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10 Assessing inflation and output variability using a New Keynesian model

An application to Egypt

*Rania A. Al-Mashat*¹

1 Introduction

Inflation targeting (IT) is one of the operational frameworks for monetary policy aimed at attaining price stability. In contrast to alternative strategies, notably money or exchange rate targeting, which seek to achieve low and stable inflation through targeting intermediate variables – for example, the growth rate of money aggregates or the level of the exchange rate of an ‘anchor’ currency – IT involves targeting inflation directly.

A relatively long list of requirements has been identified in the literature for countries to successfully operate an IT framework, with increased exchange rate flexibility being essential to eliminate confusion surrounding the central bank’s nominal anchor. However, in many cases, particularly in emerging markets, IT is sought without completely fulfilling the exchange rate requirements, on the grounds that there is a high pass-through from exchange rate swings to inflation in these countries and hence if the overriding concern is reducing inflation variability and, in turn, output variability there will be a tendency to maintain some exchange rate rule.

Although a functioning exchange rate transmission channel may add to the effectiveness of monetary policy under IT, actively manipulating the exchange rate along with inflation is likely to worsen the performance of monetary policy. However, this does not imply that central banks should not pay attention to the exchange rate. While inflation targeting may be a framework that is typically free from formal exchange rate commitments, it is nonetheless not free from exchange rate considerations. The apparent reluctance of policy makers to take a completely hands-off approach to the exchange rate may reflect neither an irrational fear nor an unconditional distaste for floating per se. There are many good reasons for any open economy to be concerned about certain types or magnitudes of exchange rate movements such as the high degree of exchange rate pass-through, effects on the external sector, financial stability and market functioning.

Against this background, research in this area has focused on introducing an exchange rate term in the conventional Taylor rule, which has been commonly used to reflect the central bank’s reaction function under an IT regime. However, the results from applying this methodology have not been conclusive, which invites the application of reduced form structural models.

This chapter builds on previous work in this strand of the literature by presenting a small open economy structural gap model with forward looking expectations and with an endogenous monetary policy response, which can be classified as a reduced form New Keynesian Model (NKM). Unlike in other structural gap models, the exchange rate equation is a modification of the standard uncovered interest rate parity equation while the monetary policy reaction function in the model represents that of a central bank under inflation targeting but captures the implications of a managed exchange rate regime. The aim of this chapter is to examine the consequences of various approaches to the conduct of monetary policy by presenting the variability of inflation and output in the light of alternative degrees of exchange rate intervention under an IT regime, applying the model to the Egyptian case.

The results reveal that a fixed exchange rate regime generates the highest output and inflation variability, in addition to the worst loss function for the economy under the specified model. As the exchange rate is allowed more flexibility, the variability of output and inflation declines. While a full-fledged inflation targeting regime does not represent the best outcomes in terms of output and inflation variability, a situation of increased exchange rate flexibility in the context of a framework close to inflation targeting provides the best combination. The remainder of the chapter is structured as follows. In the next section, the role played by the exchange rate in inflation targeting countries is discussed with a particular focus on open and emerging economies. In Section 3, we examine how the introduction of the exchange rate in the central bank's reaction function has been accommodated. Initially, the augmented 1993 Taylor rule is examined and then a reduced form NKM is considered. The suggested modification to the standard model is explored in Section 3. Section 4 assesses the inflation and output variability under varying degrees of inflation targeting and exchange rate management, and Section 5 concludes.

2 The role of the exchange rate under inflation targeting

For decades the vast majority of emerging countries had rigid exchange rate regimes – either pegs (adjustable or hard) or managed floats – given the exchange rate's importance in affecting inflation, exports, imports and economic activity. This, however, has changed as an increasingly large number of countries have moved towards adopting flexible exchange rate regimes, which coincided with the launch of IT as a way of conducting monetary policy. The conjunction of IT and flexible rates has brought up a host of policy relevant issues, including those related to the role of the exchange rate in monetary policy, and the relationship between exchange rate changes and inflation.

As described in Schaechter, Stone, and Zelmer (2000), earlier experiences of IT countries involved a combination of exchange rate and inflation targeting. For example, Chile spent more than ten years in a transition from quasi inflation targeting to fully fledged inflation targeting. During this period, the monetary policy framework was based on a crawling peg exchange rate regime as well as

announcements of an inflation target. The aim of announcing inflation targets was to gradually reduce inflation by providing an anchor for monetary policy that supplemented the existing crawling exchange rate band. In Israel, the long transition to inflation targeting similarly began with the move to a crawling exchange rate band that required inflation targets to define the upward slope of the crawl.²

Emerging market economies tend to be relatively more vulnerable to the various consequences of exchange rate fluctuations than industrial economies as the pass-through in the former has been historically large, particularly in countries that have experienced currency crises. In addition, exchange rate fluctuations could generate uncertainties that impede trade. These external sector consequences of exchange rate fluctuations are expected to be more relevant for economies that are more open to and dependent on trade (Ho and McCauley, 2003). Moreover, large and abrupt depreciations may increase the burden of dollar-denominated debt, produce a massive deterioration of balance sheets, and increase the risks of a financial crisis along the lines discussed in Mishkin (2000). Moreover, one of the arguments frequently invoked in favour of exchange rate targeting is that markets often drive the exchange rate well away from the levels implied by fundamentals and that this has damaging effects on the economy as a whole (Kirsanova, Leith and Wren-Lewis, 2006).

Hence, under IT, since achieving the inflation target is the bottom line, then sufficiently large exchange rate movements can still be a threat for any positive degree of pass-through and given the relatively larger and often still increasing role of the external sector in these economies (Jonas and Mishkin, 2003).

Against this background, emerging market countries cannot afford to ignore the exchange rate when conducting monetary policy under inflation targeting, but the role they ascribe to it should be clearly subordinated to the inflation objective (Mishkin and Schmidt-Hebbel, 2001). In their study, Mohanty and Klau (2005) estimated monetary policy reaction functions – Taylor rules – for thirteen emerging and transition economies and found that in eleven cases the coefficient of the real exchange rate was significant (Table 10.1). This has motivated the introduction of the exchange rate in the central bank's reaction function.

3 Introducing the exchange rate in the central bank's reaction function

The importance of the exchange rate as a key variable in the transmission mechanism incorporated within many policy-evaluation models has inspired the estimation of an alternative version of the Taylor rule (1993) which attempts to explain the central bank's reaction function. As described in Svensson (1999), the standard Taylor rule suited closed economies but in many instances could not fully capture important considerations facing central banks in emerging economies. As Svensson points out, including the exchange rate in the discussion of inflation targeting has several important consequences.

First, the exchange rate allows additional channels for the transmission of monetary policy. In a closed economy, the standard transmission includes an

Table 10.1 Interest rate response to changes in the real exchange rate (obtained from estimated Taylor rule equations)

<i>Country</i>	<i>Short-term</i>	<i>Long-term</i>
India	0.18	0.60
Korea	0.29	0.67
Philippines	0.09	0.13
Taiwan	0.03	0.18
Thailand	0.31	0.74
Brazil	0.10	0.36
Chile	0.00	0.00
Mexico	0.79	1.58
Peru	0.38	2.71
Czech Republic	-0.03	-0.19
Hungary	0.15	0.60
Poland	0.05	0.20
South Africa	0.12	6.00

Source: Mohanty and Klau (2005)

aggregate demand channel and an expectations channel. Regarding the first channel, monetary policy affects aggregate demand with a lag via its effect on the short real interest rate (and possibly the availability of credit). Aggregate demand then affects inflation, with another lag via an aggregate supply equation (a Phillips curve). The expectations channel allows monetary policy to affect inflation expectations which, in turn, affects inflation, with a lag via wage and price setting behaviour. On the other hand, in an open economy, the real exchange rate will affect the relative price between domestic and foreign goods, which in turn will affect both domestic and foreign demand for domestic goods, and hence contributes to the aggregate demand channel for the transmission of monetary policy. There is also a direct exchange rate channel for the transmission of monetary policy to inflation which through the exchange rate affects the domestic currency prices of imported final goods. Typically, the lag of this direct exchange rate channel is considered to be shorter than that of the aggregate demand channel. Hence, by inducing exchange rate movements, monetary policy can affect inflation with a shorter lag.

The modified Taylor rule

In expanding the standard Taylor rule to account for the exchange rate, Taylor (2001) documents the results from several studies, which typically consider policy rules of the following form:

$$i_t = f\pi_t + gy_t + h_0e_t + h_1e_{t-1} \quad (1)$$

where i_t is the short-term nominal interest rate set by the central bank, π_t is the rate of inflation, and y_t is the deviation of real GDP from potential GDP. The variable e_t is the real exchange rate. The policy parameters are f , g , h_0 , and h_1 . If $f > 1$, $g > 0$, and $h_0 = h_1 = 0$, then equation (1) is the standard Taylor rule proposed in 1993 with no reaction to the exchange rate.

In his paper, after presenting parameter values proposed in Ball (1999), Obstfeld and Rogoff (1995) and Svensson (2000), Taylor concludes by asking why reacting to the exchange rate does not yield a greater improvement in the performance of these studies and why performance actually deteriorates in some cases. He argues that there 'may be some deviations of the exchange rate from purchasing-power parity that should not be offset by changes in interest rates; the required changes in interest rates will have adverse effects on real output and inflation that may be worse than the swings in the exchange rate themselves. In some situations the changes in the exchange rate might reflect changes in productivity that should not be offset. Even a random change in the exchange rate, due perhaps to fads or irrational expectations, may have small consequences relative to the cost of smoothing them out' (Taylor, 2001: 267). He also suggests that better models are needed as an attempt to capture the exchange rate in the central bank's reaction function in order to overcome these concerns.

The reduced form New Keynesian model (NKM)

Against this background, a strand of models has been developed which blends the New Keynesian emphasis on nominal and real rigidities and the role of aggregate demand in output determination, with the real business cycle tradition methods of dynamic stochastic general equilibrium and rational expectations. These models integrate Keynesian elements (imperfect competition, and nominal rigidities) into a dynamic general equilibrium framework that until recently was largely associated with the Real Business Cycle (RBC) paradigm. Galí (2002) emphasises that these models can be used (and are being used) to analyse the connection between money, inflation and the business cycle, and to assess the desirability of alternative monetary policies. In contrast with earlier models in the Keynesian tradition, the new paradigm has adopted a dynamic general equilibrium modelling approach. Thus, equilibrium conditions for aggregate variables are derived from optimal individual behaviour on the part of consumers and firms, and are consistent with the simultaneous clearing of all markets. From that viewpoint, the new models have much stronger theoretical foundations than traditional Keynesian models. In addition, the emphasis given to nominal rigidities as a source of monetary non-neutralities also provides a clear differentiation between NKMs and classical monetary frameworks (monetary models with perfect competition and flexible prices, and no frictions other than those associated with the existence of money).

Berg, Karam and Laxton (2006) sum up by explaining that NKMs are structural because each of the equations has an economic interpretation while causality

and identification are not in question. Policy interventions have counterparts in changes in parameters or shocks, and their influence can be analysed by studying the resulting changes in the model's outcomes. Moreover, these are general equilibrium models because the main variables of interest are endogenous and depend on each other, and stochastic in that random shocks affect each endogenous variable. In addition, rational expectations are incorporated because expectations depend on the model's own forecasts, so that there is no way to consistently fool economic agents. Applying such models has proven extremely helpful in running policy experiments and testing the implications of various shocks with different magnitudes on the macroeconomic variables.

In connection to the key question of how the monetary authority attempts to control both the exchange rate and inflation, Benes and Varva (2004) present this in the framework of a simple reduced form NKM of monetary transmission. They argue that the coexistence of inflation targeting and exchange rate management can be achieved in two institutionally different ways with varying modelling implications. In one case, the monetary authority affects the exchange rate solely through manipulation of interest rates, and the exchange rate then responds to interest rate differentials according to interest rate arbitrage. In the other, the authority conducts exchange rate interventions independently of its interest rate management, violating the interest rate parity, if necessary. When the exchange rate is managed through interest rates simultaneously with inflation, the monetary authority has to consider both inflation (and output) and exchange rates in its interest rate rule. Less flexible exchange rate regimes are represented by a high weight on the deviation of the exchange rate from the desired level. The exchange rate itself is then modelled via the conventional uncovered interest parity (UIP) arbitrage relationship, and the exchange rate fluctuations remain limited by the appropriate management of policy rates. On the other hand, modelling of the situation when the exchange rate is managed through interventions becomes possible if the interest rates are set with respect to the inflation target while the interest rate parity has only a limited role in determining the exchange rate (depending on the flexibility of the regime). Although modelling of both practices is important, Benes and Varva (2004) focus on the exchange rate interventions independent of the interest rate management, arguing that: (i) managing the exchange rate via interest rates does not permit the analysis of the simultaneous functioning of fixed exchange rate and inflation targeting regimes, because in that case the interest arbitrage fixes policy rates at a parity implied by foreign interest rates; and (ii) realistic modelling of the simultaneous coexistence of IT and managed exchange rates (explicit or implicit) requires (at least partial) violation of the interest rate parity condition.

This chapter follows the methodology presented in Benes and Varva (2004), exploring the effect of different degrees of intervention in order to assess inflation and output variability under various degrees of exchange rate flexibility within an IT framework, with an application to the Egyptian case. The Central Bank of Egypt (CBE) has taken many important steps to upgrade Egypt's framework for conducting monetary policy over the last few years, with a view to adopting

inflation targeting as a new paradigm once the prerequisites are fulfilled. The steps undertaken by the CBE to reform Egypt's monetary policy framework are outlined in the Appendix.

The model is highly aggregated and provides a stylised representation of the key monetary policy transmission mechanisms in the economy. It can be viewed as the smallest model necessary to explain the interaction of output, interest rates, exchange rates and inflation under an inflation targeting framework. The model is calibrated to match salient features of the economy under consideration, drawing on theory and a wide range of empirical estimates to choose parameter values for the model that result in appropriate aggregate properties, following the methodology outlined in Coats *et al.* (2003) and Berg *et al.* (2006). The calibration process is iterative: choosing reasonable parameter values, examining the properties of the model next, and changing the parameter values or the structure of the model, until the model behaves appropriately (Bulir and Hurnik, 2006).

Expectations play an explicit role in the model. First, expectations of future inflation are of importance as they affect price- and wage-setting behaviour today. Second, expectations of future interest rate developments affect today's exchange rate. Finally, expectations of future economic cycles will affect today's spending decisions.

The model aims to explain how deviations from equilibrium develop and dissipate over the medium- to long-term. There is a clear role for monetary policy in the model, which is to provide the economy with a nominal anchor. In other words, it prevents actual and expected inflation from drifting away from the target. When the central bank fulfils its role, the economy converges to a well-defined equilibrium. The model is designed such that the monetary authorities cannot boost output above its supply-determined level in the long run. In other words, in the long run, monetary policy is neutral and there is no trade-off between the levels of output and inflation.

The four standard behavioural equations in the model are described as follows:

(a) The aggregate demand (IS) equation

$$\hat{y}_t = \hat{a}_1 y_{t-1} - a_2 rmc_i + a_3 \hat{y}_t^{Foreign} + \varepsilon_t^{Demand} \quad (2)$$

This aggregate demand or IS curve, which describes the dynamics of the output gap, relates the level of real activity to past real activity \hat{y}_{t-1} , and to the real interest rate and the real exchange rate which are both represented in the real monetary conditions index rmc_i . \hat{y} is the output gap. The term rmc_i provides the model's mechanism for the influence of monetary choices on the real economy, through the output gap, and then, through the Phillips curve, on inflation. The real interest rate gap describes the impact of monetary policy on the intertemporal substitution of economic agents. The positive real interest rate gap implies relatively costly current consumption which bears down on current consumption expenditures and increases saving and consequently future consumption. The real exchange rate describes an intratemporal

substitution, that is, the substitution between domestic and foreign goods. The term is a demand shock which could represent changes in tastes and preferences or the effects of fiscal policy.

- (b) The inflation adjustment equation (Phillips curve)

$$\pi_t = b_1\pi_{t-1} + (1 - b_1)\pi_{t+n} + b_2rmc_{t-1} + \varepsilon_t^P \quad (3)$$

The Phillips curve characterises the dynamic response of inflation π_t to inflation expectations π_{t+n} , the output gap and the real exchange rate which are jointly represented in the real marginal cost rmc_t . Hence, rmc_t is the indicator of underlying inflationary pressures.³ The Phillips curve suggests that inflation expectations are partially forward looking and partially backward looking. In addition, the curve satisfies the monetary policy neutrality condition as the parameters in front of the inflation expectation terms (partially forward and backward looking) sum to one. The monetary neutrality condition stresses that inflation can be at any level, and what anchors inflation is inflation expectations. As a consequence any monetary policy action does not impact real variables in the long run. A shock to the Phillips curve ε_t^P could represent the growing importance of cheaper imports from abroad or stronger competition in the product market.

- (c) The uncovered interest rate parity (UIP) equation

$$s_t = s_{t+1}^e + (-i_t + i_t^{Foreign} + prem_t) / 4 + \varepsilon_t^{UIP} \quad (4)$$

The UIP condition is an arbitrage condition that expresses the dynamic relationship between the expected exchange rate one quarter ahead (s_{t+1}^e) and the spread between domestic and foreign interest rates, (i_t and $i_t^{Foreign}$, respectively) adjusted for the risk premium ($prem_t$).⁴ The UIP indicates that international investors will act to equalise effective rates of return on investments in different currencies, allowing for any country-specific risk premiums. The key point in terms of effective rates of return is that changes in the exchange rate must be taken into account. A foreign investor who expects a depreciation of the local currency will demand compensation for that in the form of a higher return from local assets. Similarly, a foreign investor who expects an appreciation of the local currency will need a smaller risk premium than would otherwise have been the case. Flood and Rose (2002) show that, while a strong consensus has developed in the literature that UIP works poorly, it predicts that countries with high interest rates should on average have depreciating currencies; they add that recent research has started to provide more compelling empirical results.⁵ In its conventional form, UIP assumes a flexible exchange rate regime. Any deviation from such a regime requires a modification of the above-mentioned equation, which will be explained below. A shock to the UIP equation could represent a change in the risk premium associated with domestic financial assets.

(d) The monetary policy rule

$$i_t = d_1 i_{t-1} + (1 - d_1) (r_t^* + \pi_t^{Tar} + d_2 (\pi_{t+n} - \pi_{t+n}^{Tar}) + d_3 \hat{y}_t) + \varepsilon_t^{MP} \quad (5)$$

The central bank's policy reaction function closes the system consistently, leading inflation to return to its target (π^{Tar}) and output to its non-inflationary potential, in the case of any shock or new information. The equation above is a forward-looking reaction function, in which decisions on where to set the policy instrument (the short-term interest rate) today are made by considering what is likely to happen in the future. It also suggests that if headline CPI inflation is above the target rate, then the central bank acts to push up the short-term interest rate, all else equal. Similarly, if there is perceived to be excess demand in the system at the decision point, the central bank acts to push up the short-term interest rate, all else equal. Even if inflation is below target, if there is strong enough excess demand in the system, the central bank acts to push up rates. The first term(s) in the reaction function provide both a long-term level for rates and some additional dynamic structure. In the long-term steady state, the nominal rate goes to the equilibrium real rate (r^*) plus the inflation target. In the short term, however, there is some inertia; all else equal, the interest rate moves to its equilibrium according to a first-order autoregressive process. Instruments other than the interest rate can be accommodated, and arguments other than inflation and output may belong in the reaction function. A variety of papers have explored, in particular, the question of whether the exchange rate belongs in the reaction function.⁶ Against this background, a modified version of this equation will be examined below. Exogenous shocks ε_t^{MP} to the monetary policy rule represent interest rate responses to changes in variables that are not included in the monetary policy rule.

All model variables are in logarithms. The hat over a variable denotes the gap, which is the deviation of the variable from its potential. The potential was obtained using the recursive Kalman filter.⁷ The main parameter values are presented in Table 10.2.⁸ Even though the model is simple, its strength is in its focus on the role of monetary policy, a property that makes it well suited for the analysis carried out. Monetary policy affects inflation and the real economy through three main channels in the model. First, there is the traditional demand channel. An increase in the nominal interest rate also increases the real interest rate, due to nominal rigidities, which discourages expenditure. Less demand pressure, in turn, results in lower inflation through both lower wage inflation and profit margins (not modelled explicitly). Second, there is an exchange rate channel through which higher domestic nominal interest rates relative to those abroad cause the currency to appreciate, all else equal. Consequently, imported goods become cheaper and inflation falls. However, a stronger currency also has a negative effect on demand and output, via both an expenditure switching effect (towards imports), and reduced competitiveness for industries that compete internationally. Lower demand and output reduce inflation.

Table 10.2 Parameter calibrations

Parameter	Parameter ranges as described in Bulir and Humik (2002)	For Egypt
a_1	Output gap persistence varies between 0.1 (extremely low persistence) and 0.95 (high persistence). The linear homogeneity condition is $0 < a < 1$.	0.7
a_2	Pass-through from monetary conditions to real economy. The value varies between -0.1 (low impact) and -0.5 (high impact); the higher the parameter the more responsive is the output gap to changes in monetary policy and, hence, policy reactions need to be less pronounced. For the relative weight of the real interest rate and real exchange rate in real monetary conditions, the value varies between 0.3 (open economy) and 0.8 (closed economy).	0.15 and 0.075 for the real interest rate gap and the real exchange rate gap, respectively
a_3	Impact of foreign demand on the output gap typically varies from 0.1 to 0.5. Usually based on the export-to-GDP ratio.	0.2
b_1	Inflation persistence determines the share of forward-looking versus backward-looking agents in the goods markets. The value varies between 0.4 (low persistence) and 0.9 (high persistence); the higher is the share of forward looking agents (the lower is the parameter) the less persistent the model becomes and the less pronounced are the policy reactions required for a given disinflation goal.	0.4
b_2	Pass-through from output gap (real economy) to inflation (the 'sacrifice ratio'). The value typically varies between 0.05 (low impact and high sacrifice ratio) and 0.4 (strong impact and low sacrifice ratio). The higher the parameter the less costly is disinflation.	0.3
d_1	Policy rate persistence in the Taylor rule. The value varies between zero (no persistence in policy setting) and 0.8 ('wait-and-see' policy).	0.7
d_2	Weight put by the policy maker on deviations of inflation from the target in the policy rule. Ranges typically vary from 0.3 to 1.	1.5
d_3	Weight put by the policy maker on output gap in the policy rule. Ranges typically vary from 0.3 to 1.	0.5

Finally, there is the expectations channel. Expectations concerning future inflation and economic growth play an important role in price- and wage-setting. If monetary policy is credible, inflation will be expected to be equal or close to the inflation target. This in itself contributes to the stabilisation of inflation around the target. If the inflation-targeting framework lacks credibility, on the other hand, stabilising inflation is correspondingly more difficult.

In order to allow a degree of exchange rate management under the IT regime, the equations in the standard model outlined above have been modified. In particular, changes are introduced to the UIP equation and the monetary policy reaction function.

$$s_t = c_1 s_t^{Tar} + (1 - c_1) \left[s_{t+1}^e + (-i_t + i_t^{foreign} + prem_t) / 4 + \varepsilon_t^{UIP} \right] \quad (4')$$

The standard UIP in (4) is extended in (4') to capture a nominal exchange rate target. In its simplest form, the UIP relates the expected exchange rate change to the interest rate differential and risk premium, while in the proposed model the UIP takes into account an important aspect of monetary policy – the partially managed nominal exchange rate through intervention. The parameter c_1 in the exchange rate equation measures the extent to which exchange rate movement is driven by the interest rate differential following the standard UIP as opposed to exchange rate management through intervention. If c_1 equals one, monetary policy intervenes in the foreign exchange market to achieve the desired level of the nominal exchange rate s_t^{Tar} .

Moreover, in the proposed model within the monetary policy reaction function equation (5), there are two monetary policy variables – the nominal interest rate and the nominal exchange rate as described in equation (5').

$$i_t = d_4 \left[d_1 i_{t-1} + (1 - d_1) (r_t^* + d_2 (\pi_{t+n} - \pi_{t+n}^{Tar}) + d_3 \frac{\Delta s_t}{s_t}) + \varepsilon_t^{MP} \right] + \quad (5')$$

$$(1 - d_4) \left[\Delta s_{t+1}^e + i_t^{foreign} + prem_t + \varepsilon_t^{UIP} \right]$$

Under standard (pure) inflation targeting the monetary policy follows the inflation target using the interest rate rule, leaving the exchange rate to be determined by UIP. In this case the interest rate rule closes the model, by determining where the policy instrument has to be set to achieve the inflation target. On the other hand, in the case of a managed exchange rate there is a parameter (d_4) in the equation which can be changed to capture the control of monetary policy over money market rates. If this parameter is equal to one we assume that monetary policy is able to fully control money market rates. Values lower than one imply that monetary policy has only partial control and the domestic nominal interest rate is given by the expected nominal exchange rate appreciation and foreign interest rates adjusted by the risk premium.

Various combinations of the parameters c_1 and d_4 are explored below to determine and contrast the consequent inflation and output variability in an IT context.

4 Assessing inflation and output variability under varying degrees of inflation targeting and exchange rate management

As mentioned above, the parameters in the UIP equation and the monetary policy reaction function will be changed to present different degrees of exchange rate flexibility as well as varying degrees of IT. More explicitly the parameter c_1 will take on the values 0 to 0.9, with 0 representing a freely floating exchange rate while 0.9 represents intervention closest to an exchange rate peg. On the other hand, the parameter d_4 will take on values ranging between 1 which represents a full fledged IT regime and 0 which represents no IT. Different combinations of c_1 and d_4 are considered and the four-equation modified model described in the previous section is run under these different combinations. For each exchange rate and IT combination, the consequent inflation variability and output variability are documented. Tables 10.3 and 10.4 include the numerical values.

As is evident from Figures 10.1 and 10.2, the closer the system is to a fixed exchange rate regime the higher are the inflation variability and the output variability. The variability starts to decline as the exchange rate starts to become more flexible. This is, unsurprisingly, consistent with the situation where the monetary policy reaction function becomes closer to an IT regime. In pegged regimes, central banks are punished for their mistakes by financial markets, which act swiftly and with a force which is hard to counteract. On the other hand, mistakes in IT regimes are punished by consumers (and the public in general) through their expectations, which, however, evolve only gradually. In practice, then, monetary policy has many more opportunities to correct its mistakes when targeting inflation rather than the exchange rate. For IT, it is enough when the policy is correct on average, while for a peg a single mistake can have devastating consequences (Benes and Varva, 2004). The higher volatility of the variables under a fixed exchange rate regime does not come from the absence of the direct exchange rate–inflation channel of the transmission. It is the demand side (output gap) that stabilises the economy. In driving the demand, however, the real exchange rate does not help to stabilise the shock when the nominal exchange rate is fixed as much as when the exchange rate is flexible. Hence, the nominal (and real) interest rates have to move more to compensate for this. In other words, the conduct of monetary policy targeting inflation while maintaining a fixed exchange rate regime has to count on a larger volatility of its main macro variables, particularly output, keeping other relationships in the model as well as its calibration unchanged.

In addition to examining inflation and output variability, it is important to evaluate the loss function under the various exchange rate flexibility and IT scenarios. The loss function summarises the trade-off between inflation and output by providing a combination of inflation and output variability rather than emphasising the importance of one variable over the other. More explicitly, following Woodford (2001),

$$L = \frac{1}{T} \left[2 \sum_{i=1}^T (\pi_i - \pi^*)^2 + \sum_{i=1}^T (y_i - y^*)^2 \right] \quad (6)$$

Table 10.3 Output variability

		Degrees of exchange rate flexibility Towards more flexible exchange rate									
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Degree of inflation targeting ----- Towards full-fledged IT	1.0	0.8372	0.8579	0.8826	0.9125	0.9481	0.9886	1.0291	1.0587	1.0817	1.2030
	0.9	0.8304	0.8461	0.8632	0.8817	0.9019	0.9253	0.9575	1.0138	1.1282	1.3737
	0.8	0.8260	0.8332	0.8423	0.8555	0.8768	0.9131	0.9745	1.0751	1.2369	1.4985
	0.7	0.8250	0.8190	0.8219	0.8383	0.8737	0.9335	1.0240	1.1529	1.3322	1.5829
	0.6	0.8268	0.8042	0.8058	0.8333	0.8877	0.9699	1.0815	1.2258	1.4090	1.6426
	0.5	0.8277	0.7909	0.7972	0.8393	0.9120	1.0119	1.1376	1.2896	1.4706	1.6867
	0.4	0.8240	0.7812	0.7961	0.8527	0.9408	1.0540	1.1890	1.3443	1.5206	1.7204
	0.3	0.8172	0.7756	0.8005	0.8700	0.9706	1.0939	1.2350	1.3913	1.5617	1.7471
	0.2	0.8114	0.7737	0.8081	0.8887	0.9995	1.1306	1.2759	1.4317	1.5961	1.7687
	0.1	0.8091	0.7748	0.8174	0.9074	1.0267	1.1640	1.3121	1.4667	1.6252	1.7865
	0.0	0.8108	0.7782	0.8274	0.9253	1.0519	1.1942	1.3443	1.4972	1.6501	1.8014

Table 10.4 Inflation variability

		Degrees of exchange rate flexibility Towards more flexible exchange rate										
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Degree of inflation targeting Towards full-fledged IT	1.0	2.8283	2.7151	2.6296	2.5840	2.5973	2.6957	2.9007	3.1737	3.3207	3.1081	
	0.9	2.6712	2.5595	2.4839	2.4494	2.4592	2.5095	2.5830	2.6495	2.6953	2.7849	
	0.8	2.5575	2.4591	2.3990	2.3733	2.3758	2.3995	2.4405	2.5041	2.6125	2.8149	
	0.7	2.5103	2.4199	2.3629	2.3337	2.3301	2.3535	2.4093	2.5063	2.6580	2.8857	
	0.6	2.5335	2.4205	2.3475	2.3131	2.3172	2.3604	2.4432	2.5672	2.7353	2.9538	
	0.5	2.5674	2.4132	2.3315	2.3096	2.3376	2.4073	2.5129	2.6501	2.8167	3.0126	
	0.4	2.5300	2.3775	2.3211	2.3315	2.3895	2.4821	2.6005	2.7389	2.8935	3.0622	
	0.3	2.4350	2.3419	2.3356	2.3842	2.4681	2.5747	2.6959	2.8265	2.9633	3.1042	
	0.2	2.3578	2.3432	2.3877	2.4673	2.5670	2.6775	2.7930	2.9098	3.0258	3.1399	
	0.1	2.3512	2.3999	2.4799	2.5765	2.6802	2.7853	2.8884	2.9876	3.0817	3.1706	
0.0	2.4320	2.5139	2.6080	2.7060	2.8025	2.8946	2.9805	3.0596	3.1317	3.1972		

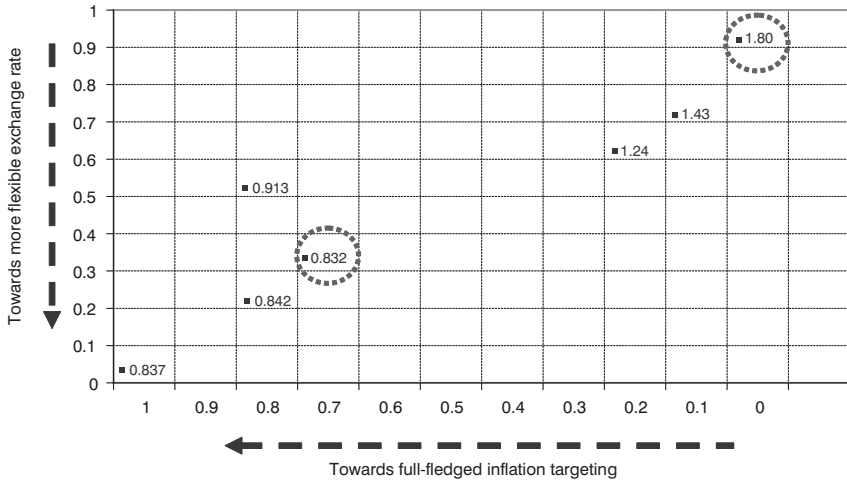


Figure 10.1 Output variability under varying degrees of exchange rate flexibility and inflation targeting

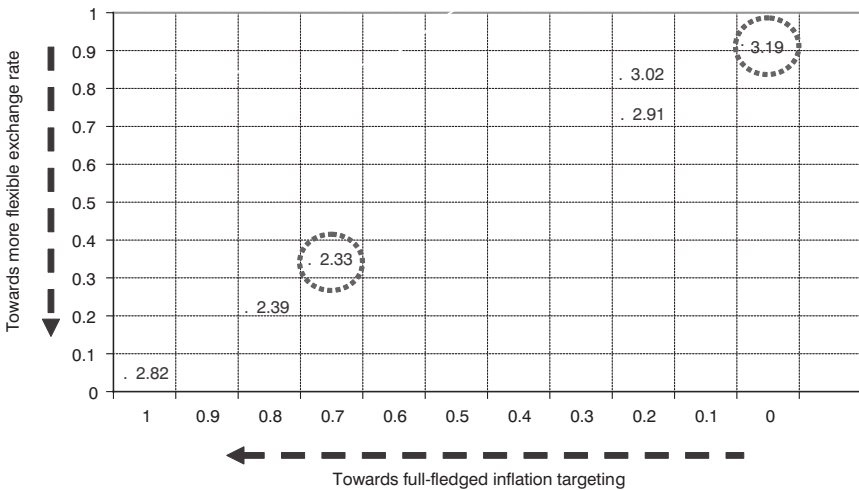


Figure 10.2 Inflation rate variability under varying degrees of exchange rate flexibility and inflation targeting

where L denotes the welfare loss to the economy, $(\pi_i - \pi^*)$ is the deviation of observed inflation at time i from its steady state value, $(y_i - y^*)$ is the deviation of real GDP at time from potential GDP and T is the time horizon required for all variables to reach their steady state values as identified in the model.

Previous results are confirmed in Table 10.5 and Figure 10.3, where the fixed exchange rate provides the highest loss in terms of inflation and output variability

put together. It is, however, important to underscore that full-fledged IT does not guarantee the lowest inflation and output variability nor the lowest loss function based on equation (6). Therefore, given calculations related to the loss function, a framework close to IT with increased exchange rate flexibility is best suited for the case being examined. However, issues related to current account sustainability should not be neglected.

This is consistent with the discussion provided earlier which highlights the importance of exchange rate considerations in emerging markets which implement (or plan) to implement IT. Amato and Gerlach (2002) point out that some countries (e.g. Chile and Israel) formally incorporated an exchange rate target range/path in their inflation targeting framework, at least in the transition phase. Using the exchange rate to guide inflation may not be incompatible with inflation targeting after all. Accordingly, when implementing policy, central banks should consider the effects of exchange rate fluctuations on inflation and the output gap, but should not consider an independent role for the exchange rate since targeting an exchange rate is likely to worsen the performance of monetary policy.

Nonetheless, it is paramount that policy makers realise that limiting exchange rate movements runs the risk of transforming the exchange rate into a nominal anchor that takes precedence over the inflation target. It is also important for central banks to recognise that after a sustained period of low inflation engineered by an inflation targeting regime, the effect of the exchange rate on the expectations formation process and price setting practices of households and firms in the economy is likely to fall. Thus, inflation targeting is likely to help limit the pass-through from exchange rates to inflation.

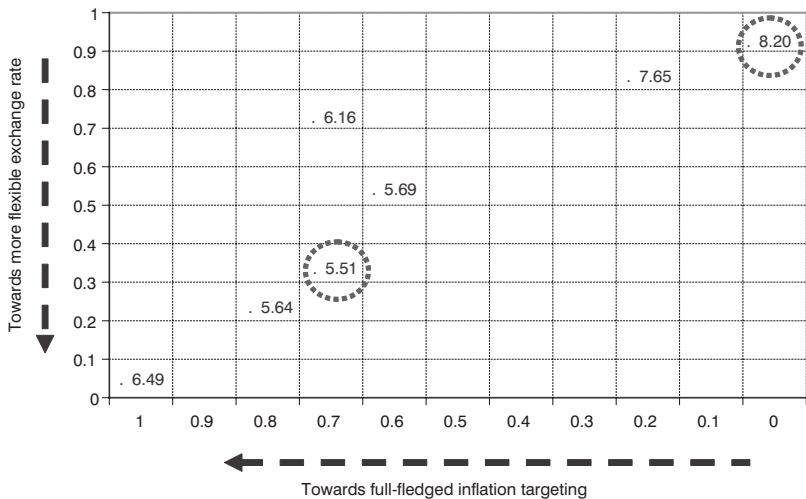


Figure 10.3 Magnitude of economic loss under varying degrees of exchange rate flexibility and inflation targeting

Table 10.5 Loss function $L = \frac{1}{T} \left[2 \sum_{i=1}^T (\pi_i - \pi^*)^2 + \sum_{i=1}^T (y_i - y^*)^2 \right]$

		Degrees of exchange rate flexibility Towards more flexible exchange rate									
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1.0	Degree of inflation targeting Towards full-fledged IT	6.4938	6.2881	6.1418	6.0805	6.1427	6.3800	6.8305	7.4061	7.7231	7.4192
0.9		6.1728	5.9651	5.8310	5.7805	5.8203	5.9443	6.1235	6.3128	6.5188	6.9435
0.8		5.9410	5.7514	5.6403	5.6021	5.6284	5.7121	5.8555	6.0833	6.4619	7.1283
0.7		5.8456	5.6588	5.5477	5.5057	5.5339	5.6405	5.8426	6.1655	6.6482	7.3543
0.6		5.8938	5.6452	5.5008	5.4595	5.5221	5.6907	5.9679	6.3602	6.8796	7.5502
0.5		5.9625	5.6173	5.4602	5.4585	5.5872	5.8265	6.1634	6.5898	7.1040	7.7119
0.4		5.8840	5.5362	5.4383	5.5157	5.7198	6.0182	6.3900	6.8221	7.3076	7.8448
0.3		5.6872	5.4594	5.4717	5.6384	5.9068	6.2433	6.6268	7.0443	7.4883	7.9555
0.2		5.5270	5.4601	5.5835	5.8233	6.1335	6.4856	6.8619	7.2513	7.6477	8.0485
0.1		5.5115	5.5746	5.7772	6.0604	6.3871	6.7346	7.0889	7.4419	7.7886	8.1277
0.0	5.6748	5.8060	6.0434	6.3373	6.6569	6.9834	7.3053	7.6164	7.9135	8.1958	

5 Conclusion

This chapter has presented a reduced form New Keynesian model, applicable to the case of Egypt, with modifications introduced to the standard uncovered interest rate parity condition and monetary policy reaction function so as to capture varying degrees of exchange rate flexibility under an inflation targeting regime. The results show that a fixed exchange rate regime generates the highest output and inflation variability, and the worst loss function for the economy, under the specified model. As the exchange rate is allowed more flexibility the variability of output and inflation declines. However, the optimal point involves less than perfect exchange rate flexibility.

Appendix: Steps towards reforming Egypt's monetary policy framework⁹

Over the last few years the Central Bank of Egypt (CBE) has taken many important steps to upgrade Egypt's monetary policy with a view to adopting IT as a monetary policy framework once the prerequisites are fulfilled. Under the new banking law, the CBE has been granted more independence and an explicit institutional framework was set up for interest rate determination. In addition, the CBE launched a comprehensive and far-reaching banking sector reform programme in 2004, which contained important steps to help overcome the previous shortcomings in the banking sector and fulfil the prerequisites for IT. It included the (non-performing-loans-related) restructuring and privatisation of banks with state participation, other regulatory reforms, the liberalisation of the foreign exchange and money markets, and ongoing efforts to strengthen the supervision of banks.

Restoring confidence in the foreign exchange market and replacing quantitative monetary instruments with price instruments were the cornerstones in the CBE's monetary policy reform programme. The exchange rate has been abandoned as the nominal anchor, and price stability has been declared the overriding policy objective. The CBE is committed to achieving, over the medium term, low rates of inflation, which it believes are essential for maintaining confidence and for sustaining high rates of investment and economic growth. Egypt made the transition to a unified, flexible exchange rate regime during 2004. The parallel market rate, which had a premium of over 15 per cent in late 2003, converged with the banking rate in the second half of 2004 as confidence was restored.¹⁰

A deep and well-developed banking sector is also important to allow for proper transmission of monetary policy actions. Monetary policy within an IT framework is highly market-oriented, and the banking sector is expected to function on market principles. The dominance of the state-owned banks in the market had tended to create rigidities in the interest rate structure in Egypt. Under the banking system reform programme, the banking sector has undergone substantial transformation which has entailed the exit of several weak banks, large-scale financial restructuring, the divestiture of state shares in private banks and the

privatisation of a major state bank. These actions have reduced the share of banks with state participation significantly. The large stock of non-performing loans (NPLs) has been largely addressed through provisioning and cash settlements. The government and the CBE have been implementing programmes designed to clean up banks' balance sheets and settle the NPLs of public and private enterprises.

Moreover, several institutional and operational changes were initiated under the programme to help facilitate monetary policy formulation and assessment.

Institutionally

To carry out its better-defined mandate, the CBE established a Monetary Policy Committee (MPC), which convenes on Thursday every six weeks to decide on key policy rates. The MPC consists of nine members from the CBE's Board of Directors.

To enhance transparency, bolster the credibility of the CBE, and help anchor inflation expectations, MPC decisions are communicated to the market through a monetary policy statement, which is released on the CBE's web-site after each meeting.

Operationally

The exchange rate has been abandoned as the nominal anchor, and price stability has been declared the overriding policy objective.

On June 2, 2005 the CBE introduced an interest rate corridor with two standing facilities, an overnight lending facility and a deposit facility. The interest rates on the two standing facilities define the ceiling and floor of the corridor, respectively. By setting the rates on the standing facilities, the MPC determines the corridor within which the overnight inter-bank rate can fluctuate. In practice, steering the overnight inter-bank rate within this corridor is the operational target of the CBE.

Starting in August 2005, in addition to deposit auctions, central bank notes were added to the CBE's toolkit as the primary instrument for liquidity management via open market operations.

Notes

- 1 The views expressed in this chapter are those of the author and should not be attributed to the Central Bank of Egypt. The author would like to thank Jan Vlcek, the IMF consultant, for introducing the MATLAB codes and for extensive discussions. In addition, special thanks go to Nadia Mounir for excellent research assistance.
- 2 See also Roger and Stone (2005).
- 3 The term rmc_t encompasses the main price determinants in an economy and, in the absence of price inertia, any changes in costs of production have to be reflected immediately in price changes. Therefore, the real marginal costs are defined as the share of nominal marginal costs over final prices and can be used as an indicator of future inflationary pressures. In the case of an open economy the real marginal costs usually comprise the relative price of imports together with the real price of domestic intermediate products. The relative price of imports is captured by the real exchange rate gap. The real price of intermediate products is approximated by the domestic

- output gap. The output gap can be viewed as an indicator of inflationary pressures stemming from diminishing returns to scale.
- 4 It is divided by 4 because the interest rates and the risk premium are measured at annual rates, while the exchange rate is quarterly.
 - 5 There is a considerable amount of heterogeneity in results, which differ widely across countries.
 - 6 For example, Parrado (2004) estimates a reaction function for Singapore in which the instrument is the change in the exchange rate. Kirsanova, Leith and Wren-Lewis (2006) show that it may be appropriate for the monetary authorities to respond to the terms of trade gap as well as the output gap, where their terms of trade gap concept has many similarities to the deviation of the real exchange rate from the fundamental equilibrium exchange rate.
 - 7 The Kalman filter is an optimal recursive data processing algorithm. The Kalman filter processes all available measurements, regardless of their precision, to estimate the current value of the variables of interest, with use of (1) knowledge of the system and measurement device dynamics, (2) the statistical description of the system's noise, measurement errors and uncertainty in the dynamic models, and (3) any available information about initial conditions of the variables of interest.
 - 8 The proposed parameter values are based on other countries' experiences using this type of model. Detailed explanations of the calibrated parameters which reflect certain stylised facts and dynamic inter-linkages of the main variables in the economy are found in Bulir and Hurnik (2002).
 - 9 Al-Mashat (2007) assesses and contrasts Egypt's preparedness for IT with the experience of other emerging market inflation targeters in light of the 2004 Comprehensive Banking Sector Reform Programme.
 - 10 In exploring the monetary transmission mechanism for Egypt, Al-Mashat and Billmeier (2008) find that, despite the shift away from the exchange rate as the nominal anchor, the exchange rate channel continues to play an important role in the transmission of monetary policy, as it greatly magnifies the impact of policy shocks.

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