Monetary Policy Rules and Inflation Targets in Emerging Economies:

Evidence for Mexico and Israel

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Abstract

This study analyses the main determinants of monetary policy in two emerging economies: Mexico and Israel. For that purpose we estimate reaction functions for each country of the form introduced by Taylor (1993) and extended by Clarida *et al*. (1998) in terms of forward-looking rules. Due to the share feature of these countries facing currency and financial crises this study consider the alternative to incorporate a financial variable such as the level of foreign reserves in the reaction function of the central bank. The main results suggest that when setting monetary policy, central banks in these countries look beyond just inflation, taking into account other variables. Moreover, movements in the exchange rate seems to play an important role especially in the case of Israel where there is not a clear commitment to price stability. This involves the introduction of inflation targeting principles along with policies based on fixed or managed exchanges rates.

Keywords: Interest rate rules, Inflation targeting, exchange rates, GMM
Classification JEL: E52, E58.

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1. Introduction

High levels of inflation characterised many emerging economies at the beginning of the nineties. As a result different mechanisms to aim at reduce inflation were set in place. In this respect, a variety of monetary policy frameworks have been suggested. Three options are the most studied ones; the exchange rate regime, the monetary regime and the inflation-targeting regime (see Mishkin, 1997). Inflation targeting (IT) however has become increasingly popular in emerging economies where its implementation has enhanced monetary policy credibility. There is a greater weight on inflation control and more willingness to vary interest rates according to inflation expectations (see Schaechter *et al*., 2000).

Countries such as Brazil in 1999, Chile in 1990, the Czech Republic in 1997, Israel in 1991, Mexico in 1994, and South Africa in 2000 have adopted inflation targeting. The success of these emerging economies in reducing inflation along with IT principles, has generated an increased interested in 'feedback rules' for these countries (see Mohanty and Klau, 2004). These rules link short-term interest rates controlled by the central bank to the rate of inflation and/or its deviation from the targeted rate. Several studies focus mainly on either individual countries or regional experiences (see Amato and Gerlach, 2002; Corbo, 2002; Bar-Or and Leiderman, 2000). Nonetheless, little attention has been paid to the comparability of emerging countries with similar experiences in their interest rate setting behaviour and whether consistency is achieved or not by incorporating additional variables to the traditional central bank reaction function. Corbo (2002) finds that, in setting their interest rates emerging economies tend to look beyond inflation and focus on other objectives as well. Moreover there is no consensus regarding the importance of IT and its main requirements at the time this framework has been adopted in these countries. Different criteria are observed as regards the main prerequisites that should be considered at the time IT is adopted (see Agenor, 2000; Schaechter *et al.,* 2000; Masson, *et a.,* 1997). The present study analyses the process through which interest rates have been determined in two emerging economies – Israel and Mexico – through the implementation of similar procedures to achieve lower and more stable levels of inflation. The main results suggest that when setting monetary policy, central banks in

these countries look beyond just inflation, taking into account other variables such as foreign reserves. Specially, movements in the exchange rate seem to play an important role especially in the case of Israel where there is not a clear commitment to price stability. This involves the introduction of inflation targeting principles along with policies based on fixed or managed exchanges rates.

The rest of the chapter is organised as follows. Section 2 examines how monetary policy has been conducted in the two emerging economies. Section 3 introduces the idea of monetary policy rules, specifies a baseline interest rate rule and describes the estimation procedure. Then, section 4 presents the empirical results and the final section concludes.

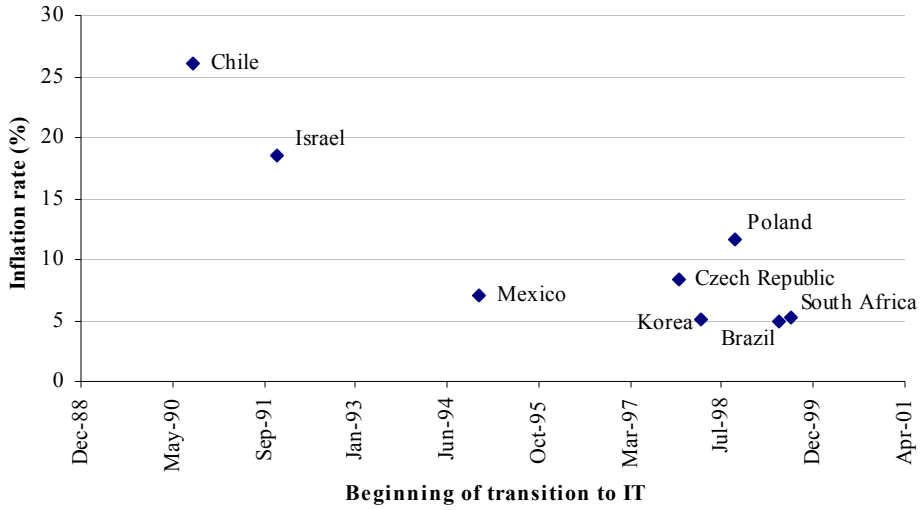
2. The practice of Monetary Policy in Emerging Economies

We can use the term 'monetary policy system', to denote some coherent framework for making monetary policy decisions and for explaining them to the public. In recent years, several emerging economies have been forced to adopt more flexible exchange rates as a consequence of serious financial or currency crises. Therefore, they have had to find a different nominal anchor to guide domestic monetary policy over the medium and long term. As a result, some of these countries have introduced inflation targets and since then they have followed successful strategies for disinflation during the transition towards a fully-fledged IT regime.[1] Bearing this in mind this section reviews the progress made by two emerging economies, Israel and Mexico, which have followed similar procedures to achieve moderate levels of inflation and where the adoption of IT principles seem to be the most important aspect. Israel is a good example of how IT has been adopted during a process of disinflation along with a crawling exchange rate band. On the other hand, Mexico has been considered as one of the few cases of a Latin American country moving towards the floating exchange rate regime in conjunction with an implicit inflation target system. The stance regarding the exchange rate policy emerges as the most importance difference. This issue has been considered essential not only in the case of emerging economies but also as one of the main requirements to successfully implement IT.

[1] This seems not to be the case for industrialised countries where disinflation had largely been completed by the time of the IT adoption.

It is important to note that although more emerging economies have recently introduced IT principles (see Fig. 1) their short experience constitutes a restriction to carry out reliable econometric analysis. Nonetheless, the experience of Israel and Mexico may be considered as pioneering cases for emerging economies in their effort to reduce high levels of inflation. [2] Furthermore, the different posture concerning the exchange rate policy in these two countries constitutes an interesting issue to be analysed. The following sections briefly introduce how monetary policy has been recently conducted in the two selected countries in their effort to reduce inflation.

Figure 1.
Inflation rate at adoption of IT in Emerging Economies



2.1. Mexico

After nearly a decade of sluggish economic activity and high inflation, the Mexican economic authorities liberalised the trade sector in 1985, adopted an economic stabilisation programme, known as the 'Pacto' at the end of 1987, and gradually introduced market-oriented institutions. At the beginning of 1988, the nominal exchange rate was fixed and became the main anchor of the anti-inflationary policy.

[2] Chile is considered as the first emerging economy that announced inflation targets in 1990. Chile's experience however has been the most thoroughly studied and its implementation relies more from the practice of developed countries.

Nevertheless, the vulnerabilities accumulated during this process – years of large capital inflows and financial liberalisation – plus the negative external and domestic shocks faced by the economy during 1994, led to the currency and financial crisis of December 1994. The central bank, under severe pressure in the foreign exchange rate market, decided to let the peso float (Gil-Diaz and Carstens, 1996).

Several measures were implemented during 1995. To contain the inflationary effects of the devaluation, a tight monetary policy was adopted. To restore the credibility of the Bank of Mexico, the authorities reiterated publicly that the primary objective of its monetary policy was to stop the inflationary effects of the peso depreciation and to rapidly bring down inflation to moderate levels. The bank also committed to increased transparency of its own actions by making available more timely information on its balance sheets as well as other monetary and fiscal indicators. Following the measures taken by the government, the peso became more stable, interest rates began to fall, economic activity recovered rapidly and inflation came down to manageable levels. Inflation declined from 51.7 percent in 1995 to 12.3% in 1999 and the central bank announced, for the firs time, a 10% inflation target for the year 2000 before the Ministry of Finance submitted to the Congress the economic programme for the year (see Fig. 2). This move contributed to the increase of accountability of the central bank regarding its inflation objectives. In addition, the Bank of Mexico started publishing inflation reports in 2000. After the implementation of these measures it can be said that Mexico has moved to a fully-fledged IT regime (see Corbo and Schmidt-Hebbel, 2001; Schmidt-Hebbel and Werner, 2002).

3.2. Israel

Inflationary developments in Israel are closely linked to exchange rate policy and demand pressure. At the beginning of the 1980s, the rate of inflation rose persistently and at increasing rate, reaching three-digit levels. This continued until mid-1985, when the Economic Stabilization Programme (ESP) was introduced. The principal role of monetary policy under the ESP was to defend the exchange rate policy (Haldane, 1995). The exchange rate against the dollar was set as the nominal anchor for prices. Nevertheless, the Israeli currency (shekel) was devaluated several times between 1986 and 1991. In March 1990, the width of the band was increased to ± 5

percent and in December 1991 the horizontal band was replaced by a crawling-band regime. The crawling-band regime was intended to reduce uncertainty with regard to the development of the real exchange rate, in order both to benefit the business sector and to reduce speculative capital movements. Since then, the width of the exchange rate band has been increased on several occasions and the focus of monetary policy has shifted toward inflation targeting (Leiderman and Bufman, 2000). [3]

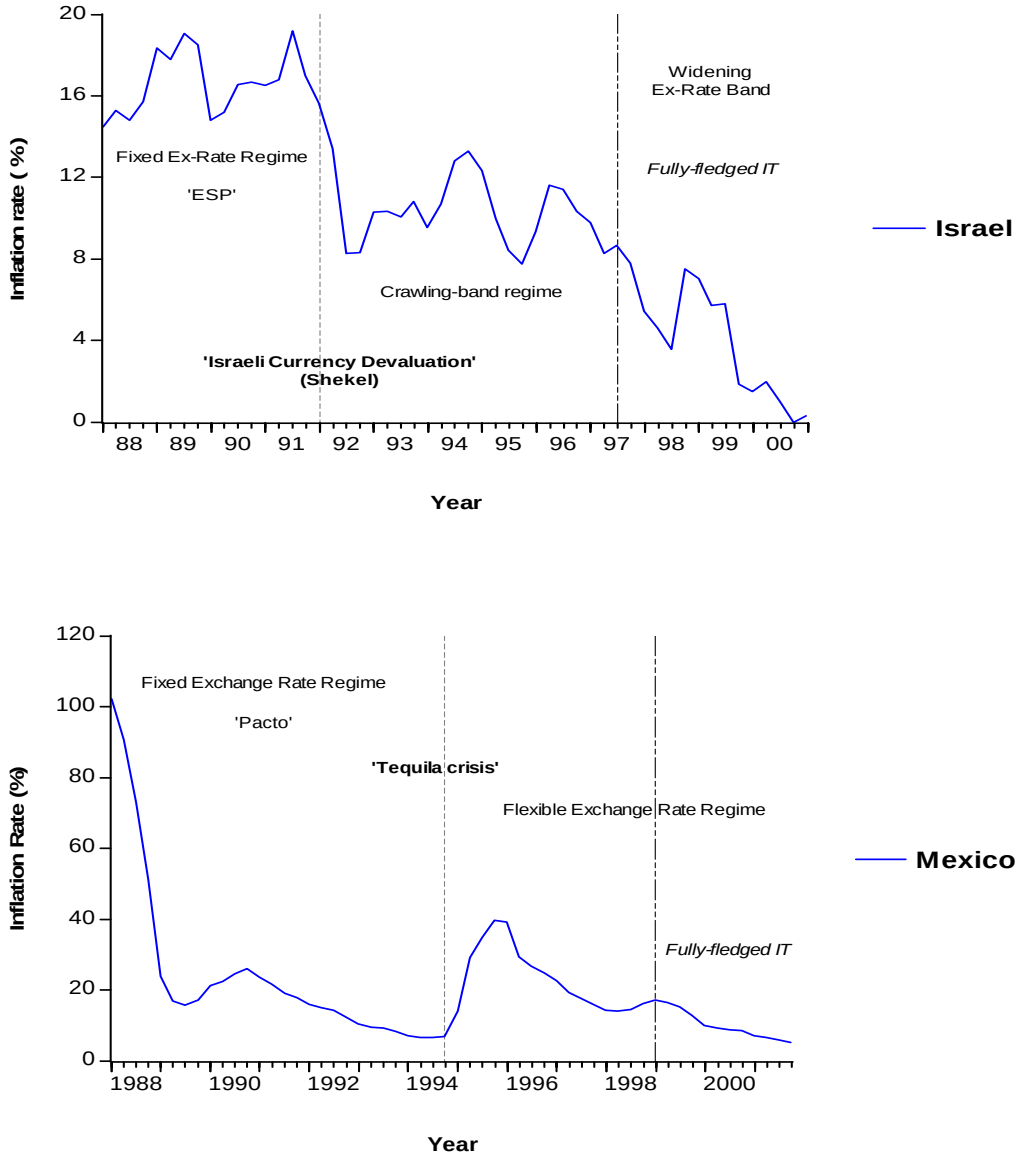
An explicit medium-term orientation for monetary policy was established in 1996 when the government announced a long-term objective to bring inflation down to the average rate of the Organization for Economic Cooperation and Development (OECD) countries by 2001. In 1999, the Ministry of Finance announced two-year targets of 3-4 percent for 2000 and 2001. The Bank of Israel only recently started publishing semi-annual inflation reports (March 1998), but it refrains from making explicit quantitative inflation forecasting. Overall, Israel's experience with inflation targeting can be broadly considered a success. With the exception of the large overshooting of the inflation target in 1994, since 1992 the inflation targets have either been met or have been exceeded by less than 1 percent. Furthermore, the shekel has been consistently hitting the lower (stronger) end of its crawling band. In short, Israeli inflation targeting provides a important example of how monetary policy can be made more flexible with no apparent loss of credibility and effectiveness.

In sum, the conduct of monetary policy in these two countries suggests that inflation targeting can become a successful medium-term strategy for monetary policy in emerging economies (see Fig. 2). At initial stages while credibility was being built and inflation was being gradually reduced, there was a transition period where the inflation target was not explicit and was usually stated as achieving a gradual reduction of inflation towards industrial countries' levels. Once enough progress was made in reducing inflation, these countries started to use explicit targets publicly announced at the end of the previous year. They adopted IT as a means of balancing the uncertainties of their external economic environment, particularly the behaviour of the exchange rate, with the need to anchor the public's inflation expectations. Israel opted for a crawling exchange rate band which has been gradually widened and

[3] The mid-point rate is adjusted on a daily basis according to a present gradient, determined by the gap between Israel's inflation target and expected inflation in its trading partners.

Mexico was forced to adopt a floating exchange rate as a result of a severe pressure on its currency.

Figure 2.
Inflation Rates in Israel and Mexico
(1988-2000)



The role of the exchange rate under IT has been a debatable issue. A country that chooses a fixed exchange rate system subordinates its monetary policy to the exchange rate objective and consequently monetary policy just supports that rate. Under a floating exchange rate, on the other hand, monetary policy is not constrained by any rule. In other words, monetary policy serves as nominal anchor of the

economy. In theory an exchange rate target could coexist with an inflation target so long as the monetary authorities make clear that the latter objective has priority if a conflict arises (Masson, Savastano and Sharma, 1998). In this respect, the analysis of interest rate rules to evaluate the main determinants of monetary policy in these two countries seems to be an appropriate approach to evaluate not only the role of the exchange rate but also additional variables that may influence the stance of the monetary policy setting interest rates. The following section introduces and discusses in more detail this procedure.

3. Monetary policy rules: Statistical framework and data

Commonly, monetary policy analysis has been approached in two ways. The first one requires an understanding of the mechanisms through which monetary policy affects the economy. In other words, monetary authorities must have a precise assessment of the timing and effect of their policies on the economy. This transmission mechanism includes interest rate, exchange rate and other asset price effects, and the so-called credit channel. The second approach, on the other hand, evaluates the conditions under which monetary authorities react to change their monetary policy. This idea can be summarized in terms of a policy reaction function that indicates how policy will react to the shocks and contingencies that will inevitably hit the economy (see Cecchetti, 1998). The success of many countries in reducing inflation, together with the adoption of formal inflation targets by a growing number of central banks, has generated an increased interest in this kind of 'feedback rules' for IT. Policy rules are seen as a guide according to which discretion should be used. Amato and Gerlach (2002), for example, evaluate IT in emerging and transition economies finding that an important distinguishing feature of inflation targeting is that it leads to a more systematic interest rate response by the central bank to inflation. To analyse the main determinants of monetary policy, this study focuses on the latter approach.

3.1. Baseline specification

Two types of rules have been the most studied ones in recent empirical work: (1) The inflation-forecast-based rule, and the (2) Taylor rule, which is by far the most popular and the one this study is based on. Rules based on inflation forecasts make the change

in the policy instrument a function of the deviation of a conditional forecast of inflation in some future period from the target rate of inflation, as follows:

$$r_t = \alpha r_{t-1} + \gamma[E_t(\pi_{t+k}) - \pi^*] \quad (1)$$

The conditional inflation forecast serves as a feedback variable, and the inflation target dictates the necessary degree of instrument adjustment. This rule allows policy-makers to adjust the horizon of the inflation forecast, depending on the length of the transmission lag for monetary policy and it uses all relevant-information for the prediction of inflation[4]. Nevertheless, there are potential difficulties such as the risk of indeterminacy and the inability to distinguish between demand and inflation shocks. Taylor (1993), on the other hand, proposed a feedback policy of the following form: [5]

$$r_t = r^* + \alpha(\pi_t - \pi^*) + (1-\alpha)(y_t - y^*) \qquad 0< \alpha < 1 \quad (2)$$

where r^* is the long run equilibrium real interest rate, π^* is the target inflation rate and y* is the potential output. This rule indicates that when the economy is in equilibrium, that is, when the inflation rate is equal to its target rate and output is equal to potential, the real interest rate is also in equilibrium. Taylor's rule says that the central bank should raise the interest rate when inflation and output rise above their target levels, with the inflation response being somewhat greater than the output response. Conversely, when inflation or output falls bellow its target, the central bank should reduce interest rates.

The theoretical foundations of the rule proposed by Taylor has been formalised by several authors. Svensson (1997), Clarida *et al*. (1999) and Woodford (2001), for instance, have shown that approximations to this rule can be obtained from an optimization process where the central bank minimises a quadratic loss function in inflation deviations from its target and the output gap, subject to a standard New Keynesian macroeconomic framework. In particular, this study follows the work

[4] The inflation-forecast-based rule is different from the Svensson's inflation-targeting rule. Svensson argues that the central bank should use an inflation forecast as an explicit intermediate policy target. Moreover, Svensson's approach requires that the central bank solve an optimal-control problem.

[5] For a more detailed analysis of the historical evolution of monetary policy rules and their implications, see Taylor (1999).

done by Clarida *et al*. (1999, 1998) where the authors postulate a forward-looking version of the rule proposed by Taylor. Specifically,

$$r_t^* = \bar{r} + \beta \cdot [E(\pi_{t+n} \mid \Omega_t) - \pi^*)] + \gamma \cdot [E(y_{t+k} \mid \Omega_t) - y_{t+k}^*] \qquad (3)$$

where $\bar{r}$ denotes the long run equilibrium nominal interest rate[6], π_{t+n} indicates the percent change in the price level between periods *t* and *t+n* (expressed in annual rates) and y_t is real output. The variable r^* is the interest rate set by the central bank; π_t^* is the target for inflation and y_t^* is given by potential output, defined as the level that would arise if wages and prices were perfectly flexible. In addition, *E* is the expectation operator and Ω is the information available to the central bank at the time it sets interest rates. [7]

The policy rule given by eq. (3) has some applications in both theoretical and empirical grounds. Empirically, this reaction function offers a reasonable good description of the way major central banks have performed recently. Clarida *et al*. (1998), for instance, estimate various reactions function to evaluate monetary policy in Europe. They applied a forward-looking version of the Taylor rule, which provides evidence to support that their baseline forward-looking specification works quite well against various alternatives. Clarida, *et al*. (2000), estimate a forward-looking monetary policy reaction function for the postwar US economy and consider how this rule evolved over time. In particular, interest rate policy in the Volcker-Greenspan period appears to have been much more sensitive to changes in expected inflation than in the pre-Volcker period. Few studies can be found in the case of emerging economies. Mohanty and Klau (2004) for example, evaluates central banks' interest rate setting behaviour in a group of emerging economies. They found that in most of these countries the interest rate responds strongly to the exchange rate and in some cases the response was higher than to changes in the inflation rate or the output gap. Another study by Corbo (2000) which estimates reaction functions in terms of forward-looking rules for six Latin American countries showed that just Chile uses

[6] By construction it is the desired nominal rate when both inflation and output are at their target levels.
[7] It is highly possible that when chosen the target interest rate, the central bank may not have direct information about the current values of either output or the price level. The specification proposed by Clarida *et al*. (1998) allows for this possibility.

monetary policy with a clear commitment to achieve the target inflation.[8] Theoretically, policy implications given by eq. (3) for the cyclical behaviour of the economy will depend on the sign and magnitude of the slope coefficients, β and γ. To illustrate the basic intuition, consider the implied target for the real interest rate, rr_t^*, given by:

$$rr_t^* = \overline{rr} + (\beta - 1) \cdot [E(\pi_{t,k} \mid \Omega_t) - \pi^*)] + \gamma \cdot [E(y_{t+k} \mid \Omega_t) - y_{t+k}^*] \qquad (4)$$

where $rr_t^* \equiv r_t - E(\pi_{t,k} \mid \Omega_t)$ and $\overline{rr} \equiv r^* - \pi^*$ is the long run equilibrium real rate. It is assumed that the real rate is stationary and is determined by non-monetary factors in the long run. As a result, $\overline{rr}$ is a constant and is independent of monetary policy[9]. As eq. (4) makes clear the sign of the response of the real rate target to changes in expected inflation and the output gap depends on whether β is greater or less than one and on the sign of γ, respectively. To the extent that lower real rates stimulate economic activity and inflation, interest rate rules characterized by $\beta>1$ will tend to be stabilizing while those with $\beta\leq1$ are likely to be destabilizing or, at best, accommodative of shocks to the economy[10]. Thus, the coefficient β turns out to be a key parameter at the moment of assessing central bank's response. If a monetary policy rule like eq. (4) with β > 1 offers a good approximation to the process through which interest rates are determined, then monetary policy works as an automatic stabiliser of inflation around its target. In other words, monetary policy plays the role of being a nominal anchor for the economy. In the same sense when a rule like eq. (4) with γ>0 offers a good approximation to the process through which interest rates are determined, monetary policy is said to be an automatic stabilizer of output around its potential level. In addition, this specification allows the control of inflation and the stabilisation of output to be identified as independent objectives[11] and considers all the information available at the time the central bank set interest rates.

[8] The rest of the countries are: Colombia, Costa Rica, El Salvador, Nicaragua and Peru.

9 If the analysis is carried out among different sub periods there exists the possibility of having shifts over time in the long-run equilibrium rate. Therefore, the real interest rate is constant only within the sub period estimated.

10 In this case although the central bank raises the nominal interest rate in response to a rise in inflation, it does not increase it sufficiently to keep the real rate from declining.

[11] In the traditional Taylor rule model, for example, the central bank reacts to lag inflation as opposed to expected inflation. Then it is not clear if the central bank can respond independently to inflation and the output gap.

Interest rate smoothing

The policy reaction function given by eq. (3) assumes an immediate adjustment of the actual interest rate to its target level. In other words, it does not allow for any uncertainty in policy actions other than that associated with incorrect forecasts of the economy. It also assumes that the monetary authorities have perfect control over interest rates. Central banks, however, adjust interest rates more cautiously towards its desired level than standard models predict (Goodfriend, 1991). To allow for this possibility, a partial adjustment equation is considered. [12] In particular, Clarida *et al.* (2000,1998), proposed the following relationship for the actual interest rate, r_t:

$$r_t = (1-\rho)\cdot r_t^* + \rho(L)\cdot r_{t-1} + \upsilon_t \qquad (5)$$

where the parameter $\rho \in (0,1)$ reflects the degree of lagged dependence on the interest rate or the degree of interest rate smoothing. The specification also includes an exogenous random shock to the interest rate, υ_t that it is assumed to be iid (0,1). The interest rate target r_t^* is given by eq. (3). Particularly, each period the central bank adjusts the interest rate to eliminate a fraction (1-ρ) of the gap between its current target level and its past value. In addition, to obtain an estimable equation the authors define: $\alpha \equiv \bar{r} - \beta\pi^*$ and $x_t \equiv y_t - y_t^*$. Then combining the partial adjustment eq. (5) with the target model (3) yields the following policy reaction function:

$$r_t = (1-\rho)\cdot\{\alpha + \beta\cdot E[\pi_{t+n} \mid \Omega] + \gamma\cdot E[x_t \mid \Omega]\} + \rho\cdot r_{t-1} + \upsilon_t \qquad (6)$$

Finally, assuming that expectations are rational expected values are replaced by realised values in order to obtain the following equation:

$$r_t = (1-\rho)\cdot\alpha + (1-\rho)\cdot\beta\cdot\pi_{t+n} + (1-\rho)\cdot\gamma\cdot x_t + \rho\cdot r_{t-1} + \varepsilon_t \qquad (7)$$

[12] Other explanations for slow adjustment of interest rates include fear of *disrupting financial markets* and disagreement among policy-makers.

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

3.2. Estimation technique

The estimation of eq. (6) is not straightforward as some of the variables considered in the right hand side of the equation may be endogenous. Moreover misspecification errors may be expected. These difficulties invalidate conventional least squares standard errors since the cov $(\pi_t,\varepsilon_t) \neq 0$ and/or cov$(x_t, \varepsilon_t) \neq 0$. To obtain unbiased and consistent estimators the model is estimated using the General Method of Moments (GMM). [13] In this respect, let U_t symbolize a vector of instruments known when r_t is set. Suitable instruments include any lagged variables that help forecast inflation and output, as well as any contemporaneous variables that are uncorrelated with the current interest rate shock υ_t. These strategy implies a set of orthogonality conditions, which provide the basis for the estimation of the parameter vector $(\alpha,\beta,\gamma,\rho)$ that are given by $E[\varepsilon_t \mid U_t] = 0$. Combining this condition with eq. (7) gives us the explicit set of restrictions used by GMM:

$$E[i_t - (1-\rho)\cdot\alpha - (1-\rho)\cdot\beta\cdot(\pi_{t+n}) - (1-\rho)\cdot\gamma\cdot(x_t) - \rho\cdot i_{t-1} \mid U_t] = 0 \qquad (8)$$

It should be emphasized that GMM naturally provides a suitable econometric framework for testing the validity of the model (see Hansen and West, 2002; Jagannathan *et al*., 2002). When the number of instruments is larger than the number of parameters to be estimated, the model is said to be over identified. In this case, Hansen's *J*-test is used to test if the over identifying restrictions hold.

Additional variables

So far, the discussion has not considered the inclusion of additional variables to the baseline equation. In practice, the output gap and inflation are not the only relevant objectives from a practical point of view. Ball (1999) and Svensson (2000) for instance argue that monetary policy rules should take into account other variables

13 For a detailed description of this method see Greene (2000) and Enders (1995).

such as foreign interest rates or the exchange rate which might reflect uncertainties about future inflation faster than expected inflation or the expected output gap[14]. In addition, some central banks in emerging economies, such as the central bank of Chile, Czech Republic and Israel have a formal objective with regard to currency stability. It is therefore useful to examine the consequences for monetary policy of introducing additional variables in the policy makers' objective function. To this end a number of simple alternatives to the baseline model are considered. Let z_t denote a variable other than inflation or output that may potentially influence rate setting (independently of its use for forecasting). For each alternative specification, the following equation is utilised:

$$r_t = (1-\rho)\cdot\{\alpha + \beta\cdot[\pi_{t+n} - \pi^*_{t+n}] + \gamma\cdot[x_{t+k}] + \varphi\cdot[z_{t+j} - z^*_{t+j}]\} + \rho\cdot r_{t-1} + \varepsilon_t \qquad (9)$$

The alternative model is then estimated in the same way as in the baseline model. This specification allows us to evaluate whether the direct effect of z_t on policy is quantitatively important. Additional variables commonly consist of changes in the nominal exchange rate, money, foreign interest rates or any other variable, which may have influence in the process through which interest rates are determined. The variables included in this study are changes in nominal exchange rates and money supply, foreign reserves, a lending boom indicator and the current account.[15] The change in prices over the previous year is also considered in order to get a direct test of the forward-looking specification versus the 'backward-looking' one. We examine each of these variables below.

It is plausible to expect that a variable that would be important in the context of small open economies would be the exchange rate. [16] Recent work by Ball (1999) and Svensson (2002) on small open economies models has examined the role of the

14 Clarida, Gali and Gertler (2001) however present a small, open-economy model in which the effect of the exchange rate on output and inflation is captured in the parameters of the policy rule. The difference is in the quantitative response (magnitude of the parameters β and γ) of interest rate to expected inflation and the output gap. The intuition behind this argument is that if movements in the exchange rate will have an effect in inflation and/or output, then these effects should be captured by changes in the expected deviation of inflation from its target and in the expected output gap.

15 Choosing the variables that could have played a role when setting monetary policy, we draw on the work of Kaminsky and Reinhart (1996, 1997) on the economic indicators for banking and currency crises.

16 When the pass-through of the exchange rate into prices is high, the exchange rate is likely to assume special importance for monetary policy.

exchange rate in monetary policy rules explicitly. Their results highlight the idea that a depreciation of the currency calls for an increase in the interest rate[17]. On the other hand, Taylor (2001) argued that although the exchange rate is important, particularly in emerging economies, any reaction of the interest rate to this variable would be indirect, through its effect on inflation and the output gap. Additionally, central banks may react to changes in the exchange rate to maintain financial stability rather than price stability. In this respect, Calvo and Reinhart (2002) for instance, attribute such 'fear of floating' behaviour to the high-risk premium they have to pay because of their low institutional and policy credibility.

Central banks in emerging economies are also typically concerned with financial stability. Thus, three more variables are considered in the augmented interest rate rule as potential indicators for external crisis. The first one is foreign reserves. Many emerging economies affected by currency crises in the 1990s lost a large part of their foreign reserves trying to defend the value of their currencies and eventually, they had to abandon the fixed exchange rate (Kaminsky *et al.*, 1997). Due to this reserve run-down associated with the financial crisis, countries have been accumulating reserves even though they have adopted more flexible exchange rate regimes. This strengthening of reserves may be seen as a method of building up credibility and therefore may be related to the process of having more stability. Hence, incorporating foreign reserves in the reaction function of the central bank might result in a monitoring variable for emerging market economies regarding financial stability. The second variable is constructed as the ratio of the logarithm of the claims on private sector to Gross Domestic Product (GDP). This 'lending boom' variable indicator has been mainly used to explain many banking crises, including Chile's in 1982 and Mexico's in 1994. During a boom, credit to the private sector increases rapidly making the banking sector more vulnerable (see Gourinchas et al. 2001). Moreover, it can be argued that the higher the ratio of this variable, the higher the potential of economic growth. Therefore more pressure on future inflation and consequently the need of raising interest rates. The third variable is the current account deficit. The current account is typically used as one of the main leading indicators for future behaviour of an economy and its importance has been mainly highlighted in emerging

[17] The significant increase in the interest rates in Mexico after the currency depreciation at the end of 1994 might be an example of such a reaction.

economies. Corbo (2002) for instance, finds that central banks in Latin America show an importance preference to stabilise current account deficits in the balance of payments even though this is not announced explicitly. It is worth mentioning that the addition of these variables constitutes mainly a shortcut to avoid a very complex model in which output and inflation may be affected by these factors. Table A1 in the appendix summarises various studies on monetary policy rules, which have extended the traditional version of the Taylor rule. These studies consider not only the formulation of forward-looking rules but also the inclusion of additional variables.

3.3 Data

The data are quarterly time series spanning the period 1982Q1-2001Q4 in the case of Mexico and the period 1988Q1-2001Q4 in the case of Israel. Data is mainly taken from the International Financial Statistics (IFS) CD-Rom regarding output, inflation, interest rates and foreign reserves and from the respective central bank's websites.

4. Empirical results

The starting equation of the empirical analysis is:

$$r_t = (1-\rho)\cdot\alpha + (1-\rho)\cdot\beta\cdot\pi_{t+n} + (1-\rho)\cdot\gamma\cdot x_t + \rho\cdot r_{t-1} + \varepsilon_t \qquad (10)$$

where β is the inflation coefficient expected to be greater than one and γ the output gap coefficient expected to be greater than zero. The output gap is calculated using the Hodrick-Prescott filter and the Core Price Index (CPI) to calculate the rate of inflation. [18] Three different specifications are considered. The first one uses actual values instead of expected of forecast ones (Baseline model). The main reason is the lack of reliable data for the entire sample period in the absence of official and

[18] Following the literature, the most common method to construct an output gap series is based on the Hodrick-Prescott filter. In this respect, potential output is determined as the output level that simultaneously minimises a weighted average of the gap between actual and potential output and the rate of change of the output trend. In addition to this method a linear and a quadratic trend are used to obtain alternative measures of the output gap. The series are constructed as the deviation of the natural logarithm of the real GDP from its potential value using the alternative methods. Alternative measures of inflation, on the other hand, are also taken into account. These include a measure of the core inflation, which excludes the relatively more volatile components of the CPI and the GDP deflator. The unemployment rate is also considered when available.

commonly accepted forecasts. In the second specification actual values of the explanatory variables are replaced by their deviations from trend values (Gap model). This is mainly because of the short experience of these countries with a fully-fledged IT and therefore with the lack of sufficient data for the announced inflation targets. The last specification includes data on inflation expectations available in each country (Forward-looking model). As it will be discuss later on this implies however the estimation of eq. (10) for a shorter sample period. The analysis is based on the primary assumption that within short samples all variables are stationary (see tables A2 and A3 in the appendix).

4.1 The case of Mexico

The Mexican experience is interesting for two reasons. First, it represents an emerging economy under a floating exchange rate regime that has been able to reduce inflation to one-digit levels. Second, the Mexican experience provides an interesting case of study for other developing countries considering the possibility of moving towards the floating exchange rate regime in conjunction IT principles. In other words, it is particularly interesting because the adoption of inflation targeting has been a useful mechanism for imposing discipline on monetary policy.

4.1.1 Baseline specification

To account for important monetary policy reforms a dummy variable is taken into consideration. This dummy permits us to evaluate issues regarding structural stability without the need to break the sample up which would be problematic given the short sample period.[19] In the case of Mexico, the date selected considers the different measures implemented by the monetary authorities as a result of the currency and financial crisis at the end of 1994. These measures include central bank independence, the adoption of a floating exchange rate, the commitment to price stability and the

[19] According to Clarida et al., 2000 the sample period must contain sufficient variation in inflation and output and must be sufficiently long in order to identify the slope of the coefficients in the policy reaction function. Chuecos (2003) and Corbo (2002), however estimate policy rules within short samples arguing sufficient variability in their estimations.

announcement for first time of inflation annual objectives. [20] In this respect, the dummy equals 0 for the pre-reform period; that is, before 1994 and takes the value of one otherwise. The dummy variable is included in the estimated equation as a constant as well as interacting with each of the explanatory variables. In the former case, i.e. $i_t = c_1 + c_2 \cdot \pi_{t+n} + c_3 \cdot x_t + c_4 \cdot dummy + \rho \cdot i_{t-1} + \varepsilon_t$ the dummy turns out to be statistically insignificant but its inclusion improves the fit of the policy rule. Alternatively, when the dummy is interacting with other terms, i.e. $i_t = c_1 + c_2 \cdot \pi_{t+n} + c_3 \cdot x_t + c_4 \cdot dummy + c_5 \cdot dummy \cdot \pi_{t+n} + c_6 \cdot dummy \cdot x_t + \rho \cdot i_{t-1} + \varepsilon_t$ just the term when the dummy variable is interacting with the inflation term becomes statistically significant. [21] This result suggests not only the existence of some kind of structural break but also provides information of how effective has been the implementation of different strategies in reducing the levels of inflation (β value). Thus, the following 'interest rate rule' is estimated:[22]

$$r_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\delta \cdot dummy95 \cdot \pi_{t+3} + \rho \cdot r_{t-1} + \varepsilon_t \qquad (11)$$

The results of this baseline equation are presented in the first row of table 1.[23] As mentioned before, β turns out to be a key parameter at the moment of assessing central bank's response. In this case, the parameter β is positive and statistically greater than one. [24] This result suggests that monetary policy in Mexico, through its effect on interest rate, has effectively stabilised the economy. The central bank does not accommodate inflationary pressures. Concerning the smoother parameter ρ, its high value suggests not only considerable interest rate inertia but also that the central bank is concerned about smoothing adjustments. In other words, a value about 0.80 implies that the initial adjustment (same quarter) in the interest rate is only 20%.

[20] A dummy variable for 1988 to account for the oil-price shock is also considered. Nevertheless just in few cases this is significant and the results do not improve considerably.
[21] Different specifications were carried out. In almost all of them the dummy both as a constant and interacting with the output gap turns out to be statistically insignificant.
[22] Although the Bank of Mexico does not directly determine interest rates, their behaviour is steered by the stance of monetary policy. Several authors assume short interest rates as the instrument of monetary policy although they embrace different monetary policy regimes. This is the case for example of Aron and Muellbauer, 2002; Corbo, 2002; Merha, 1999 and Clarida, et al., 1998.
[23] Two sets of instruments are considered. The first one includes one to four-period lags of the explanatory variables, in other words, of the inflation rate, interest rate and output gap. The second set of instruments adds to the first set, lagged information on the changes in the nominal exchange rate (depreciation rate) and monetary aggregates. The results suggest a better fit of the policy rule when the second set of instruments is used.
[24] The Wald test is used to verify that the value of the parameter is statistically greater than one.

Parameter γ although has the expected sign is statistically no different from zero. [25] The value of the dummy variable turns out to be positive and statistically significant suggesting important changes in the structure of the economy as a consequence of the currency crisis. Its positive value also reinforces the role of monetary policy as a nominal anchor after 1995 when the monetary authorities made explicitly their commitment to price stability.

Another way to evaluate the baseline monetary policy rule is to compare the estimated 'interest rate rule' with actual interest rates. That is, to compare present values with those that would have been observed if during the sample period the interest rate had been determined by the estimated policy rule. Figure 3 shows the actual and simulated values for the interest rate. Overall, the monetary policy rule does a good job in following the direction of actual interest rates. In general the fitted values are above the current ones. In the post-reform period (after 1995) this pattern becomes clearer. These results can be interpreted as suggesting a more expansionary monetary policy than what it should have been if it had been determined in accordance with the proposed reaction function. Results from the baseline case suggest that monetary policy in Mexico has been consistent with the objective of achieving lower levels of inflation. The following section, however, considers the inclusion of other variables as additional objectives in the central bank's reaction function which may describe better how interest rates are determined in Mexico.

Augmented monetary policy rules for Mexico

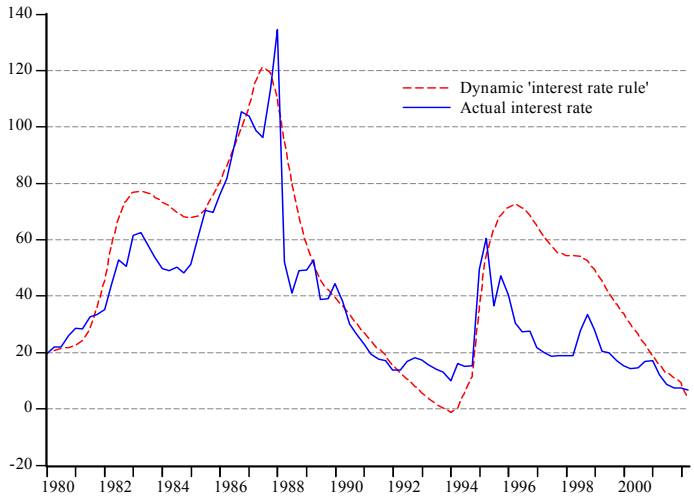
An augmented monetary policy rule is used to test the role of macroeconomic variables other than inflation and output. For this purpose, the following equation is estimated:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\delta \cdot d95 \cdot \pi_{t+3} + (1-\rho)\varphi \cdot z_t + \rho \cdot r_{t-1} + \varepsilon_t \qquad (12)$$

[25] Torres, A. (2002) and Martinez, Sanchez and Werner (2001) found similar results. Their sample period however is shorter starting in 1996.

where z_t represents any variable, other than inflation and output that may influence the process through which interest rate is determined.

Figure 3.
Actual interest rate vs. dynamic 'interest rate rule'
Baseline specification



The backward-looking component of monetary policy

To check whether interest rate are determined more in a forward-looking than backward-looking manner the augmented interest rate rule is estimated defining z_t as the observed lagged inflation (π_{t-1}). If interest rates are determined in a relatively backward-looking model the nominal interest rate would be expected to rise enough to increase the real interest rate ($\varphi>1$) rather than when inflation is generated in a forward-looking form. The results presented in table 1 suggest that there is a significant contribution of the lagged value of inflation in the determination of interest rates in Mexico although this is not good enough to stabilise the economy ($\varphi<1$). The same performance is observed with the value of the parameter β. In other words, β becomes significantly less than one suggesting that the response from the authorities to inflation shocks is not sufficient to stabilise the economy. Finally, the significant decrease in the value of parameter β once the lagged value of inflation is included in the estimation suggests either high persistence of inflation or that part of the information is already incorporated in the explanatory variables.

Money and the exchange rate

Following Taylor (2001), the interest rate reaction function estimated includes the change in the nominal exchange rate where an increase means depreciation and vice versa. [26] Results reported in table 1 indicate that parameter φ is positive and statistically different from zero. However, β is both statistically no different from zero and no longer greater than one. Parameter γ remains insignificant. It seems that part of the information enclosed in this variable is also incorporated in the observed inflation and output gap. This in an interesting result in the context of a floating exchange rate regime where the central bank seems to react to effectively maintain price stability rather than to maintain a specific level of the exchange rate.

Table 1.
Monetary Policy Rule: Augmented estimations[1]
Mexico: 1982-2001

	α	$\beta^{pre\text{-}reform}$	γ	δ	φ	ρ	*J-test*
Base specification	5.42* (3.85)	1.80* (5.28)	35.96 0.34	2.56* (2.26)	---	0.83* (13.55)	10.59 (0.78)
Backward-looking	7.84* (2.09)	0.25* (2.12)	17.50 (0.30))	−0.76* (−2.85)	0.84* (5.54)	0.67* (10.93)	10.52 (0.72)
Depreciation rate	8.43^ (1.73)	−0.50 (−0.74)	52.74 (0.45)	0.61 (1.04)	6.38* (2.06)	0.75* (8.35)	10.53 (0.72)
Money growth	−2.73 (−0.42)	1.83* (6.26)	79.70 (0.61)	0.02 (0.06)	−0.29* (−2.70)	0.81* (13.41)	9.28 (0.81)
Foreign reserves	−4.18 (−0.65)	1.41* (8.01)	−38.76 (−0.42)	1.15* (2.14)	−0.88* (−3.71)	0.80* (21.06)	10.34 0.92
Lending boom indicator	−47.81 (−1.15)	1.15* (5.87)	−4.25 (−0.08)	0.39 (1.22)	34.50 (1.18)	0.78* (13.36)	12.09 (0.84)
Current account	−22.76* (−2.62)	1.65* (9.71)	−37.88 (−0.82)	0.84* (3.49)	−0.003* (−3.16)	0.63* (13.57)	13.34 (0.92)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

The money supply, alternatively, is added to the regressors of the baseline equation. In this case z_t is defined as the annual variation of the sum of money and quasi money

[26] Taylor (2001) assumes that central banks respond to the level rather than to the change of the nominal interest rate.

(first log difference). [27] The results show that the parameter φ turns out to be negative. This is contrary to what one would expect since higher money supply growth should motivate an increase in the interest rate in order to prevent inflation from rising.

Current account, foreign reserves and lending boom indicator

After several attempts to reduce inflation to stable rates, Mexico has eventually achieved this goal even experiencing profound economic crises. So, in particular, this section investigates if the central bank behaviour has changed and if it is valuable to consider prevention variables in its policy reaction function. The results of the augmented monetary policy rule are presented in the second part of table 1. As in the baseline case, parameter β is statistically larger than one and parameter γ remains statistically no different from zero. Regarding the lending boom indicator, this seems not to contribute at the time the central bank has to make a decision concerning its monetary policy position. Nonetheless this is not the case for the change in foreign reserves and the current account deficit although both coefficients present unexpected signs.

4.1.2 Gap model

An alternative version of the baseline model is estimated where actual values of the explanatory variables are replaced by their deviations from trend values (gap model). In this respect the Hodrick-Prescott filter is used to measure the trend values. This is mainly because of the short experienced with a fully-fledged IT system and therefore with the lack of sufficient data for the announced inflation targets. [28] In addition, it is important to note that the inflation target is not considered to be constant over time as in Clarida *et al*. (1998). This value could be time-variant for a country that has an objective to reduce inflation, gradually, towards industrial country levels. Poor results however are obtained from these estimations where parameters become statistically insignificant and with the wrong signs. These results may be because of the high instability observed in the main variables at the beginning of the 80s. To address this issue the gap model is reestimated for a shorter period of time (1988-2002). The

[27] Including the quarterly change in the estimation of this variable does not alter the results.
[28] The sample period under estimation is longer than the one under this monetary policy framework.

results presented in table 2 in general support the previous findings. Parameter β is always greater than one and statistically significant suggesting the commitment of the monetary authorities to stabilise the economy even before its transition to a fully-fledged IT. Two exceptions are when the depreciation rate and the lending boom indicator are added suggesting that these variables contain information already given in the main variables. In all the augmented policy rules the signs of all estimated parameters are the expected ones and statistically significant. Parameter ρ decreases in this sample period suggesting that approximately half of the initial adjustment is achieved in one quarter. Parameter γ is statistically no different from zero in all the cases.

Table 2.
Gap model : Baseline and augmented policy rule [1]
Mexico: 1988-2002

	α	β	γ	φ_1	ρ	*J-test*
Baseline	23.35* (14.64)	2.23* (9.75)	19.20 (0.42)	---	0.53* (14.43)	9.47 (0.89)
Backward-looking	26.67* (10.89)	1.91* (6.25)	−46.39 (−0.76)	0.89* (6.36)	0.34* (5.79)	6.94 (0.95)
Money growth (GR)	22.90* (10.01)	2.55* (8.38)	−8.16 (−0.14)	0.25* (2.09)	0.52* (11.58)	7.61 (0.94)
Depreciation rate	16.02* (19.41)	0.29* (2.78)	10.50 (0.68)	0.54* (13.76)	0.16* (4.44)	9.34 (0.85)
Foreign assets (GR)	22.1.* (9.68)	2.71* (6.84)	25.02 (0.61)	0.0002* (2.44)	0.53* (11.74)	7.63 (0.97)
Lending boom indicator	10.68* (3.75)	0.53* (2.64)	17.90 (0.29)	0.21* (3.19)	0.81* (33.55)	9.34 (0.85)
Current account	25.93* (23.86)	2.49* (6.05)	− 38.77 (−0.96)	0.002 (1.61)	0.66* (23.86)	9.17 (0.95)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

4.1.3 The role of inflation expectations

The existence of reliable data on market-based inflation expectations is very useful in an inflation-targeting context. However, as Bernanke and Woodford (1997) indicate key limitations of market-based inflation expectations need to be considered. Specifically, measured inflation expectations are backward looking and reflect

adaptive behaviour by the public. Therefore, a variable that in principle should contain a strong forward-looking element is largely determined by past performance. Furthermore, in a regime where the authorities conduct inflation forecast targeting based on market-based inflation expectations as one of the key indicators, and where there has been a gradual learning about the anti inflation process stance of the authorities, it is very difficult to determine the properties of market based inflation expectations. Taking into account these difficulties, a third specification is estimated using expected rather than actual values for the inflation rate. This policy rule however includes just the sample period in which this data is available (1996-2002). The data on inflation expectations is obtained from the Central Bank of Mexico. Consequently, the inflation gap is calculated as the difference between inflation expectations at the end of the year and the value of the inflation target announced by the central bank.

The results shown in table 3 are quite remarkable. All the coefficients are statistically significance at the 5% level of significance and with the expected values. Parameter β continues above unity suggesting that Bank of Mexico has been concerned with inflation stabilization. The coefficient of the output gap for this sample period (1996-2002) turns out to be statistically significant and with the expected value in all the estimations. The monetary authorities seem to be concerned with output fluctuations. In particular, the results imply that the authorities increased interest rates when a rise in the gap between real GDP and its trend is expected. The smoothing parameter however decreases substantially in this period. On average almost 90 percent of the adjustment is achieved in the first quarter. This may reflect the gains in terms of policy credibility which makes the monetary policy stance more effective. Similar conclusions can be found in Chuecos (2003) and Torres (2002). Overall, the results suggest that monetary policy in Mexico has been consistent with IT principles. Moreover, the results from the inclusion of additional variables in the interest rate rule reflect the concern by the monetary authorities in aspects related to financial stability. Marginal and positive contributions are observed in all variables being the most significant the one from the lending boom indicator. The value of the parameter when changes in the nominal exchange rate are included becomes quite small. This suggests that a flexible exchange rate has indeed contributed to reduce inflation. In the

backward-looking estimation, the parameter φ is statistically insignificant. This implies that setting interest rates in Mexico is more forward than backward-looking.

Overall, the evidence presented shows that Bank of Mexico has been acting according to IT principles where monetary policy has performed the role of the nominal anchor of the economy. This performance becomes clearer when inflation expectations are included in the estimations. In this case not only inflation deviations from its target but also output deviations from its trend are considered. Finally, the inclusion of additional variables seems to contribute to the process through interest rate are determined in Mexico. As expected the addition of the depreciation rate is significant when the period under an exchange rate regime is included. However its contribution decreases significantly at the time a flexible exchange rate policy is in place.

Table 3.
Forward-looking model :
Baseline and augmented policy rule [1]
Mexico: 1995-2002

	α	β	γ	φ_1	ρ	*J-test*
Baseline	15.50* (138.03)	1.86* (151.47)	18.77* (7.79)	---	0.12* (15.31)	5.81 (0.92)
Backward-looking	15.46* (114.84)	1.80* (36.15)	20.17* (6.52)	0.06 (1.64)	0.12* (10.54)	5.34 (0.91)
Money growth (GR)	15.87* (443.69)	1.70* (97.95)	11.70* (12.91)	0.03* (11.07)	0.15* (40.17)	6.93 (0.96)
Depreciation rate	15.89* (355.14)	1.78* (170.91)	20.41* (16.17)	0.02* (2.62)	0.12* (35.47)	6.58 (0.96)
Foreign assets (Gap)	15.66* (239.55)	1.88* (75.28)	17.81* (12.17)	$8.6E-06$* (3.03)	0.11* (15.64)	6.41 (0.97)
Lending boom indicator	15.58* (186.87)	2.08* (38.35)	21.43* (13.57)	8.11* (5.03)	0.05* (3.32)	6.33 (0.97)
Current account	15.91* (291.76)	1.76* (47.37)	16.92* (8.86)	0.0002 (1.14)	0.15* (7.94)	6.29 (0.93)

1 The inflation gap is calculated as the difference between inflation expectations at the end of the year and the inflation target announced by the central bank.
The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

4.2 The case of Israel

4.2.1 Baseline specification

Following the same procedure as in the case of Mexico, a monetary policy rule is estimated using quarterly data for the period 1986:Q1-2001Q4. So, the 'interest rate rule' is given by:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + \rho \cdot r_{t-1} + \varepsilon_t \qquad (13)$$

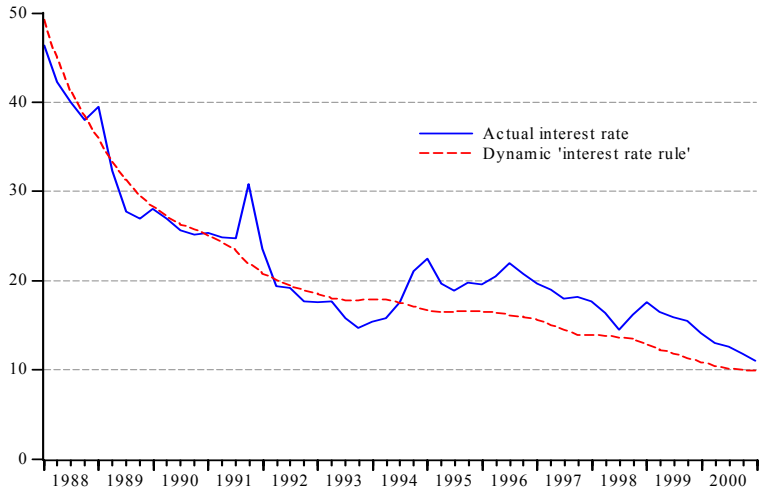
The results of this estimation using a three-quarter lead for the inflation are shown at the top of table 4a. [29] The coefficient associated to inflation is positive but less than one suggesting that monetary authorities are not particularly determined to control inflation shocks. The estimated parameter of the partial adjustment process for interest rates seems to be particularly high suggesting concern about smoothing adjustments and the coefficient of the output gap even though is positive it turns out to be insignificant. [30]

To evaluate the estimated monetary policy rule dynamic simulations are carried out. In other words, current values of the interest rate are compared with those that would have been observed if the interest rate had been determined by the estimated policy rule. Figure 6 depicts the actual and simulated values for the interest rate. In general the 'interest rate rule' follows the direction of actual rates. Nevertheless around 1994 the fitted values are always below the current ones. These results can be interpreted as having a more contractionary monetary policy than what it could have been if it had been determined in accordance to the suggested reaction function.

[29] The estimation considers as an instrumental variables lag values (up to four) of the explanatory variables and of the depreciation rate, export growth and a measure of money growth. According to Mohanty and Klau, 2004 this set of instrumental variables are suitable for emerging economies.

[30] It is worth mentioning that a dummy variable is taken into account in the specification at the time Israel decided to adopt a crawling exchange rate band along with the implementation of inflation targets. The dummy equals 0 for the pre-reform period; that is, before 1992 and takes the value of one otherwise. As in the case of Mexico both intercept and slope dummies are used. In none of the cases, however, the estimated parameter turns out to be statistically significant. These results suggest the absence of significant changes affecting the structure of the Israeli economy at that time.

Figure 6.
Actual interest rate vs. dynamic 'interest rate rule'
Baseline specification



Augmented monetary policy rules for Israel

As in the case of Mexico an augmented monetary policy rule is estimated:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\varphi \cdot z_t + \rho \cdot r_{t-1} + \varepsilon_t \qquad (14)$$

where z_t represents any variable, other than inflation and output that may influence the process through which interest rate is determined.

The backward-looking component of monetary policy

Disinflation in Israel has been a relatively slow process. It took more than a decade for the rate of inflation to fall from about 18 percent per year in the late 1980s to less than 4 percent per year in the late 1990s. Over time the central bank has placed more credibility regarding inflation as the key objective of monetary policy. In this context and prior to testing the role of additional variables the interest rate rule is estimated using observed lagged inflation. The results presented in the first row of table 4a suggest a significant contribution of the lagged value of inflation in the determination of interest rates in Israel during this sample period. All variables are statistically significant at the one-percent level and have the expected signs. The coefficient

associated with the backward-looking component suggest that there is a significant contribution of the lagged value on inflation even though this value is significantly less than one as in the case of the forward-looking component (β). The coefficient of the output gap suggests that during this period, the monetary authorities gave some weight to economic fluctuations. In particular, the results imply that the authorities increased interest rates when a rise in the gap between real GDP and its trend was expected. Finally the smoothing parameter ρ implies that for a given change in the interest rate the proportion reflected in the rate in the same quarter is about 30% of the change. The above results do not suggest the presence of a monetary policy with an institutional commitment to achieve low and stables rates of inflation. The monetary authorities seem to accommodate shocks rather than to stabilise the economy. To explore further this issue the following sections consider additional variables in the baseline equation that might influence the process through which interest rate is determined.

Table 4a.
Monetary Policy Rule: Augmented estimation[1]
Israel: 1988-2001

	α	β	γ	φ_1	φ_2	ρ	*J-test*
Baseline	7.91* (6.32)	0.78* (6.79)	0.76 (0.02)	---	---	0.84* (46.34)	9.74 (0.78)
Backward-looking	9.85* (17.86)	0.49* (4.64)	46.41* (2.63)	0.32* (2.73)	---	0.72* (29.48)	10.79 (0.93)
Money growth	9.45* (9.87)	0.79* (10.29)	12.50 (0.51)	0.10^ (1.91)	---	0.74* (26.41)	9.17 (0.86)
Depreciation rate (Case 1)	7.03* (7.45)	0.72* (7.98)	37.55 (0.99)	0.55* (2.77)	---	0.84* (66.56)	11.24 (0.91)
Depreciation rate (Case 2)	10.38* (9.19)	0.66* (8.79)	164.11* (4.02)	0.01 (0.03)	0.93* (3.27)	0.75* (22.47)	9.77 (0.94)
Money & Dep. rate[2]	6.94* (6.52)	0.67* (8.22)	46.37 (1.15)	0.12 (1.38)	0.63* (3.22)	0.86* (58.65)	10.38 (0.92)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
2 The value of the parameter for the inclusion of money and the depreciation rate are the ones for φ_1 and φ_2 respectively.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

Money and the exchange rate

In this section the inclusion of money and the exchange rate is tested in the augmented policy rule. In the former case, the variable z_t in the augmented interest

rate rule is defined as the quarterly variation (first log difference) of the monetary base (Δm_t).[31] Theoretically, the rate at which *m* expands should be in line with that of nominal GDP growth, i.e., expected or potential real GDP plus the inflation target. Thus if this aggregate expands too rapidly it implies upward pressure on the future inflation rate, so that the future inflation rate may overshoot the target and therefore an increase in the interest rate is expected. As in the baseline model the parameter β is statistically less than one and the parameter γ is positive but statistically not significant. Parameter φ is positive and statistically different from zero at the 10 percent level of significance (See table 4a). Similarly, in the second case, z_t is computed as the quarterly variation of the nominal exchange rate expressed in NIS per dollar (Δer_t). An increase means depreciation and vice versa. As discussed, inflation targets in Israel coexist with another nominal policy commitment, namely the crawling exchange rate band for the NIS (new Israeli shekel) against a basket of foreign currencies. This issue makes particularly interesting the evaluation of the role of the exchange rate in this country where the authorities have underline its priority to price stability in case of conflict.[32] The results presented in table 4a (case 1) suggest that monetary authorities increase rates when the exchange rate depreciates. Differently from the case of Mexico, not just the current but also lagged values of the change in the nominal exchange rate are considered in the augmented policy rule:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\varphi_1 \cdot z_t + (1-\rho)\varphi_2 \cdot z_{t-1} + \rho \cdot r_{t-1} + \varepsilon_t \qquad (15)$$

If shocks to the exchange rate are large and persistent and the central bank places a higher weight on exchange rate stability we would expect significant positive coefficients on both current and lagged values of the depreciation rate. The results presented in table 4a provide evidence on central bank reaction to exchange rate movements. They indicate a high degree of persistence of exchange rate shocks in this country. Furthermore it seems that the interest rate response to the exchange rate exceeds that for the inflation rate. In both cases, the parameter φ is statistically

[31] Empirical studies undertaken in the Bank of Israel (Weitzman Nagar, Bank of Israel) have shown that in the case of Israel the M1 monetary aggregate (cash in the hands of the public and current accounts) is a better predictor of the development of inflation in the future than other monetary and credit aggregates.

[32] In fact, since mid 1997 there has been a gradual widening of the currency band, which has been considered as having a floating exchange regime (within the confines of the band).

different from zero and positive. This result shows that both variables have a positive effect on the determination of interest rates in Israel. A third specification of the augmented monetary policy rule combines money and the exchange rate as variables z_{1t} and z_{2t} respectively. Results in the last row of table 4a confirm previous findings, particularly regarding the value of β, which remains statistically less than one.

Current account, foreign reserves and lending boom indicator

As in the case of Mexico, three more variables are considered as potential indicators for external crisis: foreign reserves, a lending boom indicator and the current account deficit. The inclusion of these variables in the objective function of a central bank is expected to influence notably the formulation of monetary policy. Results reported in table 4b show that with the exception of the lending boom indicator the estimated coefficients are statistically significant and with the expected signs. Parameter β remains statistically less than one suggesting either that the authorities just accommodate expected shocks to inflation or the presence of secondary objectives besides the achievement of a gradual reduction of inflation. Regarding the interest rate smoothing coefficient this reflects a high degree of persistence where actual interest rate adjusts relatively slowly. On average eighty percent of the level of the short-term interest rate is explained by its lagged value. The dynamic augmented policy rules presented in fig. 4 seem to follow the direction of actual interest rates. However, the performance is quite similar to the one observed from the baseline equation. These results suggest that the inclusion of the above variables may not be a better approximation than the baseline specification to how interest rates are determined by the monetary authorities in Israel.

In order to look for any possible change in the way monetary policy is performed after the adoption of inflation targets, the baseline equation for the sample period 1992Q1-2001Q4 is estimated. The results are shown in table 5. As in the case of the whole period, estimations for the baseline equation, backward-looking specification and augmented monetary policy rules are presented. All variables are statistically significant at the one-percent level and have the expected signs. The coefficient associated to inflation is in all cases significantly less than one, suggesting that the authorities, during this period, tended to accommodate expected shocks to inflation.

On average, the value of parameter β is smaller in comparison with the one in the whole sample period. The partial adjustment coefficient also shows that during this period the movements of the short interest rate are less persistent than in the whole period. On average almost sixty percent of the desired adjustment in the observed interest rates is obtained in one quarter. Regarding the coefficient of the output gap this is statistically different from zero in all cases. This finding suggests a significant contribution of the output gap to the process through which interest rates are determined.

Table 4b.
Monetary Policy Rule: Augmented estimation[1]
Israel: 1988-2001

	α	β	γ	φ	ρ	*J-test*
Foreign assets	7.64* (9.35)	0.82* (13.25)	38.56 (1.43)	0.11* (2.35)	0.83* (46.97)	11.06 (0.85)
Lending boom indicator	36.09 (1.52)	0.67* (5.24)	81.14* (3.87)	−10.74 (1.14)	0.81* (56.31)	11.53 (0.97)
Current Account	9.12* (11.60)	0.91* (14.17)	10.18 (0.47)	0.002* (3.35)	0.75* (32.14)	10.39 (0.88)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

Figure 4.
Actual interest rate vs. dynamic 'interest rate rule'
Foreign reserves and current account

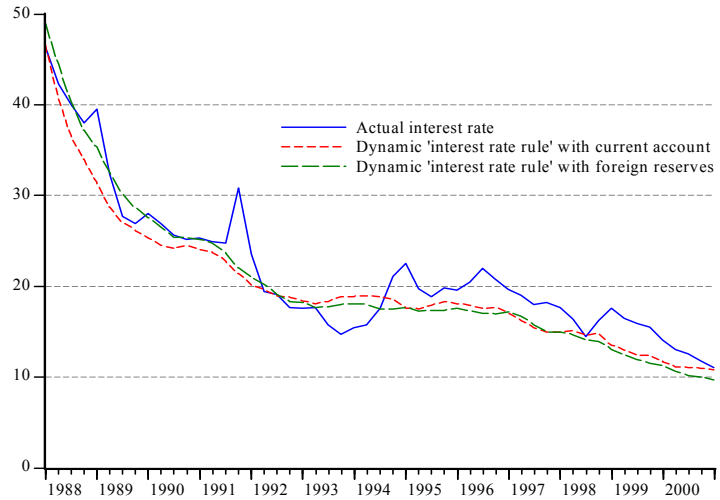


Table 5.
Monetary Policy Rules[1]
Israel: 1992-2001

	α	β	γ	φ_1	φ_2	ρ	*J-test*
Baseline	11.84* (42.36)	0.58* (18.64)	43.63* (5.26)	---	---	0.45* (16.76)	7.92 (0.89)
Backward-looking	12.28* (31.51)	0.23* (4.45)	12.42* (2.71)	0.34* (7.01)	---	0.32* (8.52)	7.53 (0.87)
Money growth	11.72* (23.81)	0.64* (8.66)	25.42* (2.60)	0.06* (2.44)	---	0.46* (18.64)	7.78 (0.93)
Depreciation rate	12.08* (49.36)	0.22* (6.79)	38.23* (5.83)	0.42* (13.91)	0.22* (2.82)	0.56* (41.07)	8.58 (0.96)
Foreign assets	13.69* (51.55)	0.39* (9.78)	146.35* (20.05)	0.12* (5.50)	---	0.33* (22.58)	8.14 (0.96)
Current account	12.43* (24.45)	0.52* (9.87)	29.78* (6.61)	0.00 (0.82)	---	0.45* (18.44)	8.70 (0.94)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

4.2.2 Gap Model

An alternative version of the baseline model is estimated where actual values of the explanatory variables are replaced by their deviations from trend values. The Hodrick-Prescott filter is used to measure the trend values as in the case of Mexico. The results using a two-quarter lead for the inflation gap are presented in table 6. Certain remarks should be made. Replacing the values from the baseline model by their respective deviations from trend values does not significantly improve the fit. Moreover the degree of interest rate smoothing remains particularly high. This finding reflects the concern of the authorities to adjust interest rates by small steps. On average ninety percent of the level of the short-term interest rate is explained by its lagged value. Concerning the values of parameters β and γ, however, different conclusions can be drawn. The value of the parameter β turns out to be statistically significant and greater than one while in most of the cases the parameter associated to the output gap has the unexpected sign and it is statistically insignificant. These results suggest that the central bank in Israel does not accommodate inflation pressures as it was suggested in the previous estimations. It seems that monetary policy has effectively stabilised the economy. In so far output stabilisation is concerned, the evidence is mixed. The baseline model suggests that in some cases monetary authorities gave some weight to

economic fluctuations whereas the gap model suggests that this is not the case. Regarding the results from the augmented policy rules, the signs of all estimated parameters are the expected ones and statistically significant. The only exception is when the current account deficit is considered.

Table 6.
Gap model : Baseline and augmented policy rule [1]
Israel: 1988-2002

	α	β	γ	φ_1	ρ	*J-test*
Baseline	11.45* (9.02)	2.72* (3.37)	−171.8* (−3.45)	---	0.90* (180.5)	10.09 (0.86)
Backward-looking	9.97* (4.57)	9.08* (7.98)	15.41 (0.22)	1.81* (4.38)	0.92* (121.1)	8.98 (0.87)
Money growth (GR)	4.39 (1.54)	7.55* (5.63)	34.48 (0.61)	0.62* (4.66)	0.88* (61.07)	8.09 (0.91)
Depreciation rate	10.52* (5.09)	3.58* (5.75)	−26.29* (−4.41)	0.003 (0.02)	0.91* (124.53)	10.23 (0.80)
Foreign assets (GR)	10.82.* (9.54)	2.14* (3.73)	−199.2* (−3.25)	0.07^ (1.94)	0.90* (165.41)	11.20 (0.92)
Lending boom indicator	4.34* (2.83)	5.23* (9.68)	262.9* (4.0)	406.9* (12.54)	0.87* (125.2)	12.02 (0.88)
Current account	8.50* (7.92)	5.35* (9.57)	−113.2* (−2.02)	−0.02* (−4.83)	0.91* (200.1)	10.81 (0.96)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

4.2.3 Inflation Targeting in Israel

To explore in more detail the previous results a third specification is considered. Expected rather than actual values for the inflation rate are used. In the case of Israel, the existence of market-based inflations expectations is available since 1992. In this sense the opportunity of comparing the results obtained from previous specifications is possible. Consequently, the inflation gap is calculated as the difference between expected inflation and the inflation target for the following four quarters. The results for the baseline equation, backward-looking specification and augmented monetary policy rules are presented in table 7. It is important to note that the forward-looking policy function confirms most findings of the gap model. Parameter β continues

above unity suggesting that Bank of Israel has been concerned with inflation stabilization. The coefficient of the output gap becomes significant and with the correct sign just when the lending-boom indicator is included in the estimation. The smoothing parameter decreases slightly in this period. On average 30 percent of the adjustment is achieved in the first quarter. The results from the inclusion of additional variables in the interest rate rule reflect the concern by the monetary authorities in aspects related to financial stability. Positive contributions are observed in all variables being the most significant the one from the lending boom indicator. Exceptions are the cases when the depreciation and the current account deficit are included. Notable are the results in the backward-looking estimation. Parameter φ is statistically significant and greater than one suggesting a significant contribution of the lagged value of inflation in the determination of interest rates in Israel. This finding does not support the idea of having a strong effect of forward-looking inflation expectations under an IT regime.

Table 7.
Forward-looking model :
Baseline and augmented policy rule [1]
Israel: 1993-2001

	α	β	γ	φ_1	ρ	*J-test*
Baseline	14.56* (48.56)	3.29* (12.39)	−37.83* (−3.27)	---	0.66* (22.69)	7.38 (0.96)
Backward-looking	8.74* (5.14)	4.32* (5.23)	−1162* (−3.55)	1.30* (5.45)	0.85* (27.56)	6.47 (0.97)
Money growth (Gap)	13.0* (28.58)	3.71* (9.26)	10.79 (1.08)	15.64* (2.07)	0.60* (18.41)	7.18 (0.95)
Depreciation rate	17.02* (71.12)	2.46* (14.91)	−86.38* (−7.17)	−0.83 (−8.63)	0.68* (36.30)	16.60 (0.96)
Foreign assets (GR)	14.73.* (85.41)	1.39* (21.16)	−19.98* (−6.52)	0.06* (11.58)	0.49* (14.76)	7.60 (0.99)
Lending boom indicator	12.98* (28.01)	3.13* (10.94)	126.1* (13.05)	406.9* (12.54)	0.80* (59.40)	7.22 (0.99)
Current account	15.17* (259.8)	1.63* (75.32)	−17.39* (−23.11)	−0.001* (−25.6)	0.70* (112.8)	8.54 (0.99)

1 The numbers in parenthesis are t-statistic values, except in the J-test column where they represent the 'p' value to reject the hypothesis that over-identifying restrictions hold.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

4.3 Comparison of the results

The evidence presented from the estimation of policy rules in terms of forward-looking rules can be analysed in terms of the three suggested alternative specifications and according to the set of variables proposed as an additional indicators to the basic specification. Overall, the evidence presented shows that Bank of Mexico has been acting according to IT principles where monetary policy has performed the role of the nominal anchor of the economy. This performance becomes clearer when inflation expectations are included in the estimations. In this case not only inflation deviations from its target but also output deviations from its trend are considered at the time interest rates are set. The Bank of Israel, on the other hand, does not seem to have a clear commitment to stabilise inflation when the rate of inflation rather than its deviation from some trend/target value is used. In other words, the respond in nominal interest rates is not sufficient to induce the real interest rate to rise to stabilise the economy. This is no the case however when output deviations from its trend take place. The results suggest that the monetary authorities gave some weight to economic fluctuations especially after the announcement of a crawling exchange rate band at the end of 1991. In contrast, when the results from both the gap and the forward-looking specifications are considered some sign reversals are observed. The value of the parameter β turns out to be statistically significant and greater than one while in most of the cases the parameter associated to the output gap has the unexpected sign and it is statistically insignificant. These findings suggest that the central bank in Israel has effectively stabilised the economy rather than just accommodate inflation pressures when deviations of inflation from its trend or its target value are perceived.

Concerning the smoother parameter ρ, this remains practically the same in all specifications for the case of Israel. Its high value suggests not only considerable interest rate inertia but also that the central bank is concerned about smoothing adjustments. Its value decreases slightly when estimations are carried out from 1992 onwards. In the case of Mexico, the shorter the sample period, the lower the estimated parameter of the partial adjustment process for interest rates. This may reflect the gains in terms of policy credibility which makes the monetary policy stance more effective. Backward-looking component

The inclusion of the change in the nominal exchange rate in the interest rate reaction function is particular interesting in this study due to different stance in each country regarding this issue. In the case of Mexico, this coefficient is always with the expected sign and statistically different from zero. However, its inclusion changes significantly the size of the β coefficient which seems to indicate that part of the information enclosed in the former variable is already incorporated in the inflation and output gap. In the forward-looking model, its value is marginally significant and parameter β continues statistically greater than one. This is a remarkable result in the context of a floating exchange rate where the central bank seems to react to effectively maintain price stability instead to defend a specific level of the exchange rate. In Israel the results are mixed. Using the inflation rate in the estimations the results indicate not only that the central bank reacts to changes in the exchange rate but also that this response exceeds that from the inflation rate. This finding however is not clear in the forward-looking specification where the coefficient of the exchange rate becomes insignificant. On the whole, the contribution of the depreciation rate decreases significantly at the time a more flexible exchange rate policy is in place.

The inclusion of additional variables in the policy rule seems to contribute to the process through which interest rates are determined in Israel and Mexico. Similar conclusions can be drawn from the experience of both countries regarding the lending-boom indicator. While this is not significant in the baseline model its contribution becomes considerable either in the gap and the forward-looking specifications. Similar performance is observed considering the foreign reserves. Concerning the value of the parameter when the current account deficit is taken into account this is insignificant in most of the cases or with the unexpected sign. Finally, interest rates in Mexico appear to respond more in a forward than in a backward–looking manner particularly after 1995 when most of the requirements to adopt IT were put into practice. In Israel a significant contribution of the lagged value of inflation is observed.

5. Conclusions

This study analyses the main determinants of monetary policy in two emerging economies: Mexico and Israel. To address this issue interest rate reaction functions of the form introduced by Taylor (1993) and extended by Clarida *et al*. (1998), in terms of forward-looking rules, are estimated. The analysis identifies a set of variables that, combined with the basic specification offer a good approximation to the process through which interest rates are determined. It is important to note however that although optimal reactions functions are estimated, these are not necessarily the best policy for day-to-day policy-making. Setting interest rates resemble a rule-like behaviour and any model, by definition, is an incomplete description of reality.

In Mexico, the evidence presented shows that monetary policy has performed the role of the nominal anchor of the economy ($\beta>1$). This implies a central bank stabilising the economy when inflationary pressures are identified rather than just accommodating them. The results are more evident after the implementation of IT. In addition an augmented monetary policy rule that includes not only inflation and the output gap but also variables such as foreign reserves or a lending-boom indicator offer a good approximation to the process through which interest rates are determined in this country. The inclusion of these variables may be a good indicator for external disturbances. The case of Mexico suggests that even with a flexible exchange rate regime it is feasible to reduce inflation when an appropriate monetary policy is adopted. In the case of Israel, the evidence presented regarding the stance of monetary policy is not as clear as in the case of Mexico. The coexistence of a crawling exchange rate band with the adoption of inflation targeting principles seems to make the conduct of monetary policy more challenging than otherwise. On the whole, the results indicate high degree of persistence of exchange rate shocks in this country although a decrease is observed at the time a more flexible exchange rate policy is in place. In addition a significant contribution of the lagged value of inflation in the determination of interest rates is found. As in the case of Mexico, the inclusion of additional variables in the monetary policy rule seems to be a good indicator for external disturbances. Overall, it can be said that although both countries have achieved lower and more stable levels of inflation, the exchange rate policy adopted in each country seems to play an important role in this process.

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Appendix

Table A1.
Selected studies on monetary policy rules*

Distinguishing features	Author(s)	Method
I. Additional Variables		
Backward-looking component	Clarida, et. al. (1998,2000) Mehra (1999) Leiderman & Bar-Or (2000) Torres (2002)	Generalised Method of Moments (GMM)
Nominal exchange rate	Taylor (2001) Aron and Muellbauer (2002) Torres (2002)	
Unemployment rate	Clarida, et. al. (1998) Corbo (2002) Eleftheriou (2003)	Generalised Method of Moments (GMM)
Money supply	Clarida, et. al. (1998) Mehra (1999) Torres (2002)	Generalised Method of Moments (GMM)
Real exchange rate	Kamin & Rogers (1996) Clarida, et. al. (1998) Ball (1999) Corbo (2002) Torres (2002) Mohanty & Klau (2003)	
Foreign interest rates	Taylor (1993) Clarida, et. al. (1998) Aron and Muellbauer (2002) Corbo (2002) Torres (2002)	
Foreign reserves	Kamin & Rogers (1996)	
Current account	Aron and Muellbauer (2002) Corbo (2002) Medina & Vales (2002)	
II. Forward-looking rules	Taylor (1993) Clarida, et. al. (1998, 2000) Mehra (1999) Leiderman & Bar-Or (2000) Aron and Muellbauer (2002) Corbo (2002) Torres (2002) Eleftheriou (2003) Mohanty & Klau (2003)	Generalised Method of Moments (GMM)

(*) Most of the studies are base on the rule proposed by Taylor (1993).

Table A2.
Results of Unit Root Tests
Case of Mexico

	ADF Test [a]		
Variables	Number of lags	ADF statistic	
IR^	0	-2.872	I(1)
INF	5	-3.592	I(0)
GAP	4	-4.907	I(0)
DEP	0	-6.801	I(0)
MG	2	-7.042	I(0)
FA	0	-6.433	I(0)
FDI	0	-7.255	I(0)
CA	1	-7.163	I(0)

The null hypothesis is that the series is I(1).
(a) The critical values for rejection are –3.467 at a significant level of 5% for models with a linear trend and constant.
(^) Applying the unit root test for short samples there is strong evidence of stationarity.
All variables are computed in growth rates except for the interest rate.

Table A3.
Results of Unit Root Tests
Case of Israel

	ADF Test [a]		
Variables	Number of lags	ADF statistic	
IR	0[c]	-4.601	I(0)
INF	1[c]	-8.662	I(0)
GAP	0[c]	-4.867	I(0)
DEP	0[c]	-8.201	I(0)
MG	2[c]	-8.849	I(0)
FA	0[c]	-6.519	I(0)
FDI	0[c]	-9.312	I(0)
CA	0[c]	-6.326	I(0)

The null hypothesis is that the series is I(1).
(a) The critical values for rejection are –3.497 at a significant level of 5% for models with a linear trend and constant.
All variables are computed in growth rates except for the interest rate.