described above is employed in the estimation of the responses of the variables to the policy shock, which is ordered fourth in the model. The estimation begins by defining a parameterized impulse vector that imposes non-positive sign-restrictions on the IRFs of the prices (the CPI and the GDP deflator) and nonborrowed reserves and non-negative sign-restrictions on the IRF of 3MDEP. We specify the parameterized restrictions to identify a one standard deviation in size contractionary policy shock.

The choice of the time horizon (K) in which the sign restrictions are forced to hold is somewhat arbitrary. To check the sensitivity of the predicted responses to the choice of K , we compare the results estimated using four different values for $K=2, 5, 11$ and 23 corresponding to time horizons of 1 quarter, 6 months, 1 year and 2 years, respectively, following the initial shock. Figure 5 portrays the impulse responses of the variables in the VAR for $K=5$ after restricting the responses of prices, nonborrowed reserves and 3MDEP as described above. Figure A3 depicts the histograms of the initial responses for the variables in the model. The histograms show how the sign restrictions cut off the upper parts from the distributions of the GDP deflator, the CPI, and nonborrowed reserves and the lower part from the distribution of the 3MDEP.

The agnostically identified IRF for real output (Figure 5) differs significantly from the one based on the Cholesky identification (Figure A2). The agnostic response of real output for $K=5$ seems insensitive to the contractionary shock. Figure A4 confirms the real output invariance for various values of K . For each of the 4 selected values of K , the ± 0.2 standard error bands appear to flank the IRF of real output around the no response line at 0. Figure A5 sketches the boundaries for the range of IRFs for real output that satisfy the sign-restrictions while varying the restriction horizon. As K is increased, the boundary range for the real output response becomes tighter as the upper bound is displaced downward and the lower bound is shifted upward. Hence, a longer restriction horizon tends to distribute the responses of real output closer to the no response line with IRFs drawing nearer to 0.

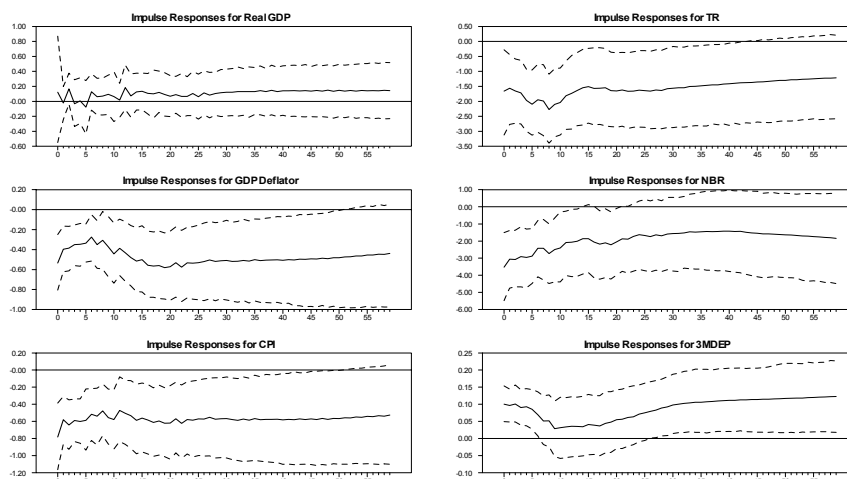
To summarize, our findings decisively show that monetary policy shocks in Egypt virtually have no real effect. Consequently, we conclude that in the long run, money is neutral to the extent that monetary policy shocks would only have an effect on the rate of inflation. The tighter IRF bands observed for the longer restriction horizons corroborate that deduction since they imply that interest rate shocks are associated with relatively stronger real variation of output in shorter runs.

We raise two more points before ending this section. First, we take a closer look at some of the differences between the estimation results based on the conventional decomposition and those derived using the sign-restrictions approach. Second, we employ the *penalty-function* model (Uhlig, 2005) as an alternative to the Cholesky decomposition and the sign-restrictions approaches to further check the real effect of policy shocks on output.

With regard to the first point, Figures A2 I,II and Figure 5 illustrate that the IRFs based on the Cholesky identification look more consistent with the conventional wisdom and have tighter error bands vis-à-vis those estimated using the sign-restrictions approach. One explanation for that difference is related to the price puzzle. We recall that unlike the Cholesky decomposition, the price puzzle is ruled out by the sign-restrictions assumptions. We surmise that there are considerable errors in the measurement of prices in Egypt and that these errors spell mistakes and induce reversals in the direction of the monetary policy, which in turn can be catalytic in stimulating the price puzzle. For instance, an inadvertent fall in the interest rate following a contractionary shock might raise the prices to accommodate the ensuing expansion in real economic activity (Figure A2). The puzzle may be aggravated if the real interest rate falls owing to the decline in the nominal interest rate and the rise in

prices. Of course, such perverse responses are ruled out by virtue of the sign-restrictions assumptions.

Figure 5
Impulse Responses with Pure-Sign Approach for $K=5$



Note: The contractionary monetary shock is chosen equal one standard deviation in size. The solid (-) and the dashed (--) lines represent the IRFs and the ± 0.2 standard error bands. The estimates are simulated with 200 draws and 200 sub-draws using an adjusted version of the Uhlig2 RATS program (Estima, 2004 and Doan, 2004).

Concerning the second point, we have seen that the Cholesky and the sign-restrictions approaches yield fundamentally different results for the size and the direction of real output changes due to policy shocks. We resort to the penalty-function model (Uhlig, 2005) as an alternative to the two other approaches³¹. The 6-variable VAR described above is fit employing the penalty-function. Restrictions are imposed for $K=5$ on the IRFs of prices (CPI and GDP deflator) and nonborrowed reserves positing non-positive responses and on the monetary policy instrument (3MDEP) positing a non-negative response. Figure A6 shows that the estimated IRF for real output in response to a contractionary shock exhibits relatively tighter bands immediately after the shock. Although the response of real output is non-negative, we notice that the error bands bestride the no response line at 0. Hence, a monetary contraction can lead to an increase, to a decrease or to no response in real output. Analogous to the earlier findings using the sign-restrictions, these results also support the neutrality of money. They imply that monetary policy shocks can only affect the inflation rate with almost no significant real impact on output.

5. Monetary policymaking by a rule

Driven by the country's need for a more flexible monetary regime that is conducive to growth, the monetary policy in Egypt recently witnessed a sea change. The CBE has publicly announced its intention to pursue inflation-targeting as the principle objective within a framework that focuses on price stability as the main policy target (CBE, 2005). The analytical approach employed so far, which has been concerned primarily with measurement of the monetary policy and stance, cannot be easily extended to

³¹The penalty-function model provides an exact identification of the monetary policy shock by minimizing a penalty function (see Uhlig (2005), especially Appendix B, for details).

deal with the intricate complexities that arise in the process of setting up the stage for the adoption of an inflation-targeting approach. This section considers some of the basic issues related to the evaluation of the prospective potency of inflation-targeting as a mechanism for price stabilization. The analysis is conducted in the context of exploring the possibility for the implementation of monetary policy by a rule.

To our knowledge, historically the CBE has been dependent on policymaking by discretion rather than by a policy rule. Two empirical issues deserve special attention once we start seeking a substitute for the prevailing discretionary regime. The first questions whether the CBE should depend exclusively on specific rule(s) in policymaking or simply make use of policy rule(s) to guide the discretionary decisions. More important, the second issue considers whether the existing discretionary framework has ever resulted in *rule-like* policy outcomes and arrangements. If so, then it would become potentially easier to instate a monetary regime that allows making policy and taking decisions in conjunction with explicit rules. We tackle both issues in the following sub-sections 5.1 and 5.2.

5.1 Rules versus discretion: A cursory overview

The question of implementing monetary policy by a rule vis-à-vis discretion is at least as old as Friedman's (1960) x-percent rule that dates back to the early 1960s. Nevertheless, that question is usually bound to stir up lively discussions, which traverses disputes concerning whether monetary policy should be implemented by strict rules or by pure discretion to explore the overall framework for monetary policymaking³². The existence of different types of rules has increased the complexity of the policy by rule versus discretion debate³³. In this study, we focus only on the pragmatic aspects of that debate. In addition, we promote the idea of deriving policy rules to guide the decision makers in Egypt toward improving their discretionary judgment. Such an approach represents a compromise between strict rules and pure discretion. We reckon that approach would be more realistic not only because of its theoretical advantages (discussed hereafter) but also owing to its potential scope for reconciling the CBE long historical experience in discretionary policymaking with the current demands for the implementation of inflation-targeting.

The strict rules approach has several advantages. Ironclad policy rules are characterized by simplicity, transparency, predictability, consistency and credibility. They increase the likelihood of insulating monetary policymaking from the effect of exogenous political pressure and rule out problems of time inconsistency³⁴. On the

³²A strict policy by rules regime implies that policymakers commit to setting policy instruments according to available data and forecasts via the specification of a simple publicly announced formula without the possibility of any discretionary modification regardless of the policy outcomes. Alternatively, under pure discretion the policymakers commit in advance only to actions based on their best value judgment and the information set that is available to them.

³³The spectrum for the different forms of rules extends from the simplest to the most complex types of rules. The simple rule approach mandates unconditional policies, e.g. raising the annual rate of growth of money supply x percent (Friedman, 1960). Complex rules restrict the monetary authority to exactly achieve a specified target objective (e.g. a particular rate of inflation) no matter how. There are intermediate types of rules that lie in between these extreme forms. For instance, feedback rules identify specific targets for the policy variables but the monetary authority is able to respond to deviations between the actual and the target levels of those variables.

³⁴Time inconsistency problems arise when policymakers pursue a different policy than the one to which they have been committed.

down side, they are rigid, too mechanical and completely lack the necessary flexibility to accommodate unanticipated shocks that affect the relation between the rates of growth of money, output and prices or to anticipate appropriate responses due to exogenous shifts in the monetary sphere. Moreover, the rules approach is generally prone to inconsistencies in situations where there might be conflicting targets (e.g. stabilizing the exchange rate and keeping a low and stable level of inflation). At the other polar extreme, the advocates of pure discretionary authority hail its flexibility in confronting and accommodating unforeseen developments in the economy and in the monetary environment without the oversimplification underlying the rules-based approach. Unfettered discretion, however, is exposed to serious deficiencies. The list of drawbacks includes low credibility, susceptibility to political intervention and unwarranted confidence in the ability of the policymakers' decisions to guide economic policy. So while the pure discretionary monetary policy has its obvious limitations, unbreakable policy rules have not been implemented in practice because of the real instability that they may create (Bernanke (2003a), Meyer (2002), Gramlich (1998) and Buchanan (1983)).

Bernanke and Mishkin (1997) propose a more sensible approach- dubbed constrained discretion- that finds a middle ground between pure discretion and strict rules. Under constrained discretion, the policymakers are strongly committed to keeping low and stable levels of inflation but at the same time they are endowed with sufficient flexibility to respond to unanticipated adverse shocks to the economy and to money markets. In addition, constrained discretion requires the monetary authority to stabilize the variance in the use of resources subject to imperfections in the information on economic conditions and on the impact of policy (Bernanke, 2003a).

Constrained discretion is closely related to the inflation-targeting approach and, thus, to the idea of employing a policy rule for monetary decision-making. On one hand, the operational aspects of monetary policy involved in inflation-targeting are similar to those of constrained discretion³⁵; and both approaches attempt to limit the variance in output and employment subject to keeping low and stable rates of inflation³⁶. On the other hand, inflation-targeting emphasizes the importance of transparency and of timely communication of policy decisions and measures to the public. These prerequisites of inflation-targeting should be able to improve the overall performance and management of monetary policy to the extent of achieving greater consistency in decision making and enhanced central bank accountability, which are themselves preconditions for the constrained discretion framework³⁷.

³⁵Both approaches share the operational aspects pertaining to the assessment of the structure of the economy and the identification of the policy instruments.

³⁶In extreme inflation-targeting situations, the monetary authority is constrained to achieve a specified inflation target.

³⁷In particular, there are three main prerequisites for inflation-targeting. The first requirement for a country to implement inflation-targeting is to guarantee the autonomy/independence of its central bank to manage monetary policy. This provides the central bank with flexible discretionary power that allows it to choose the most appropriate monetary policy instruments to achieve the inflation-target and to enhance the credibility of the policy. The second prerequisite is linked to the idea of central bank transparency. It requires the provision of a communications strategy between the central bank and both the financial markets and the public (Bernanke, 2003b). Accordingly, the central bank should provide public timely information about its objectives, strategies and decisions through publishing inflation reports and minutes of its decision-making meetings. The third prerequisite stipulates that the central bank should rely on powerful models to predict inflation (Allen, 2003). Besides, importantly, inflation-

To summarize, omniscient discretion does not exist. The preceding discussion propounds the implementation of constrained discretion as a basis for the design of monetary policy. The constrained discretion framework draws on policy rules. However, the rules act only as a means for supplying the policymakers with general roadmaps and quantitative guidance that can inform their discretionary decisions without precluding their prerogative to adjust to structural changes and real world conditions in order to reach stabilizing policy actions. In that respect, the policy rules are not a substitute for the decision makers' judgment but rather an input in the judgmental process (Feldstein, 1999). In the following sub-section, we present an empirical model for Egypt that can be used for the operationalization of the constrained discretion framework.

5.2 Estimating a policy rule for Egypt

Does it make sense to estimate a policy rule, knowing that decision makers at the CBE have been implementing policy by discretion? To answer the question just posed, we must first recognize the objective from having a policy rule. The quest for a policy rule is typically motivated by either one of the following two objectives. A rule can be employed, normatively, to design policy and to prescribe stabilizing responses conditional on incoming data and information. Alternatively, it could be derived to describe the way the decision makers have conducted the monetary policy during a specified period (Bernanke (2003a) and Gramlich (1998)). The second objective is sufficiently broad to permit the description of policymaking processes even for discretionary regimes. Good discretionary policy requires systematic decisions. And we should be able to represent those decisions by a rule-like construct (i.e. an implicit rule) that can explain the monetary policymaking choices. The following analysis aims at unveiling the implicit historical CBE policy rule and evaluating its policy relevance. The evaluation is conducted by means of a set of counterfactual simulation scenarios that study the economic and policy relevance and implications of the estimated rule in comparison with alternative hypothetical rules.

We assume that the contemporary monetary policymaking is driven by the CBE ambition to formally implement inflation-targeting. Taylor (1993) proposes a systematic perspective for modeling inflation-targeting by a rule³⁸. Interestingly the Taylor rule turns out to be consistent with the prerequisites of the constrained discretion framework. Moreover, it permits the description of the monetary policy by a feedback rule that gives great discretionary authority for decision makers to pursue the selected policy and to respond readily to deviations between the actual and the target levels of policy and non-policy variables.

Sections 3 and 4 underscore the central role of the interest rate as a policy instrument. Hence, we presume that it would be more realistic to estimate a quantitative Taylor rule for the nominal interest rate. Because there is no formal policy rule, we try to keep things simple by specifying a small model with only three variables: real output,

targeting demands the availability of an accurate and reliable consumer price index that can measure inflation correctly.

³⁸The Taylor (1993) rule specifies how the nominal interest rate should be adjusted in response to deviations of real output from its potential level (trend) and inflation from its target rate. Thus, the Taylor rule considers both the policy and non-policy choices. Taylor rules are not the only type. Besides price level stability Taylor-style rules, the monetary authority may adopt different rules such as a base money growth rule, M2 rule or a nominal income growth rule (McCallum, 2002).

CPI inflation and overnight interbank rate (the policy variable) and by focusing on the recent period February 2001 through July 2006³⁹. The (nominal) interest rate rule was estimated using the optimization-based econometric framework proposed by Rotemberg and Woodford (1997a, 1998 and 1999).

Rotemberg and Woodford introduce a generalization of the basic Taylor rule in which the monetary authority determines the nominal interest rate not only depending on the history of output and inflation but also as a function of the interest rate itself⁴⁰. The policy rule was derived from a structural econometric model based on a choice theoretic approach and assumes an intertemporal optimizing behavior for producers and consumers of goods and services. The optimization framework is articulated within a rational expectations model⁴¹. The model, therefore, embodies much more dynamics than the simple Taylor rule. A detailed discussion of the methodology developed by Rotemberg and Woodford is beyond the scope of this paper⁴². To simplify the interpretation of our results, however, we sketch a general outline of the empirical steps that were needed to estimate the CBE policy rule following the Rotemberg and Woodford (1997a, 1997b and 1998) guidelines⁴³.

Initially a trivariate just identified unrestricted structural VAR model with real output, inflation rate and the overnight interbank rate was fit to estimate the implied empirical policy rule and to determine the response of the economy to stochastic disturbances in it. In the second step, a theoretical model was proposed as an explication of the unrestricted VAR results. The theoretical model has been designed to account for the stylized responses of real output and inflation to policy shocks assuming that output and prices may not change immediately owing to the shocks because of decision lags. We calibrated the theoretical model using selected values for a set of parameters that describe the behavior of agents in the economy. Table A3 gives a brief description of these parameters and reports the values that were chosen for the calibration according to subjective beliefs about the realities of the Egyptian economy. The values of two of those parameters were freely determined by an optimization algorithm that minimizes a penalty function defined as the sum of squared differences between the theoretical and empirical impulse responses for output, inflation and interest rate in the first 4 months following a policy shock. The three discrepancies were given equal weights in the objective function as suggested by Rotemberg and Woodford (1997a)⁴⁴. Finally,

³⁹We utilized the temporally disaggregated monthly frequency data for real GDP and the CPI inflation series described earlier to estimate the policy rule. The monthly overnight interbank rate was provided by the CBE (unpublished).

⁴⁰This extension allows for the measurement of interest rate smoothing as monetary policy gradually adjusts to output, inflation and interest rate shocks.

⁴¹Rotemberg and Woodford (1997a, 1998 and 1999) discuss two advantages for the optimization-based approach: it facilitates welfare analysis of the effects of monetary policy and it circumvents the Lucas (1976) critique of econometric policy evaluation by allowing for the effects of policy shifts on the decision rules of private agents. For a detailed criticism of those advantages and of Rotemberg and Woodford's approach in general, see the comment by Feldstein (1999) and the ensuing discussion summary (Taylor, 1999).

⁴²Readers interested in more information about that methodology may wish to refer to the original articles, in particular Rotemberg and Woodford (1997a and 1998).

⁴³The adjusted Matlab code from Rotemberg and Woodford (1997b) is used with the *solds* and *reds m-files* for solving dynamic systems (<http://www.columbia.edu/~mw2230/Tools>) to estimate the theoretical policy rule and to conduct the related historical simulation experiments.

⁴⁴The choice of free parameters in this study differs from the original selection suggested by Rotemberg and Woodford (1997a and 1998). Our choices have been largely influenced by the

the results from the quantitative theoretical model and the empirical VAR were used to identify the historical shock series for the structural equations. The shock processes together with the values selected for the calibration parameters (Table A3) were in turn employed to simulate different historical paths and examine alternative counterfactual scenarios that explicate the consequences of hypothetical monetary policy rules on the economy.

The parameters of the empirical VAR model, including the overnight interbank interest rate (R), CPI inflation rate (π) and detrended real GDP (y), were estimated using monthly data for the period 2001:2-2006:7. A short estimation time horizon (5.5 years) has been selected to minimize the probability of major structural shifts in the policy regime. Table A.4 displays the parameter estimates of the unrestricted VAR.

The coefficient estimates of the feedback policy rule are reported in the column labeled R_t . The overall responsiveness of the overnight interbank rate to inflation and output shocks can be captured by means of long-run multipliers. The multipliers measure the variation in the overnight rate because of a permanent change in the levels of output and inflation. The long-run multipliers were computed using the policy rule parameter estimates and the long-run values for inflation (π^*) and the overnight interbank rate (r^*). The long-run estimates of π^* and r^* are 5.0% and 9.2%, respectively, thus implying a long-run-average real overnight interbank rate of 4.2%. The long-run multipliers are given by

$$r - r^* = 0.93(\pi - \pi^*) + 11.17y. \quad (5)$$

Our findings show that the long-run inflation rate is relatively high. If the CBE were to set the inflation target equal to the long-run value of 5%, then the nominal interest rate would have to range between 9%-10% in order to keep the real interest rate at a reasonable level that would preclude a fall in bank reserves and the adverse consequences of dollarization. Continuing to maintain interest rates at those high levels might preserve reserves but the excessive rates of interest would inevitably end up leading the economy to low long-run levels of growth.

Equation (5) shows that either a level of output that is higher than the trend or an inflation rate that exceeds the target would raise the overnight interbank rate. The output multiplier indicates that the nominal interest rate is extremely sensitive to the output gap. This sensitivity reflects the underlying rigidities in the economy as it takes a large increase in the interest rate to return output back to the trend when output rises above the natural level. In addition, the inflation multiplier is just a little bit less than 1. Hence, a fall in the inflation rate implies a relatively smaller amount of decrease in the nominal interest rate leading to a marginal increase in the short-run real interest rate and consequently to a negative effect on growth.

The estimated coefficients of the policy rule (Table A4) imply a considerable degree of interest rate smoothing since the parameter estimates for the lagged endogenous variable are all positive and sum to 0.79. The estimates also show that an increase in

convergence properties of the optimization model solution. The Matlab code, employing *cmaes.m* Version 2.40 (CMAES, 2006) used for the minimization was prepared by Ahmed Abd El Tawab.

the inflation rate does not have a significant effect on the overnight interbank rate until the next month.

The IRFs derived from the estimated VAR (Figure A7) depict the response of each variable in the model to a one-standard-deviation monetary policy shock that raises the overnight interbank rate just over 0.2%. The behavioral dynamics of the overnight interbank rate and inflation generally satisfy the prior expectations. The policy shock immediately raises the overnight rate. However, the overnight rate falls noticeably during the first month following the shock and gradually gets back to normal after one year. The inflation rate declines with the monetary tightening. The sharpest fall in inflation occurs one month following the shock, at the same time when the interest rate decreases sharply. There appears a tad of a price puzzle after three months following the shock as inflation begins to rebound to the no response level of 0. The effects of the shock on interest rate and on inflation dissipate completely after twelve and four months, respectively following the initial impulse. Though the output level returns to the no response level almost at the same time as inflation does, its estimated response is not always consistent with the prior expectations. Output first declines owing to the negative shock. The fall in output is reversed after one month following the shock and this unanticipated response persists during the next two months. Consequently, in contrast with the earlier findings (see sections 3 and 4) we discover that during the period 2001-2006, although the price puzzle is no longer significant, an apparent output puzzle occurs in response to the policy shock.

The anomalous responses of real output and to a lesser extent inflation may be attributed to the complex structural dynamics that cause reversals in their behavior once the interest rate starts to return to its normal level. Because the interest rate falls slowly, the economic agents may no longer be surprised by the shock and hence are able to adjust their expectations accordingly. Moreover, since, by that time, the inflation rate has already started to return back (increase) to its steady-state value, the real interest rate falls thereby bringing about reversals in the responses of output and prices. Because producers normally have better access to information in comparison with consumers, the output reversal takes place almost seven weeks ahead of the price reversal.

The impulse responses of the empirical VAR are employed (given the values selected for the calibration parameters displayed in Table A3) to tailor the structure of the theoretical model so that it is consistent with the dynamic characteristics of the data used in the estimation. The theoretical IRFs of output, inflation and interest rate are plotted in Figure A7 as solid lines. The diagram shows that none of the theoretical IRFs can perfectly match the predicted point estimates of the empirical VAR responses neither in terms of magnitude nor in terms of the persistence of the effect of the shock on each variable.

The responses implied by the theoretical model are considerably larger than those obtained from the actual VAR. Both models indicate that the interest rate gradually returns to normal one year following the shock. The theoretical and empirical IRFs of the policy variable, however, connote different dynamics. The actual IRF of the interest rate exhibits a sharp decline during the first month following the shock. According to the theoretical model, it takes twice that time for the interest rate to fall significantly. The theoretical response of inflation reaches a minimum also two

months following the shock. Unlike the empirical VAR, the theoretical model demonstrates an unequivocal price puzzle that persists for roughly two months, albeit that inflation falls during the first three months following the shock. Finally, despite the marked difference between the real output dynamics of the theoretical and empirical VARs, the two models demonstrate an output puzzle that takes place concurrently in different periods following the shock (Figure A7).

The poor tracking of the theoretical responses points to a specification error that probably arises due to the poor precision of the empirical VAR estimates. It also highlights the deficient specification of the theoretical model that ignores the effect of the coefficients of the estimated policy rule on the nature of the theoretical responses of output and inflation to the policy shock (Rotemberg and Woodford, 1998). The importance of the differences between the theoretical and the empirical IRFs should not be exaggerated. Even with those discrepancies, the theoretical model may still be able to capture the behavioral dynamics of the data underlying the empirical VAR. One way to predict the correspondence between the theoretical and the empirical models is through comparing the second moments for the data with those from the structural model. The nine panels in Figure A8 plot the cross-correlation functions of the three series for the theoretical (solid line) and the empirical (dashed line) VAR models. The chart shows that with the exception of output, the theoretical model accounts for the second moments of the data to similar degree as the unrestricted actual VAR. In particular, the diagram illustrates that the theoretical model efficiently captures the same degree of persistence of inflation implied by the empirical model. It also reproduces the interest rate smoothing as does the empirical VAR.

The fitness of the structural model can be tested differently through examining its capacity to simulate the variations in real output, inflation and the overnight interbank rate in the presence of Rotemberg-Woodford type historical shocks. We conduct those simulations in the following sub-section and make use of them to understand the effects of alternative counterfactual monetary policy rules on the performance of the economy.

5.3 Policy rule simulations under alternative scenarios

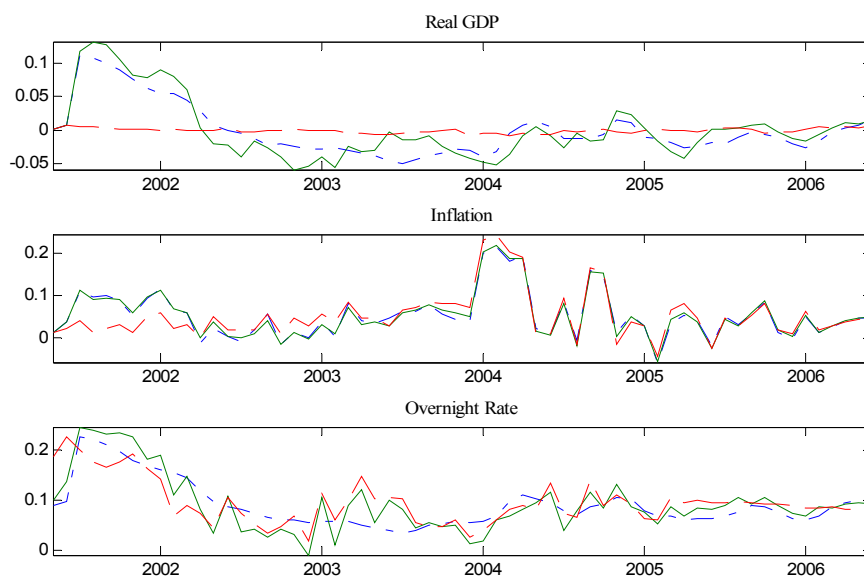
In this sub-section, we study the interest rate feedback effects for the estimated historical policy rule as well as for alternative hypothetical rules. Figure 6 graphs the actual data (dashed line) along with two model simulations. The first (HSIM3) depicts a simulated policy rule with Rotemberg-Woodford type series of historical policy and non-policy (real) shocks (solid line). The dash-dot line (-.) represents an alternative policy rule that is simulated with the historical series of real shocks only (HSIM2)⁴⁵.

Figure 6 discloses that the HSIM3 graphs trace the actual inflation and overnight interbank rate series accurately, particularly since the second quarter in 2003. The HSIM3 simulation of inflation, however, seems to follow the actual series more precisely in comparison with the overnight rate. Conversely, the HSIM3 fails to convincingly track real output except from mid-2005 until the end of the simulation horizon when a marginal improvement in tracking is discernable. That improvement possibly proceeds from the enhanced management of financial markets starting 2003

⁴⁵In other words, we assume that the historical sequence of monetary policy shocks is equal to zero.

and from the implementation of a more focused monetary policy that culminated with the selection of the overnight interbank rate as the key operational target in 2005.

Figure 6
Actual and Simulated Paths with and without a Monetary Shock



Note: The dashed line (--) represents the actual data and the solid (-) and dash-dot (-.) lines represent the HSIM3 and the HSIM2 simulations, respectively. The Taylor rule coefficients obtained from the estimated feedback policy rule for inflation (θ_π) and real output (θ_y) are 0.082 and 1.163, correspondingly.

Figure 6 illustrates the critical effect of monetary policy shocks on the performance of the economy. The diagram portrays considerable differences between the HSIM3 and the HSIM2 simulated paths for each of the three series. The deviation is relatively more pronounced for real output but it is also noticeable for the interest rate prior to 2004. These findings indicate that during the simulation horizon, stochastic disturbances to monetary policy had a significant influence on output and on the interest rate. In contrast, random shocks to monetary policy had much less important consequences on the rate of inflation.

Table 3 provides further evidence on the important role that monetary policy has to play in terms of its contribution to the variances in real output, inflation and interest rate. The table reports the variances for each of these variables under the HSIM3 and the HSIM2 historical simulations employing the estimated feedback rule with and without the stochastic disturbance term. In addition, the table depicts analogous variance estimates for various counterfactual Taylor-style (1993) feedback monetary policy rules with different arbitrary values for θ_π and θ_y .⁴⁶

We immediately notice that all the HSIM3 variances are greater than the corresponding HSIM2 variances owing to the effect of monetary policy shocks. With very few exceptions, the predicted variances are larger than one would normally expect. For example, HSIM3 predicts that a monetary policy shock accounts for approximately 32% and 15% of the variance in inflation and in interest rate,

⁴⁶We consider the simple Taylor feedback rule specification $r_t = \theta_\pi \pi_t + \theta_y y_t$.

respectively, and for almost 2.5% of the variance in the deviation of real GDP from the trend. These large moments imply that unexpected stochastic variation in the CBE monetary policy has been significantly more important than the systematic component, which leaves the CBE excessively vulnerable to unanticipated shocks and economic instability. Such vulnerability is likely to interfere with the capacity of the CBE to design sound monetary policy and calls for swift implementation of more resilient reforms that could enforce the CBE objectives and reduce its exposure to the perils of economic disturbances. We believe that a major step in the right direction involves a shift in the orientation of the monetary policy toward the implementation of constrained discretion. This obviously should entail the introduction of some organizational prerequisites capable of bringing about essential institutional adjustments that could lead to enhanced transparency, independence and credibility of the CBE monetary policy, more reliable data and finer forecasts.

Table 3
Predicted Stationary Variances of Real Output, Inflation
and Interest Rate Under Alternative Monetary Rules

	Var (R)	Var (y)	Var (π)	Var($\pi-E\pi$)	Var $\{E(y-y^s)\}$	Loss from Variability
HSIM3						
Historical policy with shock	15.423	2.443	31.754	19.147	40.461	46.551
Historical policy without shock	8.006	1.288	31.466	19.133	39.306	45.989
$\theta_\pi=1.5, \theta_y=0.5$	75.131	57.066	21.128	16.114	14.508	29.004
$\theta_\pi=1, \theta_y=5$	30.109	1.219	28.213	17.793	33.531	41.011
$\theta_\pi=10, \theta_y=0$	949.435	51.327	9.494	9.233	0.732	12.232
$\theta_\pi=1.5, \theta_y=1$	61.432	24.417	19.548	16.396	10.738	26.619
HSIM2						
Historical policy with shock	12.936	1.351	30.024	19.134	35.413	43.635
Historical policy without shock	5.520	0.196	29.735	19.120	34.258	43.073
$\theta_\pi=1.5, \theta_y=0.5$	65.877	42.788	20.362	16.002	12.709	27.786
$\theta_\pi=1.0, \theta_y=5$	26.651	0.860	26.747	17.786	28.937	38.467
$\theta_\pi=10, \theta_y=0$	937.262	41.585	9.373	9.177	0.539	12.049
$\theta_\pi=1.5, \theta_y=1$	54.899	17.991	19.370	16.340	10.329	26.330

Note: The variance estimates for inflation and interest rate are calculated in annualized percentage points; they are computed for real output as a percentage deviation from its potential level.

Table 3 examines the effects on the economy of a variety of counterfactual monetary regimes represented by simple Taylor-type rules in comparison with the estimated historical policy rule. The modeling options for the feedback rule are distinguished by the values given to the parameters θ_π and θ_y . A specific policy rule implies higher inflation or output stabilization the bigger the values of the response parameters θ_π or θ_y , respectively. The variation among the predicted variances manifests the significant differences in the policy impact of the different monetary rules. For instance, consider the output from two counterfactual policy scenarios: (i) an output stabilization regime that is parametrically determined by the values $\theta_\pi=1$ and $\theta_y=5$ and (ii) an inflation stabilization policy represented by $\theta_\pi=10$ and $\theta_y=0$ (Table 3). The relatively larger response to deviations of output from its trend ($\theta_y=5$) reduces dramatically the variance in output fluctuations from 51.3% to 1.2%. The major decrease in output volatility is associated with an equally sharp contraction of the variance in the interest rate. Meanwhile, the output stabilization scenario is accompanied by a large rise in the volatility of inflation from 9.5% to 28.2% owing to the 90% increase in θ_π .

How do the variances predicted under the historical simulation compare with those that come from the counterfactual experiments? The historical policy rule implies that

the current CBE monetary policy has devoted substantial attention to the stabilization of output and interest rates with less consideration given to the reduction of the variance in inflation. This seems in stark contradiction with the CBE announced objective to keep low and stable levels of inflation. Actually, the results displayed in Table 3 disclose a clear tradeoff between the costs of the deviation of inflation from its expected (target) value ($\text{Var}(\pi - E\pi)$) and the interest rate variance: lower costs of deviation are associated with large interest rate variance. In general, the historical monetary policy rule implies that the CBE has attached relatively lower value- in comparison with the counterfactual scenarios- to inflation stabilization thus sacrificing price stability in order to dampen monetary volatility and gain credibility from interest rate stability. By such deviation between the announced policy (price stability) and the realized objective (interest rate stability) the CBE takes the risk of being held accountable for time consistency transgression.

To summarize, the results show that the monetary policy can play a critical role in adjusting the dynamical behavior of output and inflation just by focusing on achieving price stability. Despite the constructive measures that have been taken recently by the CBE to reform the monetary sector, more effort is still required to fine-tune the performance of monetary policy. More synchronization between the monetary objectives and the actual policy realization is needed to evade the problem of time inconsistency. If the CBE were to focus, no matter how, on targeting inflation, as we think it should, it should overtly take the necessary steps required to achieve that objective without worrying too much about meeting other targets such as the reduction of variance in interest rate. After all, this is what transparency and credibility are all about.

6. Concluding remarks

This study focuses on examining the salient features and developments in monetary policy and on describing their implications for the Egyptian economy during the last two decades. The analysis employs a set of models that measure the structure and stance of contemporary monetary policy and that evaluate the responses of both policy and real economic variables to policy shocks. To improve the performance of the money markets, the CBE has recently disclosed the need for redesigning the current monetary system via a shift toward a more flexible regime that focuses on price stability as the principle objective. The shift has been endorsed by the adoption of the overnight interbank interest rate as the main operational target. The CBE has also explicitly announced its intent to select the inflation-targeting framework for monetary policymaking in general and for the stabilization of prices in particular.

Our results reveal that during the recent period, the impact of monetary policy shocks on real output and on prices was negligible and ambiguous, respectively. Hence, we conclude that policy shocks have an impact only on the rate of inflation with almost no real effect. We take this as evidence supporting the long-run neutrality of money. Naturally, this does not mean that the monetary policy is not important. What it means, however, is that the effect of monetary policy on the level of real output and on the rate of economic growth in the long run is limited by its capacity to achieve long-run price stability.

The study sheds light on the prospects for monetary decision making by a policy rule as a substitute for the current discretionary decision making regime. Egypt has a long history of monetary policy making by discretion rather than by rules. The disadvantages of such a system are well known. Discretionary policy in Egypt usually has had limited success- at least since the 1990's- in achieving a myriad of occasionally conflicting economic and monetary objectives including inflation and output stabilization, motivating real GDP growth, interest rate smoothing, exchange rate stability and restraining liquidity expansion.

In line with the mainstream literature, we advocate implementation of the constrained discretion framework that finds a middle ground between the pure discretion and the strict rules approaches. It also permits the decision makers to remain committed to some target via a policy rule but at the same time allows sufficient flexibility to respond to unanticipated adverse shocks to the economy and to disturbances in the money markets. The literature shows that constrained discretion is closely related to the inflation-targeting framework, which involves the idea of employing a policy rule.

Picking up on the theme of inflation-targeting, we estimated a variant of the Taylor-type interest rate feedback rule à la Rotemberg and Woodford (1998) as part of a system for real output, inflation and overnight interbank rate determination. The estimation model zoomed in on the recent period from 2001 to mid-2006. Our findings disclose that the discretionary monetary regime in Egypt may not be inconsistent with rule-like policy outcomes. The results illustrate a noticeable tradeoff between inflation and interest rate stabilization. Moreover, historical simulations point to a problem of time inconsistency. During the period under consideration, the CBE has given precedence to the reduction of the interest rate variance rather than to the stabilization of inflation. Counterfactual policy oriented scenarios suggest that it might be possible to improve the capacity of the CBE in stabilizing inflation through abiding by policy intervention measures that can appropriately influence the responses of the (nominal) interest rate to deviations of inflation from its target value and of real output from its trend.

All our quantitative results are subject to the conventional drawbacks brought forth by flawed data and possible errors arising from model misspecification. Nevertheless, we believe that our findings should offer a few practical insights for the design and implementation of a sensible transparent monetary policy that is capable of achieving the current CBE objective.

References

Abu El Eyoun, M., 2003, "Monetary Policy in Egypt: A Vision for the Future," *The Egyptian Center for Economic Studies (ECES)*, Working paper number 78. (In Arabic)

Allen, William, 2003, "Inflation-targeting—an Overview," Lecture to the Egyptian Banking Institute.

BUYUSA, A Country Commercial Guide for U.S. Companies, 2006, Chapter 7: Trade and Project Financing, <http://www.buyusa.gov/egypt/en/ccg07.html>.

Bartley, Robert L., 2001, "Dervish Lira, Peso Mariachi," Wall Street Journal.

Bernanke, B.S. and Blinder, A.S., 1992, "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, 82 (4), 901-921.

Bernanke, B.S. and Frederic Mishkin, 1997, "Inflation-targeting: A New Framework for Monetary Policy?" *Journal of Economic Perspectives*, vol. 11 (Spring), 97-116.

Bernanke, B.S. and Mihov, I., 1998, "Measuring Monetary Policy," *Quarterly Journal of Economics*, 113 (3), 869-902.

Bernanke, B.S., 2003a, "Constrained Discretion and Monetary Policy" Remarks before the Money Marketakers of New York University, New York.

Bernanke, B.S., 2003b, "A Perspective on Inflation-targeting," Remarks at the Annual Washington Policy Conference of the National Association of Business Economists, Washington, D.C.

Blanchard, Olivier J. and Danny Quah, 1989, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, vol. 79, 655-673.

Buchanan, James M., 1983, "Monetary Research, Monetary Rules and Monetary Regimes," *Cato Journal*, vol. 3 (Spring), No. 1.

Canova, Fabio, 1995, *VAR: Specification, Estimation, Testing and Forecasting*, in Pesaran, H. and M. Wickens, eds., *Handbook of Applied Econometrics*, 31-65.

Canova, Fabio and Gianni de Nicolo, 2002, "Monetary Disturbances Matter for Business Fluctuations in the G-7," *Journal of Monetary Economics*, 49(6), 1131-59.

Caporello, G. and A. Maravall, 2004, "Tramo and Seats Program (TSW)," Banco de España, Spain.

Central Bank of Egypt (CBE), 1990/1991 to 2004/2005, Annual report, CBE, Cairo, Egypt. (In Arabic)

Central Bank of Egypt (CBE), 2005, Monetary Policy Statement, CBE, Cairo, Egypt, <http://www.cbe.org.eg>.

Central Bank of Egypt (CBE), 2006, "The Discount Rate and Interest Rates on Deposits and Loans in Egyptian Pounds," <http://www.cbe.org.eg/timeSeries.htm>, CBE, Cairo, Egypt.

Central Bank of Egypt (CBE), unpublished, Monthly InterBank Rates on Egyptian Pound.

Chow, G. and A.L. Lin, 1971, "Best Linear Unbiased Distribution and Extrapolation of Economic Time Series by Related Series," *Review of Economic and Statistics*, vol. 53, no. 4, pp. 372- 375.

Christiano, Lawrence and Martin Eichenbaum, 1992a, "Liquidity Effects and the Monetary Transmission Mechanism," *American Economic Review*, vol. 82 (2), 346-353.

Christiano, Lawrence and Martin Eichenbaum, 1992b, *Identification and the Liquidity effect of a monetary policy shock*. In: Cukierman, A., Hercowitz, Z., Leiderman, L. (Eds.), *Political Economy, Growth and Business Cycles*. MIT press, Cambridge, MA.

CMAES, 2006, <http://www.bionik.tu-berlin.de/user/niko/cmaes060523.m>.

Cosimano, Thomas and Richard Sheehan, 1994, "The Federal Reserve Operating Procedure, 1984-1990: An Empirical Analysis," *Journal of Macroeconomics*, 16 (summer), 573-88.

Doan, 2004, *New Developments in VAR Modeling*, Prepared for RATS User's Group Meeting Trinity College.

Economic Research Forum (ERF) and Institut de la Méditerranée (IM), 2004, *Egypt country profile, the Road Ahead for Egypt*, A report by ERF, ERF Egypt.

Eichenbaum, Martin, 1992, "Comments on 'Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy' by Christopher Sims," *European Economic Review*, vol. 36, no. 5, 1001-1011.

EL-Asrag, H., 2003, "The Performance of Monetary Policy in Egypt during the Period (1997-2003)," A research presented to the 24th Egyptian economists' conference. (In Arabic)

El Mossallamy, Mai, (2004), "Analyzing the Behavior of Inflation in Egypt: A Modern Approach," Unpublished MA Thesis, Department of Economics, Faculty of Economics and Political Science, Cairo University. (In Arabic).

EL-Refaay, F., 2000, "The Issue of Liquidity in Egypt: Reasons and Solutions," *The Egyptian Center for Economic Studies (ECES)*, Working paper number 41. (In Arabic)

Estima, 2004, RATS User's Guide Version 6.

Faust, J., 1998, "The Robustness of Identified VAR Conclusions about Money," *Carnegie Rochester Conference Series in Public Policy*, 49, 207-244.

Feldstein Martin, 1999, "Comment in Interest Rate Rules in an Estimated Sticky Price Model," In: John B. Taylor (Eds.), *Monetary Policy Rules*, National Bureau of Economic Research.

Friedman, Milton, 1960, *A Program for Monetary Stability*, New York: Fordham University Press.

Gordon, D.B. and Leeper, E.M., 1994, "The Dynamic Impacts of Monetary Policy: An Exercise in Tentative Identification," *Journal of Political Economy*, 102 (6), 1228-1247.

Gramlich, Edward M., 1998, "Monetary Rules," Remarks at the Samuelson Lecture before the 24th Annual Conference of the Eastern Economic Association, New York, New York.

Hussein, K. and Nos'hy, A., 2000, "What Caused the Liquidity Crisis in Egypt?," *International Center for Economic Growth (ICEG)*, <http://www.iceg.org/NE/projects/financial/liquidity.pdf>.

IMF-IFS, 2006, International Financial Statistics, CD-ROM.

Information and Decision Support Center (IDSC), 2005, "Index for the Performance of the Financial Economy," IDSC, Cairo, Egypt.

Kim, S., 1999, "Does Monetary Policy Matter in the G-7 countries? Using Common Identifying Assumptions about Monetary Policy across Countries," *Journal of International Economics*, 48(2), 387-412.

King, R. G. and M. W. Watson, 1996, "Money, Prices, Interest Rates and the business Cycle," *Review of Economics and Statistics*, 78(1), 35-53.

Khalid, Ahmed M., 2006, "Is Inflation-targeting the Best Policy Choice for Emerging Economies? A Survey of Emerging Market Experiences and Lessons for Pakistan," The State Bank of Pakistan (SBP) Research Bulletin, Vol. 2, NO. 1.

Litterman, R.B., 1983, "A Random Walk, Markov Model for the Distribution of Time Series," *Journal of Business and Economic Statistics*, vol. 1, no. 2, pp. 169-173.

Lucas, Robert E., 1976, "Econometric Policy Evaluation: A Critique," *Carnegie Rochester Conference Series on Public Policy* 1, 19-46.

McCallum, Bennett T., 2002, "The Wall Street Journal Position on Exchange Rates," <http://www.somc.rochester.edu/Apr02/McCallum.pdf>.

Meyer, Laurence H, 2002, "Rules and Discretion," Remarks at the Owen Graduate School of Management, Vanderbilt University, Nashville, Tennessee.

Mundell, Robert, 2000, "Currency Areas, Exchange Rate Systems, and International Monetary Reform," Paper given at Universidad del CEMA, Buenos Aires, Argentina.

Quilis, Enrique M., 2004, "A Matlab Library of Temporal Disaggregation Methods: Summary," Instituto Nacional de Estadística, Paseo de la Castellana, 183, 28046 - Madrid (SPAIN).

Rotemberg, J. J. and M. Woodford, 1997a, "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," In *NBER Macroeconomics Annual*, ed. Ben Bernanke and Julio J. Rotemberg, Cambridge, Mass.: MIT Press, 297-346.

Rotemberg, J. J. and M. Woodford, 1997b, "Notes on the programs for Rotemberg and Woodford an Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," *NBER Macroeconomics Annual*.

Rotemberg, J. J. and M. Woodford, 1998, "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy: Expanded Version," *NBER Technical working paper series*, No. 223, Cambridge, Mass.: National Bureau of Economic Research.

Rotemberg, J. J. and M. Woodford, 1999, "Interest Rate Rules in an Estimated Sticky Price Model," In: John B. Taylor (Eds.), *Monetary Policy Rules*, National Bureau of Economic Research.

Sims, Christopher A., 1972, "Money, Income and Causality," *American Economic Review*.

Sims, Christopher A., 1980, "Macroeconomics and Reality," *Econometrica*, vol. 48, 1-48.

Sims, Christopher A., 1986, "Are Forecasting Models Usable for Policy Analysis," *Minneapolis Federal Reserve Bank Quarterly Review*, 2-16.

Sims, Christopher A., 1992, "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy," *European Economic Review*, vol. 36, 975-1011.

Sims and Zha, "Error Bands for Impulse Responses," 1999, *Econometrica*.

Strongin, Steven, 1995, "The Identification of Monetary Policy Disturbances: Explaining the Liquidity Puzzle," *Journal of Monetary Economics*, 35(3), 463-497.

Taylor, John, 1993, "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, vol. 39, 195-214.

Taylor, John, 1999, "Monetary Policy Rules," Chicago: University of Chicago Press for the National Bureau of Economic Research.

Uhlig, Harald, 1994, "What Macroeconomists Should Know about Unit Roots: A Bayesian Perspective," *Econometric Theory*, vol. 10, 645-671.

Uhlig, Harald, 2005, "What are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," *Journal of Monetary Economics*, 52, 381-419.

Wichern, Hanke, J. and D., Reitsch, A., 2001, *Business Forecasting*, 7th edition, Prentice Hall, p. 155-157.

Appendix

I. Tables

Table A1
Monetary Policy in Egypt

Year	Objective	Target		Instruments
		Operational	Intermediate	
1990/1991	-PLS -ERSTAB	-ERES -SNIRM	-NAB	-Nominal interest rate liberalization with 12% floor on 3-month deposit rate -Modify calculations of RRR -DLR=20%, FLR=25% -Use OMO -Exchange rate liberalization and unification -DRRR=FRRR=15% -TB interest rates determine discount rates -Ceilings on bank credit to control monetary expansion
1991/1992	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Interest rate liberalization without interest rate ceilings -Eliminate credit ceilings for private sector -Exchange rates unification -Issue TB with different maturities -DRRR=FRRR=15% -DLR=20%, FLR=25% -Increase 3-month deposits interest rate to 16.7% -Decrease 182 days TB interest rate to 17.9% -Modify banking and credit legislation -Decrease DR to 19.8%
1992/1993	-PLS -ERSTAB -Control ME -Reduce interest rate on LE	-ERES -SNIRM	-DOMLIQ	-Eliminate credit ceilings for public sector -Cancel 12% floor for 3-month deposits -Decrease issue of TB -Increase credit available to private sector -DRRR = FRRR = 15% -DLR=20%, FLR=25% -Decrease DR to 17%
1993/1994	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 15.25% -Decrease 3-month deposits interest rate to 10.81%
1994/1995	-PLS -ERSTAB -Control ME -Output growth	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 14% -Decrease 3-month deposits interest rate to 10% -Decrease 182 days TB interest rate to 11.1% -Decrease interest rate on ≤ one year loans to 14.6% -Issue TB with 5 years maturity
1995/1996	-PLS -ERSTAB -Control ME	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 13.5% -Decrease 182 days TB interest rate to 10.2% -Increase 3-month deposits interest rate to 10.2% -Decrease interest rate on ≤ one year loans to 13.8%
1996/1997	-Promote investment -Economic growth -Monetary stability	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 12.25% -Decrease 3-month deposits interest rate to 9.9% -Decrease 182 days TB interest rate to 8.9% -Decrease interest rate on ≤ one year loans to 13.2% -Issue government bonds with value LE 4 billion -Maintain RRR at 15%

Continued

Year	Objective	Target		Instruments
		Operational	Intermediate	
1997/1998	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Maintain DR at 12.25% -19 Repos injecting liquidity by LE 7.5 billion -Decrease 3-month deposits interest rate to 9% -Maintain interest rate on \leq one year loans at 13.2% -Maintain 182 days TB interest rate at 8.819% -Increase bank lending to the private sector
1998/1999	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 12% -Increase Repos to LE 60.1 billion -Issue treasury bonds with value LE 6 billion -Increase 3-month deposits interest rate to 9.14% -Decrease interest rate on \leq one year loans to 12.8% -Increase 182 days TB interest rate to 8.848%
1999/2000	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Maintain DR at 12% -Increase 3-month deposits interest rate to 9.3% -Increase 182 days TB interest rate to 9.095% -Increase interest rate on \leq one year loans to 13.1% -Increase Repos to LE 209 billion -Maintain DRRR at 15%, decrease FRRR to 10% -DLR=21.4%, FLR=38.8% -Issue new treasury bonds
2000/2001	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Decrease DR to 11% -Modify calculations of RRR and LR -Set central ER at pt/\$385 with $\pm 1\%$ band margin -Increase 3-month deposits interest rate to 9.43% -Decrease 182 days TB interest rate to 9.077% -Increase interest rate on \leq one year loans to 13.57% -Increase actual reserve ratio to 15.9% -DLR=25.6%, FLR=43.6% -Issue TB with LE 3.1 billion -Decrease Repos to LE 122 billion
2001/2002	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Decrease RRR from 15% to 14% -Maintain DR at 11% -Modify the calculation of RRR -Maintain 3-month deposits interest rate at 9.4% -Decrease 182 days TB interest rate to 7.651% -Increase interest rate on \leq one year loans to 14.1% -Modify central ER to pt/\$ 451 with an increase in band margin to $\pm 3\%$ -Decrease Repos to LE 51 billion
2002/2003	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Abolish the system of US\$ central rate -Announce floatation of LE exchange rate -Decrease DR to 10% -Modify calculation of RRR -Decrease 3-month deposits interest rate to 8.46% -Increase 182 days TB interest rate to 10.23% -Decrease interest rate on \leq one year loans to 13.45% -Decrease Repos to LE 6.3 billion -Increase in TB balance to LE 55.3 billion

Continued

Year	Objective	Target		Instruments
		Operational	Intermediate	
2003/2004	-PLS -ERSTAB	-ERES -SNIRM	-DOMLIQ	-Maintain RRR at 14% -Maintain DR at 10% -Use OMO to absorb excess liquidity -Update base year of CPI (1999/2000=100) -Start primary dealers system -Increase in TB balance to LE 83.3 billion -Introduce reverse Repos and outright sales -Set interest rate on ≤ one year loans equal 13.27% -Increase 182 days TB interest rate to 11.3% -Decrease 3-month deposits interest rate to 7.68%
2004/2005	-PLS -ERSTAB -Soundness of Banking sector	-Overnight Interbank Interest rate	-DOMLIQ	-Decrease DR to 9% -Issue central bank notes -Use OMO, reverse Repos, outright sale of TB -Maintain 3-month deposits interest rate at 7.7% - Increase interest rate on ≤ one year loans at 13.4% -Apply non-expansionary monetary policy -Increase overnight interbank interest rates

Note: PLS: price level stability; NAB: controlling net domestic assets of banks; ERSTAB: exchange rate stability; ERES: excess reserves with CBE in local currency; SNIRM: short term nominal interest rate management; DOMLIQ: control domestic liquidity (M2) growth; ME: monetary expansion; TB: Treasury Bill; DR: discount rate; RRR: required reserve ratio; DRRR/FRRR: domestic/foreign required reserve ratio; DLR/FLR: domestic/foreign liquidity ratio; Repos: repurchasing operations of TB; M1: money supply; CPI: consumer price index; OMO: open market operations; BS: banking sector; ER: exchange rate.
Source: CBE 1990/1991-2004/2005.

Table A2
Lag Length Selection Tests

Lags	1985:1 2005:12		1990:1 2005:12	
	AIC	SBC	AIC	SBC
15	-44.675	-35.026	-42.190	-34.225
14	-44.587	-35.575	-42.132	-34.714
13	-44.215	-35.839	-42.152	-35.276
12	-44.156	-36.416	-41.842	-35.509

Table A3
Values Selected for Calibration Parameters

Parameter	Description	Value [▲]
α	Determines the average length of time during which individual prices remain in effect. Chosen value assumes prices do not change within 3 quarters	0.660
β	Discount factor	0.217
θ	Constant elasticity of substitution (assumed > 1)	10.000
η	Elasticity of output with respect to hours worked	0.700
ω	Elasticity of marginal disutility of producing output with respect to an increase in output: $\epsilon_{wy} - \sigma + ((1-\eta)/\eta)$	0.977
FE	Frisch elasticity of labor supply with respect to the real wage: $1/\eta (\epsilon_{wy} - \sigma)$	2.605
ϵ_{wy}	Elasticity of average real wage with respect to variation in output (assuming variations in output that are not associated with shifts in preferences or technology)	0.571
σ	Free parameter*	0.023
γ	Free parameter*	0.845
κ	$(1-\alpha)(1-\alpha\beta)(\omega + \sigma)/\alpha(1 + \omega\theta)$	0.041
Ψ	$(1-\gamma)/\alpha\gamma$	0.278

Note:

*The free parameters (σ and γ) are computed by minimizing a criterion function whose value equals the sum of squared differences between the theoretical and empirical impulse responses for output, inflation and interest rate in the first 4 months following a policy shock, with equal weights given to the three discrepancies that make up that sum.

*Boldface italics font indicates the optimal values for the free parameters from the optimization model and boldface font indicates the parameter values that are computed residually given the other parameter values.

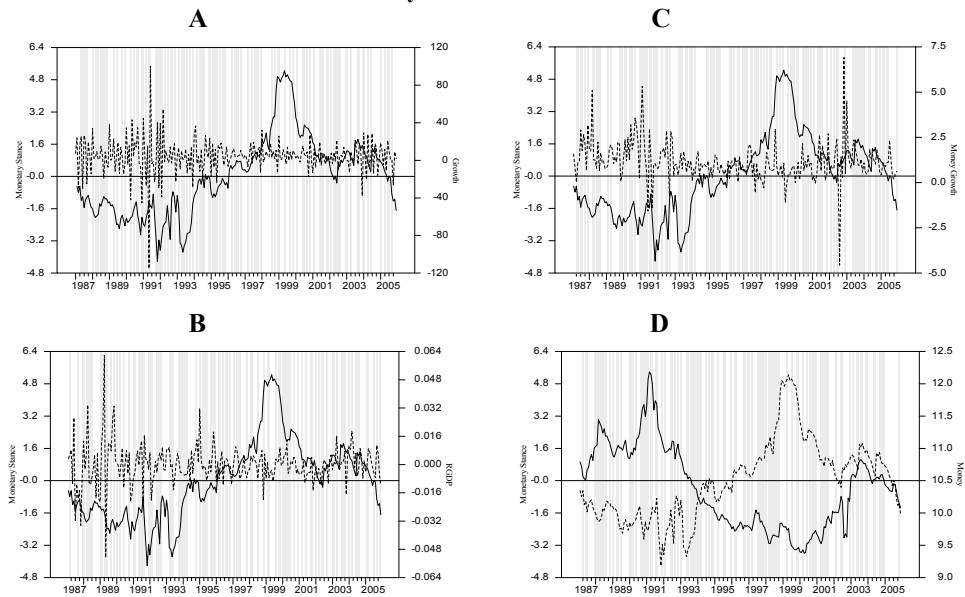
Table A4
Unrestricted Trivariate VAR Estimates: 2001:1-2006:7
Standard errors in parentheses

Independent Variables*	R_t	π_{t+1}	y_{t+1}
$\pi_{t+1} (\phi_3)$			0.004 (0.008)
$R_t (\mu_0)$		-0.002 (0.249)	-0.010 (0.014)
$R_{t-1} (\mu_1)$	0.407 (0.128)	-0.533 (0.252)	-0.002 (0.015)
$R_{t-2} (\mu_2)$	0.256 (0.136)	0.030 (0.253)	0.018 (0.014)
$R_{t-3} (\mu_3)$	0.127 (0.130)	0.311 (0.236)	-0.005 (0.013)
$\pi_t (\phi_0)$	0.082 (0.077)	0.442 (0.139)	-0.005 (0.009)
$\pi_{t-1} (\phi_1)$	-0.059 (0.083)	-0.019 (0.150)	-0.018 (0.008)
$\pi_{t-2} (\phi_2)$	0.172 (0.077)	0.036 (0.144)	0.014 (0.008)
$y_t (\theta_0)$	1.163 (1.479)	-6.271 (2.674)	0.692 (0.156)
$y_{t-1} (\theta_1)$	-0.127 (1.682)	5.334 (3.024)	0.073 (0.173)
$y_{t-2} (\theta_2)$	1.305 (1.489)	-1.075 (2.696)	0.070 (0.150)
Constant	-0.055 (0.035)	0.051 (0.064)	0.047 (0.043)
R^2	0.687	0.395	0.621
Durbin-Watson statistic	1.840	1.968	1.893

Note: *Coefficient symbol in parentheses.

II. Graphs

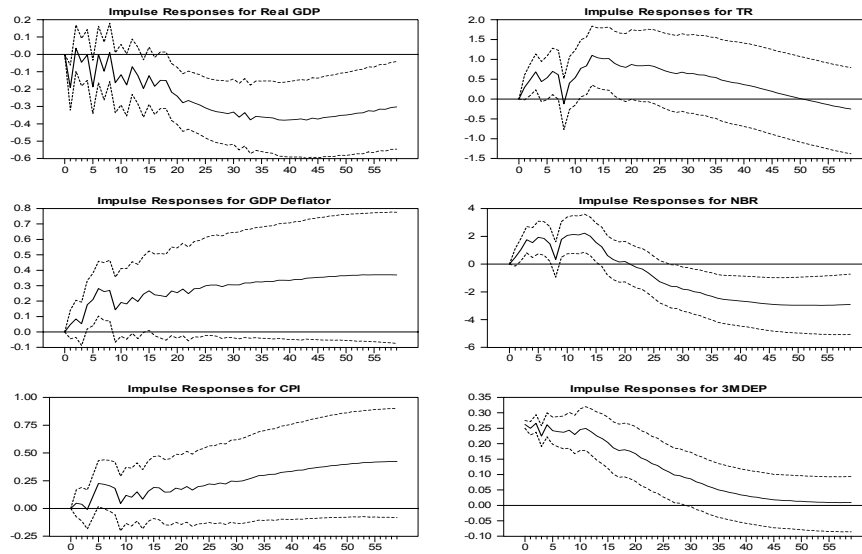
Figure A1
Selected Monetary and Macroeconomic Indicators



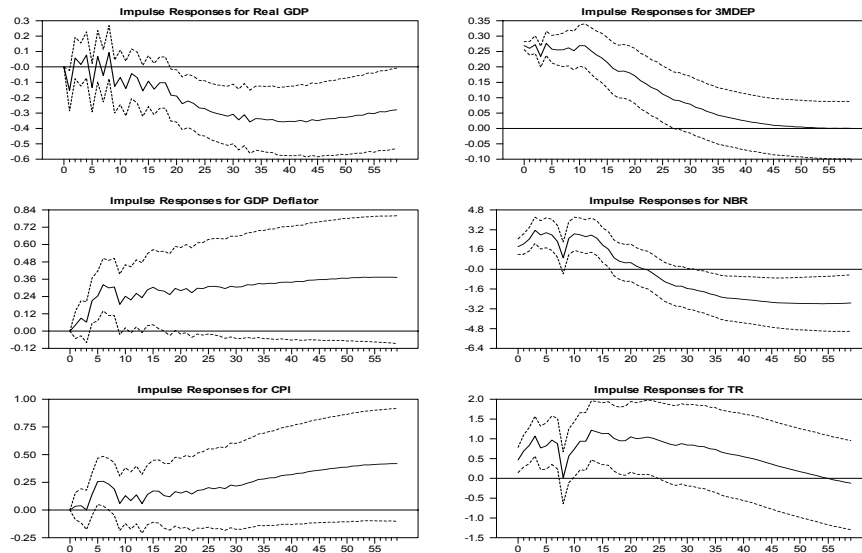
Note: The pictures in panels A-D contrast the overall index of monetary stance from the JI model with:

- Annualized real GDP (RGDP) growth; shading indicates monetary tightness (easing) with lower (higher) growth (panel A)
- RGDP; shading indicates monetary tightness (easing) with lower (higher) RGDP (panel B)
- M2 growth; shading indicates monetary tightness (easing) with lower (higher) money growth (panel C)
- Normalized M2, 2002:1=10, (standardized by a 36 month moving average of M2); shading indicates monetary tightness (easing) with lower (higher) M2 (panel D)

Figure A2
Impulse Responses to a Contractionary Monetary Policy Shock
Using Lower Triangular Cholesky Decomposition
I. Variable Identifying Policy Shock Ordered Sixth

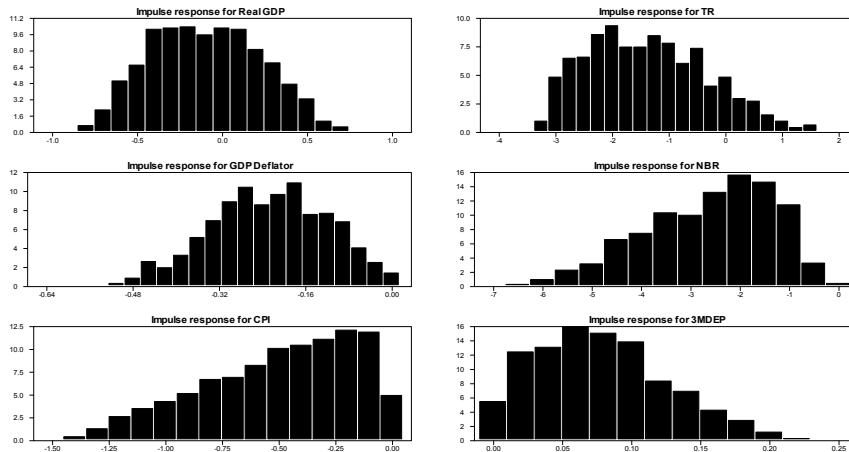


II. Variable Identifying Policy Shock Ordered Fourth



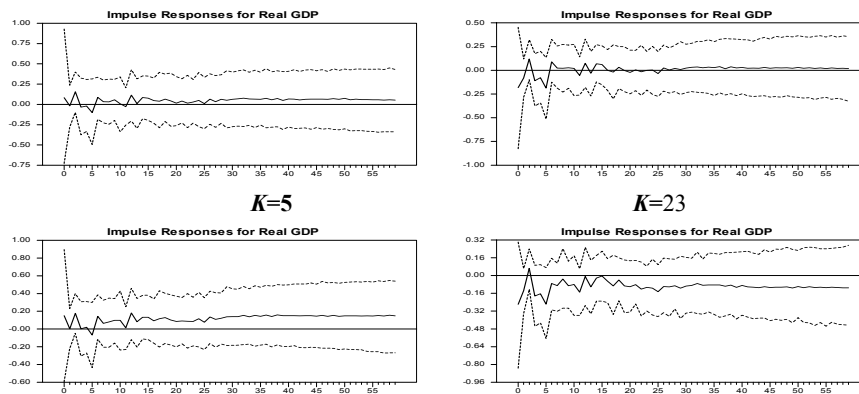
Note: The diagram depicts the IRFs (the middle solid (-) line) for a contractionary monetary shock identified with a one standard deviation rise in the 3MDEP rate. The dashed (..) error bands correspond to the 0.16 and 0.84 fractiles of the response distribution generated from 50,000 draws using Estima (2004) *monteva2* procedure based on Sims and Zha (1999). Except for the difference in the sample estimation horizon, the IRFs computed in Figure A2I are analogous to those portrayed in Figure 2.A with the 3MDEP ordered sixth (rather than fourth) after TR and NBR à la Bernanke and Mihov. The IRFs and error bands portrayed in Figure A2II and Figure A2I are similar save for the ordering of the variables.

Figure A3
Distribution of the Impact Impulse Response



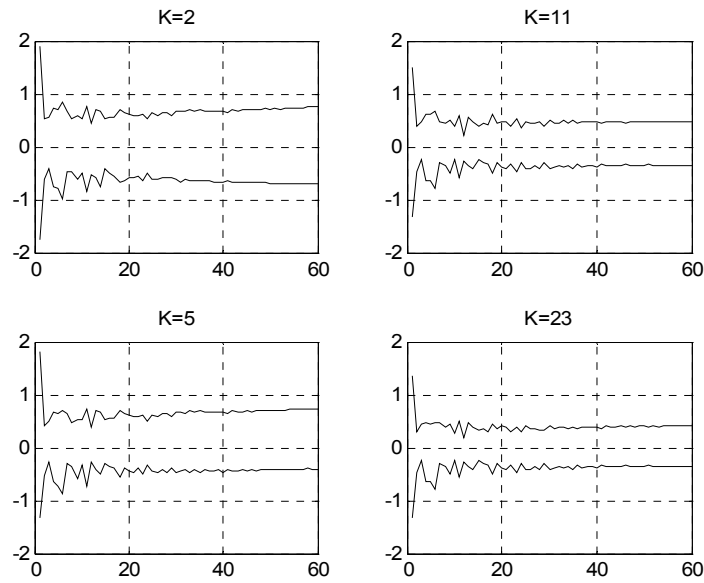
Note: Histograms for the distribution of the initial impulse responses with sign-restrictions for $K=5$. The estimates are simulated with 50,000 uniform draws using an adjusted version of the Uhlig1 RATS program (Estima, 2004 and Doan, 2004).

Figure A4
Impulse Responses Ranges with Pure-Sign Approach for Real GDP



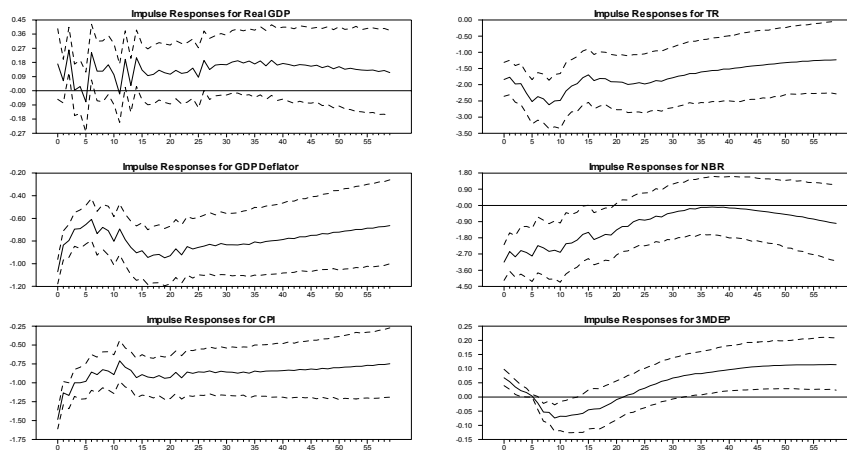
Note: The negative monetary shock is set equal one standard deviation in size. The solid lines (-) represent the IRFs; the dashed lines (--) indicate the ± 0.2 standard error bands. The estimates are simulated with 200 draws and 200 sub-draws using an adjusted version of the Uhlig2 RATS program (Estima, 2004 and Doan, 2004).

Figure A5
Impulse Responses Ranges for Real GDP
with Pure-Sign Approach



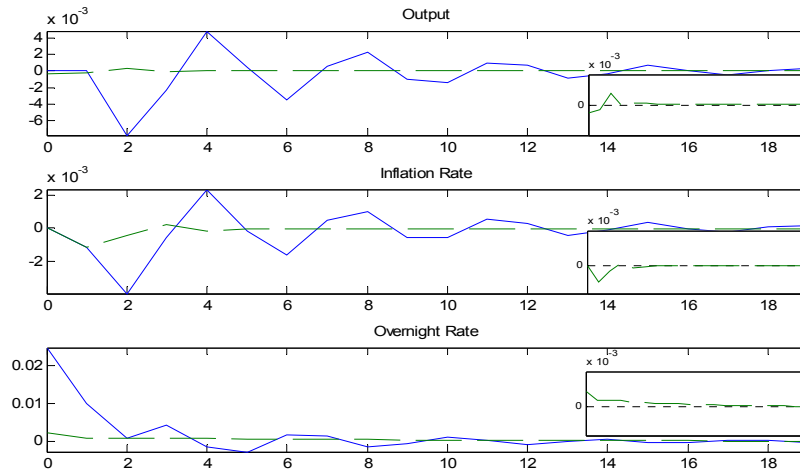
Note: The range of IRFs is defined for a negative monetary shock chosen equal one standard deviation in size when imposing the sign-restrictions for $K=2, 5, 11$ and 23 . The estimates are simulated with 50,000 uniform draws using an adjusted version of the Uhlig1 RATS program (Estima, 2004 and Doan, 2004).

Figure A6
Impulse Responses with Penalty-Function Approach for $K=5$



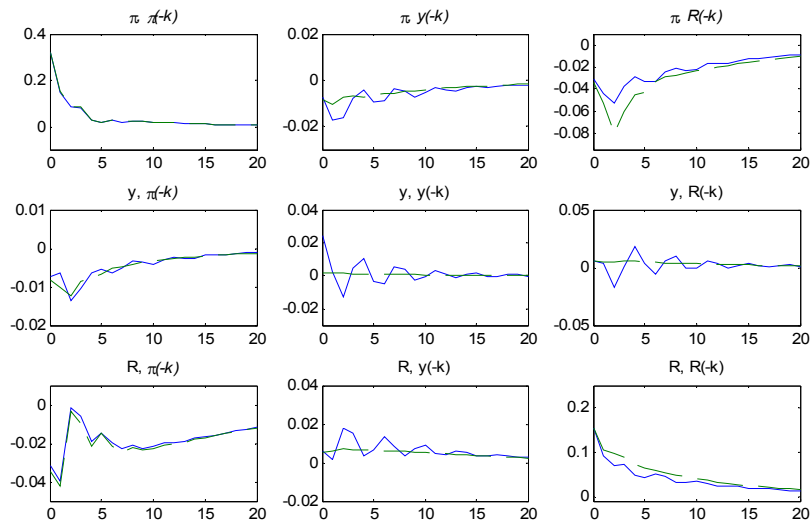
Note: The negative monetary shock is chosen equal one standard deviation in size. The solid lines (-) represent the IRFs; the dashed lines (--) indicate the ± 0.2 standard error bands. The estimates are simulated with 1000 draws using an adjusted version of the Uhlig3 RATS program (Estima, 2004 and Doan, 2004).

Figure A7
Actual and Theoretical Responses
to a Monetary Policy Shock



Note: The dashed (--) and the solid (-) lines indicate the actual point estimates and the theoretical responses of the IRFs, respectively. The inserts portraying the actual IRFs are incorporated to facilitate exposition.

Figure A8
Cross-Correlation Functions for
the Theoretical and Empirical VAR Models



Note: The dashed line (--) represents the cross-correlation function for the unrestricted VAR characterizing the actual data and the solid line (-) represents the theoretical cross-correlation function.