Inflation Targeting in Emerging Economies: An Empirical Assessment

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To my beloved parents:

Rebeca and Antonio

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ABSTRACT

This doctoral thesis consists of three chapters which are focused on the analysis of monetary policy in emerging economies. In particular, Chapter 2 measures the output cost of disinflation; namely, the sacrifice ratio (SR) for emerging economies with and without Inflation Targeting (IT). Three alternative approaches are adopted: first, disinflationary episodes are identified for individual countries. Second, aggregate supply curves are estimated. Third, a structural VAR model is employed. The results suggest that for countries where the process of disinflation has been accompanied by the implementation of IT, lower and more stable levels of inflation can be achieved. Furthermore, sacrifice ratios have increased as the level of inflation decreases. In Chapter 3, the main determinants of monetary policy in Mexico and Israel are analysed. To this end, reaction functions for each country in terms of forward-looking rules are estimated. The results generally suggest that when setting monetary policy, central banks in these countries look beyond just inflation and output. Moreover, 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. Chapter 4 investigates the impact of exchange rate behaviour on domestic investment in the Mexican Manufacturing Industry within the context of IT. Standard investment equations are utilised to analyse the role of the level and volatility of exchange rates on investment. The results support the view that a depreciation of the exchange rate has a positive effect through the export channel. Volatility also matters and its effect is mainly observed in those sectors that rely more on exports. Differences are observed within different competitive markets.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 2

Appendices Chapter 2

Chapter 3

Appendices Chapter 3

Chapter 4

LIST OF FIGURES

Chapter 2

Appendices Chapter 2

Chapter 3

Chapter 4

Appendices Chapter 2

CHAPTER ONE

INTRODUCTION

Nowadays, there is a general consensus among policy makers to achieve price stability. By pursuing a strategy that ensures that inflation does not distort decisions that concern investment, production and savings; monetary policy is able to lead to sustainable improvements in living standards. In this respect, Inflation Targeting (IT) has emerged, in recent years, as the leading framework for monetary policy conducted around the world. Inflation Targeting means that monetary authorities explicitly specify an inflation target and establish precise institutional arrangements to reach it. There is a growing literature looking at IT from different perspectives such as the rationale for inflation targeting (see Blejer *et al.*, 2000; Fry *et al.*, 2000; Mahadeva and Sterne, 2000), implementation issues (see Bogdanski *et al.*, 2000; Morande and Schmidt-Hebbel, 2000) and IT as an alternative to monetary and exchange rate anchors (see Bernanke *et al.*, 1999; Cecchetti and Erhmann, 1999). Few studies however consider the performance of IT in the increasing number of emerging economies adopting this framework which differs in several respects from their industrialised counterparts.

Emerging economies have implemented IT, mainly as a means of balancing the uncertainties of their external economic environment, predominantly the behaviour of the exchange rate. Inflation has decreased, central banks have become more independent, fiscal deficits have become more manageable and capital mobility has increased (see Schaechter *et al.*, 2000). The experience of these countries with IT, however, is very recent and therefore there are no conclusive results. This thesis attempts to contribute to the aforementioned literature by providing new evidence on the effectiveness of IT in emerging economies. To address this aim, this research encompasses three main objectives. First, it evaluates how costly the disinflation process has been during the transition to a fully-fledged IT in emerging economies. This is an important feature in the experience of these countries, which differs from industrialised ones, where disinflation has largely been completed by the time of the IT adoption. Moreover, this issue involves the selection of the starting date for the adoption, which constitutes one of the main debates in emerging economies. In this respect, the key elements of the framework that can determine the starting date, such as the abandonment or broad widening of an exchange rate band, are considered.

Second, the alternative of incorporating additional variables to the traditional central bank reaction function is examined. In particular, a forward-looking version of the Taylor rule is considered. This specification allows us to evaluate the central bank response to inflation and output under IT principles, but also to incorporate other macroeconomic variables. In particular, variables that may be a good indicator for economic disturbances are considered. This is mainly the common feature of emerging economies facing more financial and currency crises. The experience of two emerging economies adopting IT; Israel and Mexico, is evaluated. These countries have followed similar procedures to achieve moderate levels of inflation. However, the different approach towards the exchange rate policy seems to play an important role in the whole process. This is particularly interesting in the context of inflation targeting, where an institutional commitment to price stability is the primary goal of monetary policy.

Third, the effects of movements of exchange rates on investment decisions are investigated. Central banks in emerging economies aim to ensure that exchange rate movements do not destabilise inflation expectations or domestic financial market. Very little attention, however, has been paid to the impact of exchange rate movements on the real economy in the context of IT principles. In this respect, our third objective deals with the case of Mexico which offers the possibility of evaluating how fluctuations in the exchange rate have affected investment decisions during the transition of the economy to a fully-fledged IT system.

This thesis consists of three empirical chapters. These chapters are focused on the experience of emerging economies in areas particularly related to monetary policy, exchange rates and investment decisions, where the existing literature is still scarce and the results generally ambiguous. Different methodologies, estimations and econometric methods are used, varying from macroeconomic and time-series procedures to microeconomic and panel-data techniques. In the following a brief summary of each chapter is given.

In chapter 2, we compare the effectiveness of anti-inflationary monetary policies of 11 emerging economies in Latin America, Asia and Africa, as case studies, and reports on the benefits of an IT policy. These countries are Brazil, Chile, Israel, Mexico, Nigeria, the Philippines, South Africa, South Korea, Turkey, Uruguay and Venezuela. The countries are divided into two groups according to whether they adopted IT and the sacrifice ratio (the output cost of disinflation) for each group is computed. In assessing the impact of IT in these economies, three alternative measures of sacrifice ratios are used, in order to overcome any possible shortcomings of each approach. First, disinflationary episodes for individual countries are identified (see Ball, 1994). Then the sacrifice ratio is calculated, as the cumulative deviation of output from its equilibrium level divided by the permanent decline in inflation. The results suggest that among the countries with IT, the sacrifice ratio amounted to an average of 2.8, whereas it was 3.6 percent for non-IT countries. The second alternative calculates sacrifice ratios from the estimation of simple aggregate supply curves using ordinary least squares (OLS). Regressions are computed for each country and the implied sacrifice ratios are reported. The results are mixed, suggesting different patterns according to the short and long-run average estimates. The last approach uses a structural vector autoregressive (VAR) model, to evaluate the quantitative impact of a shift in policy on output and inflation (see Cecchetti and Rich, 2001). The results can be interpreted as the cumulative output loss, corresponding to a permanent one-percentage point decline in the rate of inflation. The findings suggest relatively constant values as the horizon lengthens for all countries. On average, however, the estimated values are higher in those countries without inflation targeting. Overall the empirical evidence suggests that emerging economies with IT, have a better ability to achieve lower and stable levels of inflation. Nonetheless, the implementation of this monetary policy regime has been accompanied by other important structural and institutional developments, which have not been considered in this chapter.

Chapter 3 evaluates the experience of Israel and Mexico which have implemented inflation targeting under similar circumstances with a different stance concerning the exchange rate policy. In this respect, it analyses interest rate rules to evaluate the main determinants of monetary policy in these two countries. In particular, 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. Our baseline model offers a reasonably good description of the way major central banks have performed recently, and also allows us to evaluate the role of other variables, rather than just the output gap and inflation rate. These additional variables have been considered as important indicators in recent crises (see Kaminsky and Reinhart, 1996) and include changes in the exchange rate, money growth, foreign reserves, a lending boom indicator and the current account deficit. The model is estimated using the generalised method of moments.

The findings on Mexico suggest that the Central Bank has been acting accordingly to IT principles with monetary policy performing the role of the nominal anchor of the economy. Furthermore, the inclusion of additional variables in the baseline interest-rate rule seems to contribute to the process through which interest rates are determined in Mexico. Special attention has been paid to the contribution of changes in the exchange rate, which has decreased significantly with the adoption of a flexible exchange rate regime. Conversely, in the case of Israel, the evidence is not as clear. The results indicate that the central bank reacts to changes in the exchange rate, and in some cases this response exceeds that of inflation. A significant contribution of lag values of inflation is also observed. 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. 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.

Exchange rate matters, potentially for any economy but, particularly for emerging economies with relatively low incomes and histories of higher inflation. The last chapter focuses on the role of the exchange rate within an IT regime from a microeconomic perspective. The exchange rate influences the economy in two principal ways. Firstly and most directly, exchange rates can influence inflation through the prices of traded final goods and imported intermediated goods and through their impact on inflation expectations. Imported goods are both purchased by consumers and used as inputs in the production process. When there is a depreciation of the exchanger rate, the prices of imported consumption goods increase, directly raising the consumers' price index. The prices of imported intermediate inputs also rise, raising firms' production costs. Higher production costs also tend to end up in higher consumer prices, as firms attempt to pass on their higher costs to consumers through higher prices for their final product. Secondly, the exchange rate affects the competitiveness of domestic goods in world markets and therefore the level of aggregate demand in the economy. In other words, the level of real exchange rate influences world demand for domestically produced goods, as both foreign and domestic consumers substitute cheaper foreign products for more expensive domestic ones. Falling domestic demand decreases pressure on prices to rise and may even lead to falling prices.

A large body of empirical research deals with the implications of exchange rate movements for the real economy. Nevertheless, the majority of these studies have been focused on macroeconomic comparisons or country-level evidence for industrialised countries with little attention to the effect that flexible exchange rates may have in emerging economies. Moreover, this aspect has not been fully considered in the context of IT principles. The exchange rate becomes important under any policy regime that cares about inflation but turns out to be particularly relevant when inflation is the key goal. The case of Mexico offers the possibility to evaluate how fluctuations in the exchange rate have affected investment decisions during the transition of the economy to a fully-fledged IT system.

Chapter 4 focuses on the role of the exchange rate and its influence on investment decisions. Few studies have been conducted using industry or firm-level data to analyse the impact of exchange rate fluctuations on the performance of the economy. This chapter concentrates on the effects of movements of exchange rates on domestic investment. In particular, standard investment equations are evaluated, to assess the relationship between investment and exchange rates in the Mexican Manufacturing Industry. The Mexican economy went essentially from a fixed exchange rate regime, during the 1980s and first half of the 1990s, to a floating exchange rate regime after the mid-1990s. Moreover, the adoption of this flexible exchange rate regime coincides with the implementation of important economic reforms, such as IT principles, as a result of a severe crisis at the end of 1994. Therefore, special attention is paid to the post-crisis period. The empirical evidence form the panel data estimations suggests that movements in exchange rates have influenced investment decisions in Mexico. The results highlight the importance of considering exchange rate variability. The level of the exchange rates but also the volatility matters for investment decisions in the Mexican Manufacturing Industry. In addition, the investment equations incorporate revenue and cost exposure measures and consider the importance of market structures into the investment-exchange rate link. A depreciation of the exchange rate stimulates investment through the revenue or export channel. Volatility, on the other hand, has a negative impact on investment in exported-oriented sectors and a positive one in industries that rely more on intermediary-imported inputs. These results, however, are statistically significant primarily in those sectors with export exposure. The empirical evidence also suggests discrepancies when different competitive market structures are introduced. The sensitivity of investment to exchange rate movements is stronger in those sectors with weaker market power.

The last chapter of this thesis, Chapter 5, presents the conclusions. It provides a discussion of the overall findings as well as avenues for future research.

CHAPTER TWO

Inflation Targeting in Emerging Economies: A Comparative Sacrifice Ratio Analysis*

2.1. Introduction

In recent years, many central banks have not only pursued explicit inflation targets but they have also implemented Inflation Targeting (IT) as their new monetary policy regime (see Mahadeva and Sterne, 2000). The aim of inflation targeting is to contain inflationary expectations and enhance accountability regarding monetary policy by making a numerical target a medium-term objective (see Bernanke *et al.*, 1999). The performance of IT around the world has been positive. Average inflation rates in both emerging economies and industrialised countries are substantially lower after the adoption of this regime. Nonetheless, differences in the implementation of IT in emerging economies can be identified (see Schaechter *et al.*, 2000). This chapter focuses on the initial rate of inflation at the time IT is adopted and the transition towards a fully-fledged IT regime. Most of these countries have started with high levels of inflation at the time they have announced

* Findings form this Chapter have been published in *Dynamic Models and their Applications in Emerging Markets*, ed. by Sima Motamen-Samadian, Palgrave, May, 2005. I am indebted to Miguel Angel Mendoza for encouraging me to continuing working on this topic and for his helpful comments. I also thank Wojciech Charemza, Panicos Demetriades, Anthony Garratt, Monica Hernandez, Ali al-Nowaihi, Robert W. Rich, Julio Santaella, George Saridakis, Alberto Torres, and seminar participants at the University of Leicester, Bank of Mexico, the 7th International Conference in Macroeconomics and Finance and the International Conference on Emerging Markets and Global Risk Management for their valuable comments and discussions.

inflation targets. Therefore, they have faced the challenge of disinflating to single-digit levels of inflation.

This chapter considers a sample of emerging economies with moderate and high levels of inflation that have followed different strategies for disinflation. These countries are divided according to the monetary policy regime under which they have attempted to reduce inflation. Therefore, the sample can be distinguished in two categories: (1) Countries that have adopted IT regime and (2) countries with another monetary policy framework. The main objective is to assess the effectiveness of IT by estimating sacrifice ratios using three alternative approaches. First, actual changes in inflation are compared with changes in standard measures of output (see Ball, 1994). Second, the sacrifice ratio is estimated using the Phillips curve approach to capture the output-inflation trade-off for a given time period. Third, following Cecchetti and Rich (2001) estimates of the sacrifice ratio are derived using a structural VAR model. A summary of the results shows that for countries where the process of disinflation has been accompanied by the adoption of IT, lower and more stable levels of inflation can be achieved. Sacrifice ratios in IT countries have increased as the level of inflation decreases. This finding highlights the importance of real and nominal rigidities at lower rates on inflation.

The structure of this chapter is as follows: Section 2.2 presents a brief review of the literature on IT on both industrialised and emerging economies. Section 2.3 describes the methodological approaches and data used. Section 2.4 discusses the empirical results and section 2.5 concludes.

2.2. Inflation Targeting: A Brief Overview

A vast amount of research on inflation targeting has been carried out in recent years, mainly for industrialised countries. These studies have examined a range of aspects of IT, such as the rationale for inflation targeting (e.g., Mishkin and Schmidt-Hebbel, 2002; Kuttner and Posen, 1999; Debelle, 1997; McCallum, 1996), implementation issues (e.g., Schaechter *et al.*, 2000; Bernanke and Mishkin, 1997; Haldane, 1995) and inflation targeting as an alternative to the use of monetary targets (e.g., Groeneveld *et at.*, 1998; Mishkin, 1997). However, the empirical findings on the effectiveness of IT remain unclear. Mishkin and Posen (1997) examine the experience of the first three industrialised countries to adopt IT; New Zealand, Canada and Sweden. They suggest that these countries have successfully maintained low inflation rates along with an improvement in the climate for economic growth. Similar conclusions arise from a study by McCallum (1996), who compared the inflation performance for New Zealand, Canada, Sweden and the United Kingdom, with an average of CPI inflation rates across 23 industrialised nations. The inflation rates in IT countries fell below the OCDE average after the implementation of this framework.

In contrast, there are a number of studies arguing that the performance of IT has not been clearly successful. Lee (1999), for example, examines whether regime effects, such as inflation reductions, have been associated with a global disinflationary environment rather than the implementation of IT. He found that the sustained reduction of inflation rates in targeting countries could have been achieved in the absence of IT. Lee's findings are based on the comparison between three IT countries (New Zealand, Canada, the United Kingdom) and three non-IT countries (Australia, the U.S., Germany). Another study by Groeneveld *et al.* (1998), which evaluates the success of inflation targeting in Canada, New Zealand and the United Kingdom, found similar results of inflation and interest rate instability, with a group of non-IT countries (the United States, Australia and Germany). In the same way, an earlier study by Laubach and Posen (1997) with a sample of eight industrialised countries threw doubt on the successfulness of IT. They evaluated whether inflation targeting achieves positive results with less cost in terms of output or in terms of maintainable expectations. Using sacrifice ratios and forecasts from Phillips curves, they suggest that disinflation under IT is not less costly than without it.

Turning to the case of emerging economies, a few studies have been carried out which make drawing conclusions difficult. Studies including those by Leiderman and Bufman (2000), Schaechter *et al.* (2000), Bogdanski *et al.* (2000) and Masson *et al.* (1998) mainly summarise the institutional and operational practicalities of inflation targeting without considering econometric specifications. The lack of substantial empirical work may be explained due to the recent adoption of IT by emerging economies. Therefore, the debate mainly focuses on technical issues regarding how IT should be practiced in emerging economies, and whether the existence of such a regime has been beneficial for these countries (see Fraga *et al.*, 2003; Reyes, 2004). Interestingly, Corbo *et al.* (2002, 2001) suggest that a large number of questions on the results of IT remain unanswered. Their investigation provides a wide empirical analysis on the rationale and consequences of adopting IT by comparing policies and outcomes in fully-fledged IT countries with two control groups of potential targeters and non-targeters. The empirical analysis is conducted for the 1980-99 period introducing three country groups. The first one includes countries that have had inflation targeting in place until 1995. The second one is composed of five emerging economies on their way to inflation targeting during the 1990s. The last one is composed of 10 industrial economies countries that are not inflation targeters. They reported that inflation persistence declined sharply among IT countries, suggesting that this regime played an important role in strengthening the effects of forward-looking expectations on inflation. Furthermore, they showed that output volatility had fallen in both emerging and industrialized economies after adopting inflation targeting.

In sum, the performance of inflation targeting has been mainly evaluated in industrialised countries and there is no conclusive evidence from those studies as regards whether IT has been effective in reducing inflation. Few studies have attempted to evaluate the experience of the increasing number of emerging economies implementing this framework. One way to measure the effectiveness of IT is to compare sacrifice ratios among countries or among different sample periods. In this respect, it is widely accepted by economists that lower inflation rates give rise to long-run benefits for society. However, there is also a strong belief that conducting monetary policy to slow down inflation involves some short-run cost in terms of loss in output, namely the *sacrifice ratio* (see Mayes and Chapple, 1995). Although there are a number of studies analysing the cost of disinflation (see Andersen and Washer, 1999; Hutchinson and Walsh, 1998), little information is known in the case of emerging economies. This chapter attempts to shed more light on this issue by estimating and comparing sacrifice ratios for eleven emerging economies with and without the adoption of IT during their process of achieving stable levels of inflation. Three alternative methods are used to estimate sacrifice ratios in order to compensate the possible shortcomings of each of them. [1] First, disinflationary episodes for individual countries are identified and the sacrifice ratio for each period is calculated (see Ball, 1994; Andersen, 1992). Second, Phillips curves are estimated to derive the output-inflation tradeoff (see Hutchinson and Walsh, 1998; Blanchard, 1984). Finally, following Cecchetti and Rich (2001) a structural vector autoregressive (VAR) model is considered. The following section discusses each approach from a more analytical perspective and the data used for this study.

2.3. Methods and Data Used

2.3.1. Methodology

2.3.1.1. Sacrifice Ratios during Episodes of Disinflation

Ball (1994) identified disinflationary episodes for individual countries and calculated the sacrifice ratio (SR) for each episode, as the cumulative deviation of output from its equilibrium level divided by the permanent decline in inflation.[2] The sacrifice ratio is interpreted as the cost of reducing inflation one point through an aggregate demand contraction. [3] More specifically, he defines trend inflation as a centred nine-quarter moving average of actual inflation. Then he identifies peaks as quarters in which trend inflation is higher than in the previous and the following four quarters. A trough is defined by an analogous comparison. A disinflation

1 Mayes and Chapple (1995) discuss in detail possible shortcomings using sacrifice ratios.

2 Ball (1994) examined all OECD countries for which trend inflation has stayed below 20% since 1960. He concludes that the sacrifice ratio is lower when disinflation is quick and when wage setting is more flexible.

3 However, a shortcoming of this method is that only shifts in demand affect inflation. There are no supply shocks.

episode is any period that starts at an inflation peak and ends at a trough with an annual inflation rate at least two points lower than the peak (see Ball, 1994). This method is relatively transparent, intuitive and one of the most frequently used. Cross-section studies, for example, commonly find that low inflation countries, or those with relatively independent central banks tend to have comparatively high sacrifice ratios (see Andersen and Wascher, 1999; Bernanke *et al.*, 1999; Sanchez *et al.* 1999; Laubach and Posen, 1997).

One of the main issues involved in using this approach is the measurement of the potential output. Standardised approaches in calculating trend output, such as the Hodrick Prescott (HP) filter, tend to minimise deviations from the trend that might understate or even eliminate recessions. To calculate the output losses associated with each disinflation episode the criteria used by Ball (1994) is adopted. Hence, the following three assumptions are considered:

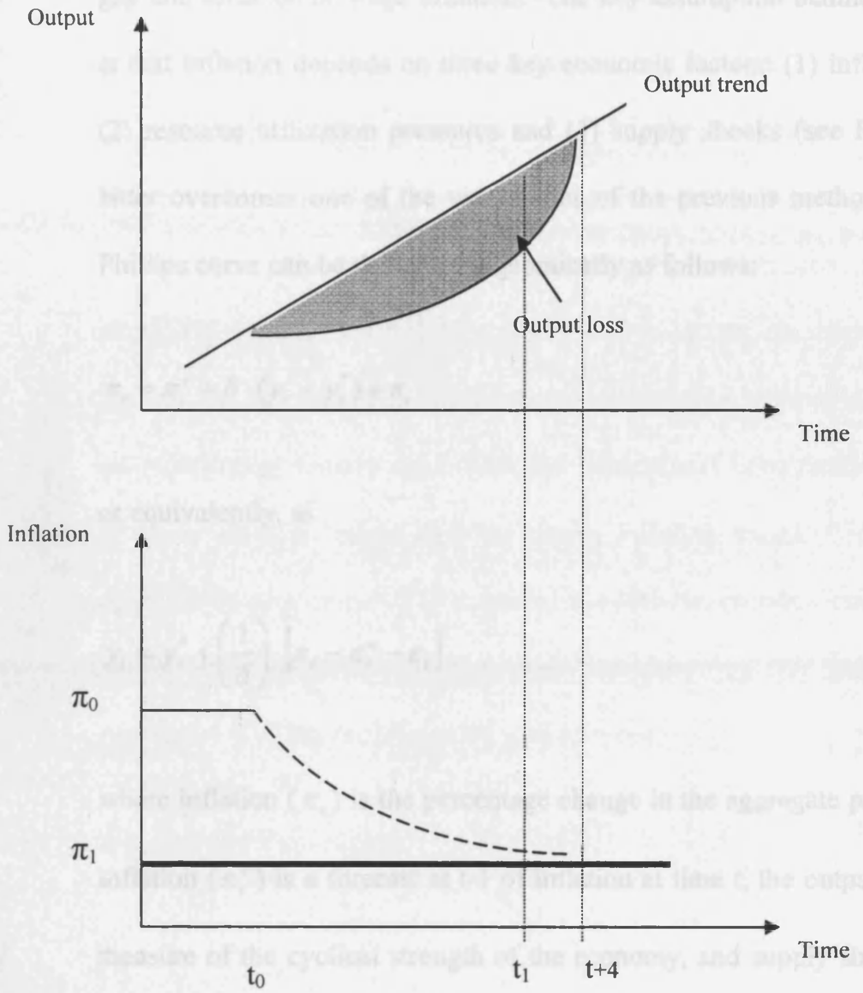
i) The output is at its potential level at the inflation peak.

ii) Output returns to its natural level one year after the end of the episode (i.e., four quarters after an inflation trough).

iii) Trend output grows log-linearly between the two points where actual and trend output is the same. Geometrically, trend output is the straight line connecting these two points (see Figure 2.1).

This methodology, however, depends upon assumptions about what constitutes a disinflation period and how to determine equilibrium levels. It also overlooks the impact of other policies on both output and inflation, including structural changes and exogenous shocks. Finally, this approach focuses entirely on disinflationary periods rather than on both disinflation and inflation episodes.

Figure 2.1.
Output Loss Associated with Disinflation



Source: Filardo, 1998

2.3.1.2. Sacrifice Ratios estimated from the Aggregate Supply Curve

An alternative technique used in the literature to estimate sacrifice ratios is based on the Phillips curve. This methodology, followed by Gordon and King (1982), Filardo (1998), Hutchinson and Walsh (1998) and Andersen and Washer (1999), among others, models the sacrifice ratio as the inverse of the slope of the Phillips curve. The Phillips curve represents the relationship between the output or unemployment gap and inflation or wage inflation.[4] The key assumption behind the Phillips curve is that inflation depends on three key economic factors: (1) inflation expectations, (2) resource utilization pressures and (3) supply shocks (see Filardo, 1998). The latter overcomes one of the weaknesses of the previous method. The basic linear Phillips curve can be described algebraically as follows:

$$\pi_t = \pi_t^e + \delta \cdot (y_t - y_t^*) + \varepsilon_t \tag{2.1}$$

or equivalently, as

$$y_t = y_t^* + \left(\frac{1}{\delta}\right) \cdot \left[\pi_t - \pi_t^e - \varepsilon_t\right] \tag{2.2}$$

where inflation (π_t) is the percentage change in the aggregate price level, expected inflation (π_t^e) is a forecast at t-1 of inflation at time t, the output gap ($y_t - y^*_t$) is a measure of the cyclical strength of the economy, and supply shocks (ε_t) are other factors that have temporary effects on inflation (through, for example, oil shocks and exchange rate changes). The coefficient δ which is expected to have a positive value ($0<\delta<1$), measures the sensitivity of inflation to changes in the output gap. In other words, δ is the trade-off between output and inflation. In this framework, monetary policy actions affect inflation through the output gap channel in the short

4 Phillips (1958) describes the relationship between wage inflation and unemployment, where there is a trade-off between unemployment deviations from its equilibrium value and wage inflation. For a more detailed discussion of the historical development of the Phillips curve see: Rudd and Whelan (2005), Razzak (2002), Mankiw (2001) and Ball *et al.* (1988).

run. That is, because δ is a positive number, an easing of monetary policy stimulates economic activity relative to its potential value (trend) causing inflation to rise, whereas a tightening of monetary policy has the opposite effect. In the long run, monetary policy works primarily through the expected inflation channel.

Disinflation should be less costly if the policy implemented is credible and clearly announced. Thus, a potential effect of inflation targeting would be to lower the sacrifice ratio by making monetary policy announcements more credible. However, as Andersen and Wascher (1999) point out, the importance of real and nominal rigidities must be taken into account at lower rates of inflation. In addition, an independent central bank with the institutional commitment to maintain low levels of inflation might shift the output inflation trade-off leading to a steeper aggregate supply curve. The expected sign for the sacrifice ratio then depends on which of these effects is the most important. In this study, the following specification of the Phillips curve is considered:

$$\Delta\pi_t = \sum_{i=1}^{k} \beta_i \Delta\pi_{t-i} + \sum_{i=0}^{k} \delta_i gap_{t-i} + \sum_{i=1}^{k} \gamma \Delta e_{t-1} + \varepsilon_t \qquad (2.3)$$

where π_t is the inflation rate, *gap* is the output gap, e_t is the nominal exchange rate, and ε_t is a random error term. All variables are in natural logarithms specified as annual growth rates. Expected inflation is calculated assuming some form of adaptive expectations mechanism where an average of past inflation rates is taken into account. The output gap is constructed following the Hodrick-Prescott procedure and the analysis is based on the primary assumption that within short samples all variables are stationary. It is worth mentioning however that over the sample period covered in this chapter and for most of the countries, the null hypothesis that the rate of inflation contains a unit root cannot be rejected (see Table 2.1A in the appendix). Therefore our specification uses changes in inflation.[5] An important consideration in the estimation of equation (2.3) is the addition of the exchange rate as a control variable.[6] The exchange rate is important not only under inflation targeting, but also for emerging economies that are more vulnerable to currency crises. Agenor (2000), for instance, suggests that the exchange rate is affected by interest rate differentials, foreign disturbances, and expectations of future exchange rates and risk premia that depend on domestic factors, such as the size of the domestic public debt and the degree of credibility of the monetary authorities.

The sacrifice ratio which is the output gap required to change inflation by one percentage point is simply the inverse of the coefficient of the gap $(1/\sum_{i=0}^{k}\delta_i)$.[7] In the long run, however, the sacrifice ratio depends on both the gap and the distribution of the lagged inflation coefficients. Therefore the sacrifice ratio is calculated as follows:

$$SR = \left(1-\sum_{i=1}^{k}\beta_i\right) \Big/ \sum_{i=0}^{k}\delta_i \qquad (2.4)$$

5 I would like to thank particularly Wojciech Charemza and Robert Rich for drawing attention to this issue.

6 It can be also argued that the (growth rate of) real import prices may be used as an alternative control variable for supply shocks. However, we do not have data available for all countries under the sample- period.

7 For example, if the model is estimated using quarterly data, with inflation measured at annual rates, then 4 x δ should be substituted for the parameter δ if what we want to estimate is the percentage of a year's output lost in reducing inflation by one percentage point (see Cozier and Wilkinson, 1991).

The above equation measures the output gap required to achieve a one percent reduction of inflation in the long run. It is worth noting the numerical value of the β_i coefficient in the Phillips curve equation. If the coefficient equals one, then the natural rate hypothesis is valid and there exists no long run trade-off for the policymakers to exploit.[8] But if the coefficient is less than one a long run trade-off exists. Under the assumption of (weak-form) rational expectations, the sum of the coefficients on past inflation depends on the inflation generation process and does not necessarily have to equal unity (see Humphrey, 1985, Cozier and Wilkinson, 1991, Cuñado and Perez de Gracia, 2003, Reyes, 2004).[9] Adaptive expectations are not entirely rational if other information besides past inflation can improve inflation predictions.

The estimation of Phillips curves is a natural approach for the task at hand since the concept of the sacrifice ratio in this case has a clearer meaning. Moreover, information on disinflationary episodes and also periods characterised by rising inflation are taken both into account. Finally, this approach offers the advantage to control for a variety of factors other than aggregate demands shifts that may influence the short-term behaviour of output and inflation. A shortcoming, however, is that the estimated sacrifice ratio is not varying over time. This mechanism constraint the output-inflation trade-off at the same level during disinflation

8 According to the natural rate hypothesis there is no permanent trade-off between unemployment (output) and inflation. In other words, there is no tradeoff when inflation is fully anticipated.

9 This assumption allows the estimation of long-run sacrifice ratios taking into account the expected inflation channel into the analysis. In the long run equilibrium, of course, expected inflation equals actual inflation.

episodes as in periods with increases in trend inflation and temporary fluctuations in demand (see Nadal-De Simone, 2001; Mayes and Chaple, 1995).[10]

2.3.1.3. Structural Estimates of the Sacrifice Ratio

Cecchetti and Rich (2001) used a structural VAR model of decomposing monetary policy into a systematic and a random component to identify changes in the stance of policy. They analyze the effect of recent disinflationary policies of the Fed on aggregate output in the U.S. economy. The evaluation of the sacrifice ratio focuses on unanticipated policy evaluation, in which the effects of a contractionary policy correspond to 'pure' (exogenous) monetary tightening rather than a systematic (endogenous) response to other shocks. The specific indicator measures the cumulative output loss after λ periods of a policy shock at time t, where the (persistent) shock is measured as the change in the level of inflation. Using an estimated structural VAR system, the dynamic responses of variables to a monetary-policy shock can be traced, and thereby allow assessment of the quantitative impact of a shift in policy on output and inflation. This approach has the advantage of measuring the sacrifice ratio over different time horizons.

In this chapter, the estimation of the sacrifice ratio follows a simple system that includes only output and inflation.[11] This allows a comparison of the results

10 The specification and estimation of a non-linear functional form of the Phillips curve constitutes one of the objectives of future research.

11 Cecchetti and Rich (2001) examined two other VAR models, a three-equation model of Shapiro and Watson (1988), which adds an equation in real interest rates and a four- equation model by Gali (1992). They suggest that the sacrifice ratios obtained from structural VAR models are highly sensitive to the size of the model and the identification restrictions imposed. Our analysis is restricted to the two-equation model in the interest of simplicity.

with those obtained from the previous techniques. The structural VAR model proposed to estimate the ratio is as follows:

$$\Delta y_t = \sum_{i=1}^{n} b_{11}^i \Delta y_{t-i} + b_{12}^0 \Delta \pi_t + \sum_{i=1}^{n} b_{12}^i \Delta \pi_{t-i} + \varepsilon_t^y$$

$$\Delta \pi_t = b_{21}^0 \Delta y_t + \sum_{i=1}^{n} b_{21}^i \Delta y_{t-i} + \sum_{i=1}^{n} b_{22}^i \Delta \pi_{t-i} + \varepsilon_t^\pi \qquad (2.5)$$

where y_t is the aggregate real output in period t and π_t is the rate of inflation from period t-1 to t. The innovations, $\varepsilon_t=[\varepsilon_t^y, \varepsilon_t^\pi]'$ are assumed to have mean zero, contemporaneous covariance matrix $E[\varepsilon_t, \varepsilon_t'] = \Omega$ for all t and to be strictly non-autocorrelated. Δ denotes the difference operator (1-L). Expression (2.5) can be also rewritten more conveniently as:

$$B(L)\begin{bmatrix} \Delta y_t \\ \Delta \pi_t \end{bmatrix} = \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^\pi \end{bmatrix} \qquad (2.6)$$

where $B(L)$ is a (2x2) matrix of polynomials in the lag operator. The components of the disturbance (innovation) vector ε_t are identified as shocks to aggregate supply and aggregate demand, respectively.[12] Estimations of the sacrifice ratio are based on the impact over time of structural shocks to output and inflation. To evaluate these magnitudes, the impulse responses of the system to structural shocks are calculated. To this end the vector moving average (VMA) representation of (2.5) is used:

12 There is an assumption concerning the use of the aggregate demand (AD) shock as a proxy for a monetary policy shock. Specifically, the assumption is either that the only source of AD shocks is monetary policy, or that the economy responds to monetary policy in the same way that it does to other demands shocks.

$$\begin{bmatrix} \Delta y_t \\ \Delta \pi_t \end{bmatrix} = \begin{bmatrix} \sum_{i=0}^{\infty} a_{11}^i \varepsilon_{t-i}^y + \sum_{i=0}^{\infty} a_{12}^i \varepsilon_{t-i}^\pi \\ \sum_{i=0}^{\infty} a_{21}^i \varepsilon_{t-1}^y + \sum_{i=0}^{\infty} a_{22}^i \varepsilon_{t-i}^\pi \end{bmatrix} = \begin{bmatrix} A_{11}(L) A_{12}(L) \\ A_{21}(L) A_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^\pi \end{bmatrix} \tag{2.7}$$

Specifically, for inflation, the sum of the first λ coefficients in $A_{22}(L)$ measures the effect of a monetary-policy shock on its level λ periods forward. In particular, the effect on the change in inflation λ periods later of a change in ε_t^π in period *t*, is a_{22}^λ. In the case of output, the sacrifice ratio requires consideration of the cumulative effect on its level resulting from a monetary policy shock. This quantity can be expressed as a function of the coefficients in $A_{12}(L)$. An estimate of the sacrifice ratio can then be computed, based on the structural impulse response functions from (2.7). Taken together, the relative impact of the monetary policy on output and inflation and hence the sacrifice ratio, over the time horizon λ, is just the ratio of these effects and can be calculated as follows:

$$SR_{\varepsilon^\pi}(\lambda) = \frac{\sum_{i=0}^{\lambda} \sum_{j=0}^{i} a_{12}^i}{\sum_{i=0}^{\lambda} a_{22}^i} \tag{2.8}$$

where

$$SR_{\varepsilon^\pi}(\lambda) = \left[\frac{\sum_{j=0}^{\lambda} (\partial y_{t+j} / \partial \varepsilon_t^\pi)}{(\partial \pi_{t+\lambda} / \partial \varepsilon_t^\pi)} \right] = \left[\frac{\left(\left\{ \sum_{i=0}^{0} a_{12}^i \right\} + \left\{ \sum_{i=0}^{1} a_{12}^i \right\} + \cdots + \left\{ \sum_{i=0}^{\lambda} a_{12}^i \right\} \right)}{\left\{ \sum_{i=0}^{\lambda} a_{22}^i \right\}} \right]$$

For a disinflationary monetary strategy undertaken at time *t*, the numerator measures the cumulative output loss through the first λ periods, while the denominator is the difference in the level of inflation λ periods later. The function SR(λ) is then examined over long periods to study the long-term effects of monetary policy, which can be seen as an advantage of using this approach.

2.3.2. Data

This study uses seasonally adjusted quarterly data from 1980 to 2002 on industrial production, consumer prices and nominal exchange rates. The data has been collected from the IMF's International Financial Statistics (IFS) and the corresponding Central Banks and/or National Institutes of Statistics. All the variables are expressed in natural logarithms and specified as annual growth rates. Output is measured by the Industrial Production Index (IPI) and inflation by the Consumer Price Index (CPI).

In the Phillips curve estimations, industrial production (IP) is used as an approximation of the output cost of inflation stabilisation due to the availability of the data. The estimated series are an approximation of the output gap between actual and potential output. The latter is calculated with a Hodrick-Prescott filter with a 1600 penalty parameter (recommended for quarterly data). The output gap variable is then measured as the logarithmic deviation of the output (IP) from the trend.[13] The unemployment gap can be also used as a proxy of excess demand pressures. The limitation of the data, however, does not allow us to test with this variable.

13 Estimations including the output growth instead of the output gap give similar results.

Figure 2.1A in the appendix present the development of the change in inflation and output gap. In the structural VAR analysis, on the other hand, output growth is measured as 100 times the difference in the log level of the output series while inflation rate is measured as 400 times the differences in the log levels of the price series. In order to have a stationary series, the inflation rate is differenced again, and then both series are de-meaned for the VAR estimation.

To conduct our empirical analysis a sample of eleven emerging economies, divided into two main groups is considered. The first group is comprised by six emerging economies - Brazil, Chile, Israel, Korea, Mexico and South Africa that have implemented IT. The second group includes five emerging economies - Nigeria, Philippines, Turkey, Uruguay and Venezuela with a different monetary policy framework. These countries were selected in an effort to cover a wide variety of macroeconomic experiences and inflationary histories. Table 2.1, for instance, shows the average, coefficients of variation, minimum and, maximum values of inflation of all countries. The diversity is remarkable: while Brazil has, in average, an inflation rate of around 594.60 percent, Korea's inflation rate is just 5.56%. These countries, however, have experienced severe currency pressures that have led either to the abandonment of currency pegs or to large depreciations well beyond what could reasonably have been expected. The response in terms of monetary policy has been in all cases to secure macroeconomic stability and to prevent a loss of confidence. In this respect, they have followed different strategies for disinflation and therefore they have incurred in different costs in terms of output.

Table 2.1.
Descriptive Statistics for Inflation
1980-2002

	Mean	Standard Dev.	Minimum	Maximum	Median	CoV*
Emerging Economies **with** IT						
South Africa	11.44	4.18	1.96	19.25	11.93	0.37
Korea	5.56	4.37	0.59	26.10	4.75	0.79
Mexico	40.82	39.49	4.75	177.44	25.32	0.97
Israel	59.53	103.51	0.00	464.54	15.75	1.74
Chile	13.96	8.76	2.20	35.50	12.92	0.63
Brazil	594.60	1109.77	1.81	6038.53	136.17	1.87
Emerging Economies **without** IT						
Nigeria	25.97	22.42	-2.64	87.88	18.06	0.86
Philippines	10.60	10.20	-2.80	55.82	8.43	0.96
Turkey	60.67	22.00	27.62	123.70	62.90	0.36
Uruguay	46.68	31.57	3.51	128.67	44.75	0.68
Venezuela	33.53	25.62	5.88	114.18	30.65	0.76

(*) Refers to the coefficient of variation (Standard deviation/mean).

Countries that have adopted inflation targeting believe they can improve the design and performance of monetary policy compared with conventional procedures followed by central banks (see Schaechter *et al.*, 2000). Table 2.2 summarises some of the main aspects that the countries in this study have followed since the adoption of inflation targets. One salient feature is the initial level of inflation at the time they adopted IT. Inflation is above stationary inflation rates. Hence, the disinflation strategies to achieve lower and more stable inflation are important for these countries.[14] On the other hand, the group of countries without IT principles has experienced periods of high and persistent inflation as well. They have adopted stabilisation programmes in order to reduce the level of inflation and achieve macroeconomic stability. Therefore, an important difference deals with the adoption of IT as a monetary policy regime to pursue the stabilisation of inflation.

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

Table 2.2.
Inflation Targeting: Emerging Market Economies

Country	Date introduced	Central Bank Legal Framework	Target Inflation Rate	Exchange rate policy	Main Objectives
Chile	Sep 1990* Sep 1999	Instrument independence Loans to government prohibited	1991: 18% 1992: 15-20% 1993:10-12% 1994: 9-11% 1995: 8% 1996: 6.5% 1997: 5.5% 1998: 4.5% 1999: 4.3% 2000: 3.5% 2001 onwards: 2-4%	Flexible Exchange rate Crawling peg before Sep. 1999	Currency stability as primary goal
Israel	Dec 1991* June 1997	Instrument independence Loans to government prohibited	1992: 14-15% 1993: 10% 1994: 8% 1995: 8-11% 1996: 8-10% 1997: 7-10% 1998: 7-10% 1999: 4.3% 2000: 3-4% 2001: 3-4%	Crawling exchange rate band	Multiple objectives Currency stability as primary goal
Brazil	June 1999	Instrument independence Loans to National Treasury prohibited	1999: 8% (± 2%) 2000: 6% (± 2%) 2001: 4% (± 2%)	Flexible exchange rate	Currency and price stability as main objectives
Korea	April 1998	Instrument independence	1998: 9% (± 1%) 1999: 3% (± 1%) 2000: 2.5% (± 1%) 2001: 3% (± 1%)	Flexible exchange rate	Price stability as main objective
Mexico	Dec 1994* Sep 1999	Instrument independence Loans to government prohibited	1995: 42% 1996: 20.5% 1997: 15% 1998: 12% 1999: 13% 2000: 10% 2001: 8.5% 2002: 4.5%	Flexible exchange rate	Price stability as primary goal
S. Africa	Feb. 2000	Instrument independence Loans to government prohibited	2002: 3-6%	Flexible exchange rate	Currency stability as primary goal

Sources: Central bank websites and publications; Bernanke, *et al.* (1999); Schaechter, *et al.* (2000).

2.4. Empirical Analysis

2.4.1. Empirical Results from Ball's Approach

Using the first approach the definition of trend inflation was slightly modified. This is estimated as the centred five-quarter moving average of actual inflation instead of the nine-quarter moving average as in Ball (1994). By shortening the range of the moving average procedure, a less smoothened inflation trend in which disinflation can be seen more clearly is found.[15] To measure the output gap Ball's assumptions are adopted (see section 2.3.1.1). Particularly, the output is assumed to be at its potential level at the inflation peak and four quarters after an inflation trough, and it is also assumed that the trend output increases at a constant rate between these two points. Table 2.3 presents the estimations of the sacrifice ratios for all the countries. The results suggest that among the countries with IT, the sacrifice ratio amounted to an average of 2.8, while 3.6 percent for non-IT countries. [16] To be specific, the cost of reducing inflation by one percentage point is on average 2.8 points in terms of output for IT countries, for example.

15 When the nine-period centred moving average of actual inflation is used as trend inflation, the number of episodes is lower for most of the countries.

16 This average is computed just for positive values of the sacrifice ratio.

Table 2.3.
Sacrifice Ratios during Disinflation Episodes for Emerging Economies

Country	Disinflation period	Initial π	Length in quarters	π after 2 years	SR(*) Linear Trend	Speed of disinflation
With IT						
Brazil	85Q3-86Q4	229.47	5	782.4	0.000	18.46
Brazil	90Q1-91Q3	3426.28	6	1946.18	0.000	492.00
Brazil	94Q1-98Q4	2906.73	19	6.72	0.000	152.84
Chile	83Q3-84Q3	26.11	4	20.25	-0.034	1.39
Chile	85Q3-88Q4	29.53	13	25.61	0.008	1.22
Chile	90Q4-99Q4	25.61	36	2.99	-0.092	0.62
Korea	90Q4-93Q2	9.56	10	4.75	0.023	0.48
Korea	98Q2-99Q3	7.03	5	3.84	0.005	1.21
Israel	85Q1-88Q1	406.56	12	18.35	-0.001	32.48
Israel	89Q2-90Q3	19.6	5	11.88	0.042	0.46
Israel	91Q2-93Q1	18.81	7	12.06	0.025	1.27
Israel	94Q4-95Q4	12.55	4	7.22	-0.058	0.67
Israel	96Q3-00Q4	11.07	17	4.86	-0.062	0.60
Mexico	83Q2-85Q2	100.57	8	123.88	0.004	5.29
Mexico	87Q4-89Q4	146.42	8	19.68	0.001	15.73
Mexico	90Q4-94Q2	26.72	14	37.9	-0.012	1.39
S Africa	86Q2-88Q3	18.41	9	14.35	-0.025	0.61
S Africa	91Q4-94Q1	14.54	9	6.9	0.084	0.62
S Africa	95Q1-96Q1	9.46	4	6.77	0.029	0.64
S Africa	97Q1-98Q2	8.88	5	3.92	0.111	0.40
S Africa	98Q4-00Q1	7.54	5	6.58	-0.001	0.72
Average		**355.31**	**10**	**146.05**	**0.028**	**34.72**
Without IT						
Philippines	84Q3-86Q4	45.42	9	11.12	0.008	5.13
Philippines	91Q2-93Q1	17.59	7	7.29	0.007	1.48
Philippines	96Q1-97Q2	9.68	5	7.46	0.013	0.72
Philippines	98Q3-00Q1	9.76	5	4.21	0.128	1.10
Nigeria	84Q2-85Q4	38.93	6	25.83	0.003	6.42
Nigeria	88Q4-90Q4	61.14	7	51.63	-0.006	7.94
Nigeria	95Q2-97Q4	73.78	10	2.81	-0.003	6.68
Nigeria	98Q4-99Q4	11.62	4	17.41	0.036	2.20
Turkey	88Q3-90Q3	71.11	8	68.49	0.025	1.29
Turkey	92Q1-92Q4	70.29	3	109.85	0.004	1.67
Turkey	94Q4-96Q4	109.85	8	75.02	0.004	3.80
Turkey	98Q1-01Q1	91.44	12	51.18	-0.003	3.60
Uruguay	86Q2-88Q1	76.95	7	95.45	-0.040	2.42
Uruguay	90Q4-01Q1	117.09	37	7.66	-0.022	3.05
Venezuela	84Q4-85Q4	13.22	4	31.07	0.099	0.76
Venezuela	89Q3-92Q2	80.99	11	56.72	-0.011	4.50
Venezuela	96Q3-01Q2	95.21	19	20.26	-0.017	4.33
Average		**58.47**	**10**	**37.85**	**0.036**	**3.36**

(*) SR stands for Sacrifice Ratio.
The average sacrifice ratio is calculated just for positive values.

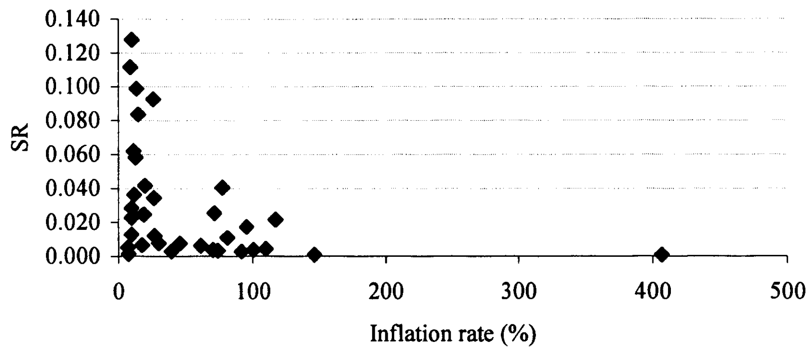
Some of the estimations of the sacrifice ratio are negative. This may suggest that inflation stabilisation has been achieved either without output cost or that the implementation of a disinflation programme has not been successful in the medium term achieving stable inflation rates (see Sanchez *et al.*, 1999). The latter is the case, for example, of fourteen out of seventeen disinflation episodes in non-IT countries that present 'after two years' inflation rates greater than the ones when these episodes ended. Another issue to be considered is that during the crisis periods while output is in a downward trend, high levels of inflation rates are observed. In other words, it could be inferred than in these periods tight monetary policy did not reduce output level because there were other factors that hit positively the economy. Hence, a relative rise in output is very likely to occur in line with a fall in inflation in the post-crisis period. This is the case for countries such as Venezuela (89Q3-92Q2) and Mexico (90Q4-94Q2).

It is usually presumed that where a disinflationary policy is believed to be credible, and is clearly announced, disinflation will be less costly because firms and households will reset their expectations and reduce them rapidly. This may generate a low sacrifice ratio during the transition from one monetary regime to another. Hence, a negative value for the sacrifice ratio may imply no cost for disinflation. Moreover, Ball *et al.* (1988) argue that the average level and variability of inflation are crucial aspects for emerging economies along with less independent central banks than for their more advanced counterparts. These aspects can lead to more frequent price and wage adjustments and consequently to a steeper output-inflation trade-off. In other words, high inflation reduces the extent of nominal rigidities and thus, the cost of disinflation. It can be argued that for those disinflation episodes that coincide with the implementation of IT, the value of the sacrifice ratio is negative in all the cases. Moreover, the change in inflation and the speed of disinflation have been considerably greater for this group of countries.

To examine in more detail the results presented in Table 2.3, the sample is divided according to the initial level of inflation for the different episodes of disinflation. Following the classification in Bruno and Easterly (1998), four groups are considered: (1) The first group comprises countries with initial levels of inflation equal or more than 40 percent, (2) the second group includes countries with initial levels of inflation between 20 and 40 percent, (3) the third group has rates of inflation between 10 and 20 percent and (4) the last one comprises countries with less than 10 percent. In general, the higher the initial level of inflation, the lower the sacrifice ratio. A scatter graph is given in Figure 2.2 for the whole sample. According to Figure 2.2 there is a clear negative association between the variables.[17] More variability is observed in IT countries presenting lower values of the sacrifice ratio in all the cases. Finally, most of disinflation episodes considered in the group with higher initial levels of inflation belongs to countries that have not implemented IT. More disinflation episodes with moderate and low initial levels of inflation consist of countries, which have adopted this regime.

17 Similar conclusions can be drawn from other studies such as Andersen and Wascher (1999), Sanchez *et al.* (1999), Laubach and Posen (1997).

Figure 2.2.
Initial Inflation vs. Sacrifice Ratio



Similar conclusions are observed when the results are divided according to the 1980s and the 1990s. During the eighties, the sacrifice ratio, the initial inflation, the change in inflation and the speed of disinflation are greater in IT countries than in non-IT. This tendency however, is the reverse for all the indicators in the 1990s (see Table 2.4). These results support the ones found by Lee (1999) for industrialised economies in the sense that a global disinflationary environment has been observed during the 1990s. However, in the case of emerging economies we found evidence that IT may contribute to lower and stable levels of inflation. Moreover, there is some evidence of a reduction in the sacrifice ratios for both country groups, although these reductions tend to be greater in those countries that have adopted explicit inflation targets. Overall, the results obtained from this first approach reflect the effectiveness of the measures implemented under the IT regime and the convergence to stable and low values of inflation with a lower cost in terms of output than the rest of the countries.

Table 2.4.
Sacrifice Ratios during the 1980's and 1990's

Country group	Initial π	SR Linear Trend	Speed of disinflation
IT Countries			
80's	98.66	4.32	7.62
90's	12.52	2.75	0.69
Non-IT Countries			
80's	55.39	3.37	4.06
90's	55.87	3.51	2.62

2.4.2. Econometric Results derived from the Phillips Curve

This section reports the estimation of sacrifice ratios estimating the supply slope coefficients from equation (2.3) using Ordinary Least Squares (OLS). Two periods are considered for each country: the pre-reform and post-reform period. The date selected for the division corresponds to the implementation of IT for the first group of countries and to the date where crucial stabilisation programmes or institutional reforms took place in countries belonging to the second group (see Table 2.5). Regressions are computed for each country, including up to six lags of each of the explanatory variables. Subsequently, those variables that are insignificant at the 10 percent level using the general to specific modelling approach are omitted (see Charemza and Deadman, 1997). Dummies are included when necessary to improve the estimation. The final parsimonious models are then used to estimate the sacrifice ratios.

The estimation of equation (2.3) implies that the variables included in the specification are expected to be stationary, *I(0)*. The output gap is by definition stationary and the annual change in the nominal exchange rate is expected to be *I(0)* as well. Inflation, however, presents a unit root (see Table 2.1A in the appendix).[18] Therefore, the change in inflation is used in our estimations. This assumption is expected to be valid, at least in our sample, in which there are considerable drifts (both upward and downward) in the inflation rate. Detail results from OLS regressions are reported in the appendix. Tables for all countries include the estimation of equation (2.3) using quarterly data over three sample periods: the whole sample period, the pre-reform and the post-reform period. In general, the models fit the data reasonably well and the diagnostic test statistics suggest that the residuals have satisfactory statistical properties.

Table 2.5.
Date of the Reform Period Division

With IT		**Without IT**	
Israel	1992q1	Nigeria	1990q1
South Africa	1997q1	Philipinnes	1993q3
Brazil	1994q3	Turkey	1995q3
Chile	1991q1	Uruguay	1990q1
Mexico	1995q1	Venezuela	1989q1
Korea	1998q1		

Table 2.6 presents the values of the implied sacrifice ratios in the short run for all countries in the pre-reform and post-reform periods. Taking into consideration the short-run average estimates, the results suggest that IT countries present higher sacrifice ratios during both sub-periods in comparison with non-IT countries. A different perception can be drawn from the analysis of the sacrifice ratio looking at its value in each group. An important reduction is observed in the

18 Philippines is the only country where inflation follows a stationary process. Nonetheless, the estimation of Phillips curves using inflation instead of the change of inflation do not alter the general results (see Muñoz Torres, 2005).

post- reform period in IT countries as it was expected since a disinflationary policy is believed to be credible under IT principles. The opposite pattern is observed in non-IT countries. Another interesting observation is that the sign of the sacrifice ratio is the same before and after the reform for six countries –Brazil, Chile, Korea, Mexico, South Africa and Philippines, five of them belonging to the first group. These results are similar to those found using disinflationary episodes when the sample was divided between the 1980's and 1990's (see Table 2.4).

Table 2.6.
Sacrifice Ratios from the Estimation of Phillips Curves
Short run*

Country	Pre-reform period	Post-reform period		Pre-reform period	Post-reform period
With IT			**Without IT**		
Brazil	-1.99	-0.17	Philippines	0.79	0.81
	[0.42]	[3.69]*		[1.08]	[4.87]*
Chile	0.17	1.78	Nigeria	0.33	-0.59
	[5.53]*	[0.78]		[1.89]**	[1.06]
Israel	-0.37	2.18	Turkey	0.43	-1.35
	[0.67]	[0.43]		[2.91]*	[1.02]
Korea	5.14	2.47	Uruguay	-1.88	1.37
	[0.53]	[0.64]		[0.56]	[2.19]*
Mexico	2.18	2.84	Venezuela	-0.30	2.07
	[0.14]	[0.69]		[1.92]**	[1.04]
South Africa	2.44	0.96			
	[1.36]	[1.95]**			
Average	**2.48**	**1.64**		**0.52**	**1.42**

(*) The overall average sacrifice ratio is computed just for positive values.
t-statistics in parenthesis. * significant at 5%; ** significant at 1%
To calculate the value of the standard error, see Hendry (1997), pp 741-42

The estimations of the sacrifice ratio taken into consideration the expected inflation channel into the analysis (see equation 2.4) are presented in Table 2.7. Overall the value of the sacrifice ratio is quantitatively smaller than the one obtained from short run estimations. The pattern followed by both country groups is very similar. Sacrifice ratios have increased in the post-reform period. Generally, countries with IT have raised the value of the sacrifice ratio from 0.93 to 1.42 whereas the non-IT countries have increased it from 0.30 to 0.75. This finding may reflect the achievement of lower and more stable rates of inflation as well as the importance of real and nominal rigidities at lower rates on inflation. An important observation is the reasonably difference in the increase between the two country groups (52% and 150% for IT and non-IT countries respectively) which may reflect the better ability of IT countries to achieve lower levels of inflation.

Table 2.7.
Sacrifice Ratios from the Estimation of Phillips Curves
Long run*

Country	Pre-reform period	Post-reform period		Pre-reform period	Post-reform period
With IT			**Without IT**		
Brazil	-0.56	-0.04	Philippines	0.45	0.47
	[0.41]	[4.14]*		[1.34]	[3.61]*
Chile	0.12	0.46	Nigeria	0.15	-0.26
	[3.99]*	[0.61]		[2.35]*	[1.10]
Israel	-0.19	1.68	Turkey	-0.57	-0.34
	[0.77]	[0.44]		[2.99]*	[0.92]
Korea	1.95	3.41	Uruguay	-0.54	1.41
	[0.54]	[0.65]		[0.50]	[2.21]*
Mexico	0.59	0.69	Venezuela	-0.16*	0.38
	[0.15]	[0.65]		[3.39]	[0.81]
South Africa	1.07	0.85			
	[1.07]	[1.92]**			
Average	**0.93**	**1.42**		**0.30**	**0.75**

(*) The overall average sacrifice ratio is computed just for positive values.
t-statistics in parenthesis. * significant at 5%; ** significant at 1%
To calculate the value of the standard error, see Hendry (1997), pp 741-42

The negative values found in some of the estimations seem to contradict the Phillips curve theory where the expected value for the SR should be positive. However, recent evidence suggests that an attempt to stabilize high inflation is not necessarily contractionary, and it may be expansionary. Bruno and Easterly (1998), for example, examine the case of 26 countries that have had episodes of high inflation over the period 1961-92. [19] They show that per capita growth is negative during high inflation crises, but after stabilization growth recovers strongly. This contradicts the view that reducing further low rates of inflation is associated with lower growth in the short to medium term. Similarly, Mendoza (1998) suggests that after the devaluation of the peso in Mexico in 1995, the increase in inflation induce a contraction of the economy.

To determine whether the results obtained from the estimations of the Phillips curves are reflecting significant changes in the economic structure of each country, the Phillips curve equation is reestimated over the full sample period to test for a structural break. In other words, to check for parameter stability the chow-test is applied. The results presented in Table 2.8 suggest that the null hypothesis of unchanged parameters cannot be rejected at the 5% level in most of the countries. This suggests that the implementation of economic reforms, including the adoption of IT, has not contributed to significant changes in the economic structure of these countries.[20] Additionally, the estimations of the Phillips curve are used to generate out-of-sample forecasts from the period of policy shift to the end of the sample period (see Figure 2.2A in the appendix). Consistent with the results from structural

19 An episode of high inflation is defined as a period of two years or more in which inflation exceeds 40 percent annually.

20 Three more stability tests are carried out: Recursive residuals test, Cusum test and Cusum of squares test. According to these tests, there is no evidence of parameter instability in most of the countries. The stability analysis is related to the non-linearity of the Phillips curve.

break tests, for none of the countries there is much evidence of a change in the behaviour of inflation. Table 2.9 reports the Root Mean Squared (RMS), the Mean Absolute Error (MAE) and the Theil Inequality (TI) coefficient from forecasting inflation. For the first two forecast errors statistics it can be said that the smaller the error, the better the forecast. The coefficient derived from the third statistic always lies between zero and one, where zero indicates a perfect fit. The statistics suggest a slightly satisfactory forecast for IT countries.

Table 2.8
Chow Stability Test*

Country	F-Statistic	probability
Mexico (94q1)	1.78	0.069
Brazil (94q2)	2.73	0.006
Chile (90q4)	3.03	0.002
Israel (91q4)	0.78	0.726
Korea (97q4)	0.79	0.713
S. Africa (96q4)	1.82	0.061
Nigeria (89q4)	1.20	0.987
Philippines (93q2)	1.99	0.043
Turkey (95q2)	0.34	0.989
Uruguay (89q4)	1.90	0.041
Venezuela (95q1)	0.62	0.999

(*) Ho: Regressions are the same or there is structural stability.
Fstat =[RSSs - (RSSs1 + RSSs2) / k] / [(RSSs1 + RSSs2) / (n1 + n2 - 2k)]

In summary, the value of the sacrifice ratio derive from the estimation of Phillips curves suggests a better performance for IT countries where the sacrifice ratio has either decrease or increase less than non-IT countries after the implementation of several economic reforms to achieve lower levels of inflation. The estimation of Phillips curves to compute the sacrifice ratio represents an improvement from our first approach which focuses only on disinflationary periods.

The Phillips curve however assumes that the sacrifice ratio is symmetric on inflation. In other words, this method constraint the output-inflation trade-off at the same level during both disinflation episodes as in periods with increases in trend inflation. The specification and estimation of a non-linear functional form of the Phillips curve constitutes an interesting area for future research.

Table 2.9.
Forecast Evaluation of Inflation

With IT

Country	RMSE	MAE	TIC
Brazil	0.191	0.156	0.105
Chile	0.025	0.019	0.026
Israel	0.042	0.033	0.068
Korea	0.019	0.014	0.422
Mexico	0.084	0.057	0.238
South Africa	0.024	0.018	0.466

Without IT

Country			
Nigeria	0.087	0.065	0.261
Philipinnes	0.049	0.039	0.219
Turkey	0.057	0.046	0.245
Uruguay	0.059	0.046	0.297
Venezuela	0.072	0.058	0.235

2.4.3. Identification and Estimation of the Structural VAR Model

To obtain the structural impulse response functions (SIR), the reduced-form VAR representation of (2.5) in conjunction with identifying restrictions are used. The unrestricted VAR representation is given by:

$$y_t - D_1 y_{t-1} - D_2 y_{t-2} - \dots - D_k y_{t-k} = D(L) y_t = \mu_t \qquad (2.9)$$

where y_t is an $(nx1)$ vector of endogenous variables, D(L) is a *k*th-order lag polynomial matrix, and μ_t is the $(nx1)$ vector of innovations to the system. It is assumed that μ_t has zero mean and is serially uncorrelated with the covariance matrix $E[\mu_t \mu_t^{'}]=\Sigma$ for all t. Equation (2.9) can be estimated and inverted to yield its unrestricted VMA representation:[21]

$$y_t = \mu_t + C_1\mu_{t-1} + C_2\mu_{t-2} + ... = C(L)\mu_t \tag{2.10}$$

From (2.6) and (2.7), the VAR and VMA representations of the structural system can be written, respectively, as:

$$B_0 y_t = B_1 y_{t-1} + B_2 y_{t-2} + ... + B_k y_{t-k} + \varepsilon_t \tag{2.11}$$

and

$$y_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + ... = A(L)\varepsilon_t \tag{2.12}$$

Equations (2.11) and (2.12) imply that:

$$E[(A_0\varepsilon_t)(A_0\varepsilon_t)'] = A_0\Omega A_0^{'} = \Sigma = E[(\mu_t)(\mu_t^{'})] \tag{2.13}$$

and

$$A(L) = C(L)A_0 \tag{2.14}$$

The estimation of the matrix A_0 becomes crucial to link the unrestricted VAR to the structural VAR model. Complete identification for A_0 requires a total of n^2 restrictions (i.e., four restrictions). One set of identifying restrictions is based on the assumption that the structural shocks are uncorrelated and have unit variance. That is, assuming that $\Omega=I_n$, where I_n is the (nxn) identity matrix, $A_0 A_0^{'} = \Sigma$, where

21 Detailed analysis of this procedure can be found in Greene (2003), pages 597-600

Σ is an estimable matrix with three free parameters. Finally, since A_0 is 2x2 one more restriction is needed to secure identification. Following Blanchard and Quah's (1989) methodology, the additional restriction for the Cecchetti's model is that aggregate demand shocks have no permanent effect on the level of output. This is equivalent to the condition that $A_{12}(1) = \sum_{i=0}^{\infty} a_{12}^{i} = 0$.

Once A_0 is estimated, the SIF are generated in order to obtain the response of the level of output and inflation at each horizon to the monetary shock. Dividing the appropriate quantities at each horizon provides the sacrifice ratio (see equation 2.8). Cecchetti's model identifies two shocks and associate shifts in monetary policy with aggregate demand disturbance.[22] This scheme provides a good approximation for analyzing the relative importance of nominal and real shocks and therefore for the estimation of the sacrifice ratio. In the interest of simplicity, this study is restricted to the analysis of the Cecchetti's two-equation model to compare the relative magnitude of the sacrifice ratios under alternative techniques. The inclusion of more variables would be interesting for future research although there is evidence that the estimates from structural VAR models are very imprecise (see Cecchetti and Rich, 2001).

Stationary properties of the series are examined to determine the degree of integration. The results from the application of the Dickey-Fuller test provided evidence that output (in logs) and inflation contain a unit root. According to Cecchetti and Rich (2001) these findings are primarily important for the concept of a sacrifice ratio. The evidence of a unit root in the output process allows long-run

22 The restrictions in the Cecchetti's model, however, fail to identify separate components of the aggregate demand disturbance. In other words, the estimated monetary-policy shock would include not only policy shifts, but also other shocks such as those related to government spending or investment functions.

restriction on the effects of aggregate demand shocks to be well defined and meaningful, while the evidence of a unit root in the inflation process allows for permanent shifts in its level. The lag-length of the reduced-form VAR varies from each country accordingly to the Akaike Information and Schwarz criterion. Table 2.10 presents the point estimates of the sacrifice ratio at horizons of one to five years for the two country groups. The results should be interpreted as the cumulative output loss corresponding to a permanent one-percentage-point decline in the rate of inflation measured on an annual basis. A negative value for the sacrifice ratio may imply no cost for disinflation.

Table 2.10.
Sacrifice-Ratio Estimates for Emerging Economies from SVAR Analysis
1980-2002

IT Countries

	λ=4	λ=8	λ=12	λ=16	λ=20
Brazil	-0.044	-0.022	-0.019	-0.021	-0.022
Chile	-0.269	-0.181	-0.047	-0.229	-0.103
Israel	-0.015	-0.083	-0.205	-0.246	-0.294
Korea	0.378	0.409	0.353	0.361	0.361
Mexico	0.364	0.515	0.351	0.433	0.381
South Africa	1.498	0.485	2.024	0.757	1.479
Average	**0.75**	**0.47**	**0.91**	**0.52**	**0.74**

Non-IT Countries

	λ=4	λ=8	λ=12	λ=16	λ=20
Philippines	3.432	6.873	10.477	7.061	5.711
Nigeria	0.099	0.074	0.657	0.257	0.499
Turkey	-0.219	-0.170	-0.142	-0.122	-0.110
Uruguay	0.057	0.111	0.109	0.114	0.114
Venezuela	0.069	0.055	0.057	0.057	0.056
Average	**0.91**	**1.78**	**2.83**	**1.87**	**1.60**

(*) The overall average sacrifice ratio is computed just for positive values.

Overall, the results for the estimation of the sacrifice ratios suggest relatively constant values as the horizon λ grows for all countries. This pattern is supported by the results found by Cecchetti and Rich (2001) for the US sacrifice ratio using the same approach. Exceptions are South Africa and Philippines where the highest value is reached after three years and stars to decrease thereafter. Taken into consideration the average value of the sacrifice ratio for both country groups interesting results emerge. The sacrifice ratio is smaller all along the period of five years ($\lambda = 20$) for IT countries.

To analyse in more detail our previous results, the sacrifice ratio is calculated only for the post-reform period. The results at different horizons are presented in Table 2.11. The sacrifice ratio estimations are also relatively constant as the horizon lengthens and quantitatively smaller. Looking at the average value of the sacrifice ratio, this is smaller in IT countries, after one year of analysis (0.38 and 0.57 respectively). This finding suggests that a disinflation strategy can be more effective under IT principles since a one-percentage point decline in the rate of inflation requires less output loss in this group of countries. As the horizon extends, however, the sacrifice ratio increases in IT countries and decreases in the non-IT ones. These results seem to support the view that the lower the initial rates of inflation the higher the sacrifice ratios are expected to be. Similar results were found using alternative approaches.

Table 2.11.
Sacrifice-Ratio Estimates for Emerging Economies from SVAR Analysis
Post-Reform Period

IT Countries

	λ=4	λ=8	λ=12	λ=16	λ=20
Brazil	0.003	0.006	0.008	0.009	0.011
Chile	0.405	0.436	0.439	0.438	0.438
Israel	-0.312	-0.284	-0.278	-0.285	-0.242
Korea	1.041	1.946	1.530	1.683	1.669
Mexico	0.051	0.033	0.030	0.031	0.031
South Africa	-0.118	-0.118	-0.118	-0.118	-0.118
Average	**0.38**	**0.61**	**0.50**	**0.54**	**0.54**

Non-IT Countries

	λ=4	λ=8	λ=12	λ=16	λ=20
Philippines	1.323	0.958	0.800	0.799	0.777
Nigeria	0.015	0.022	0.024	0.024	0.025
Turkey	-0.050	-0.035	-0.023	-0.013	-0.006
Uruguay	0.746	0.825	0.846	0.854	0.858
Venezuela	0.212	0.116	0.133	0.145	0.142
Average	**0.57**	**0.48**	**0.45**	**0.46**	**0.45**

(*) The overall average sacrifice ratio is computed just for positive values.

2.5. Conclusions

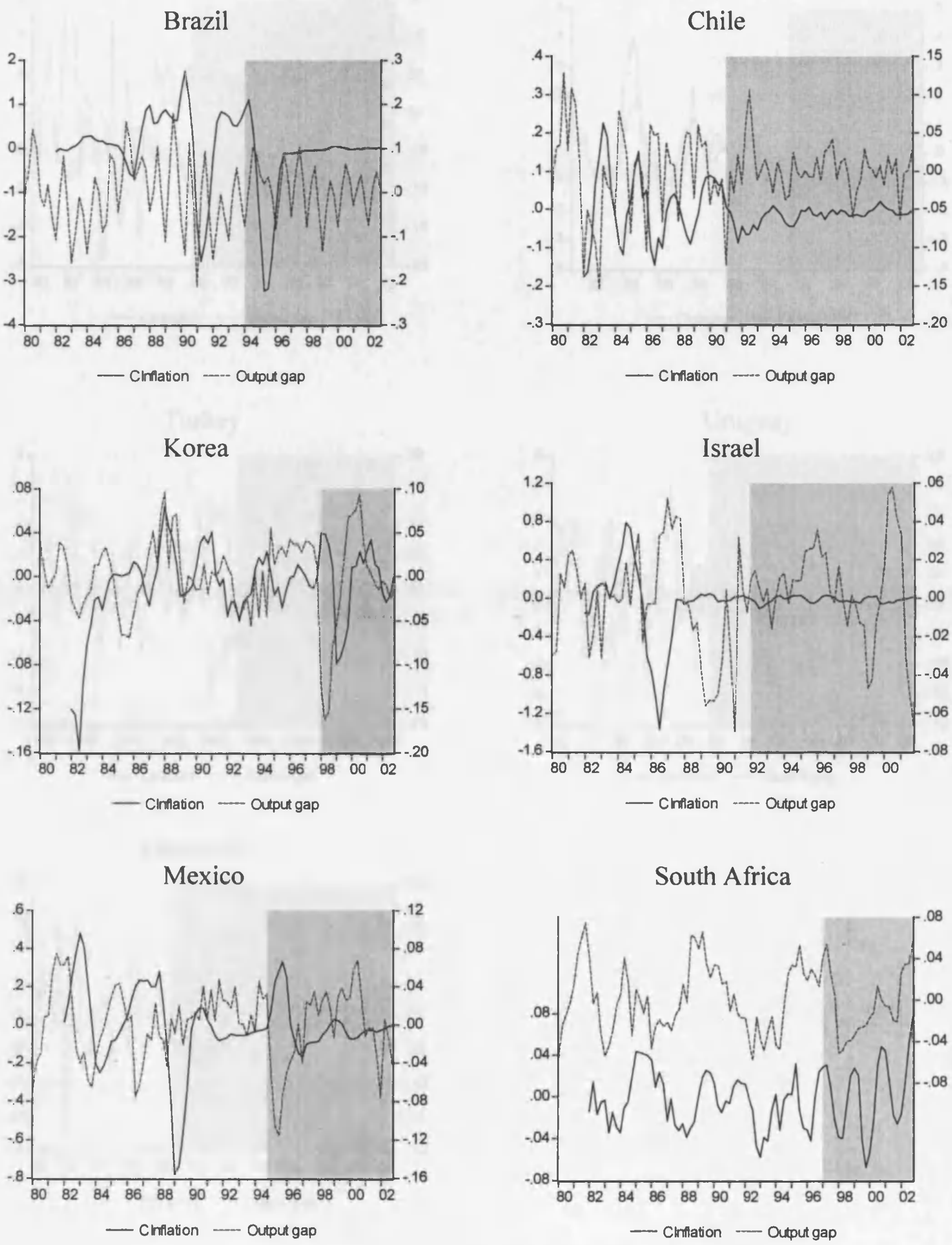
This study carries out estimations for the sacrifice ratio of eleven emerging economies with and without IT using three different approaches: (1) comparison of actual changes in inflation with changes in standard measures of output, (2) estimation of aggregate supply curves and (3) employment of a structural VAR model. It is worth noting that the estimation of sacrifice ratios for emerging economies may lead to some difficulties due to the unstable path of inflation and growth in these countries. In other words, it may be difficult to observe a stable and long-lasting fall in inflation after a disinflation programme. Taking this into account, this chapter estimates sacrifices ratios from three alternative methods in order to compensate any possible shortcoming in each of them. Overall, the results suggest a better performance in those countries that have adopted IT. These countries have achieved more stable levels of inflation and the implied sacrifice ratios have either decrease or increase less than non-IT countries after the implementation of important economic reforms (i.e. inflation targeting) to achieve lower levels of inflation.

Using the first approach it was found that for the countries with IT, the sacrifice ratio amounted to an average of 2.8 while the equivalent average is 3.6 percent for non-IT countries. Some evidence that lower initial rates of inflation are associated with higher sacrifice ratios was also found. Interesting findings were also obtained from the estimation of Phillip curves. A decrease of the sacrifice ratio is observed after the implementation of crucial economic reforms for IT countries whereas the opposite occurs in non-IT countries. Taken into account the expected inflation channel into the analysis, the sacrifice ratios increased in both country groups in the post-reform period even though the increase was less in IT countries. Using the final approach the results suggest a smaller sacrifice ratio for those countries that adopted IT at least after one year of undertaken the monetary policy strategy (0.38 and 0.52 respectively). As the horizon lengthens however the sacrifice ratio increases in IT countries and decreases in non-IT. These findings may reflect the achievement of more stable rates of inflation in IT countries and therefore reducing inflation further has become more costly in terms of output.

Finally, it is worth mentioning that our results take into account the estimated relative magnitudes of sacrifice ratios. The complexity of the sample of countries used in our study may difficult to derive specific conclusions. Measuring the output-inflation trade-off is difficult and very sensitive to identifying restrictions. However, general conclusions can be drawn and used for further research. These include, for example, different criteria to group the countries or the inclusion of additional variables that may improved the estimations. In addition, this study offers the possibility to analyse the specific case of one country which will allow the possibility as well to enrich the techniques that have been used. The inclusion of other important structural and institutional developments, which are not considered in this study, could be also an issue for further research.

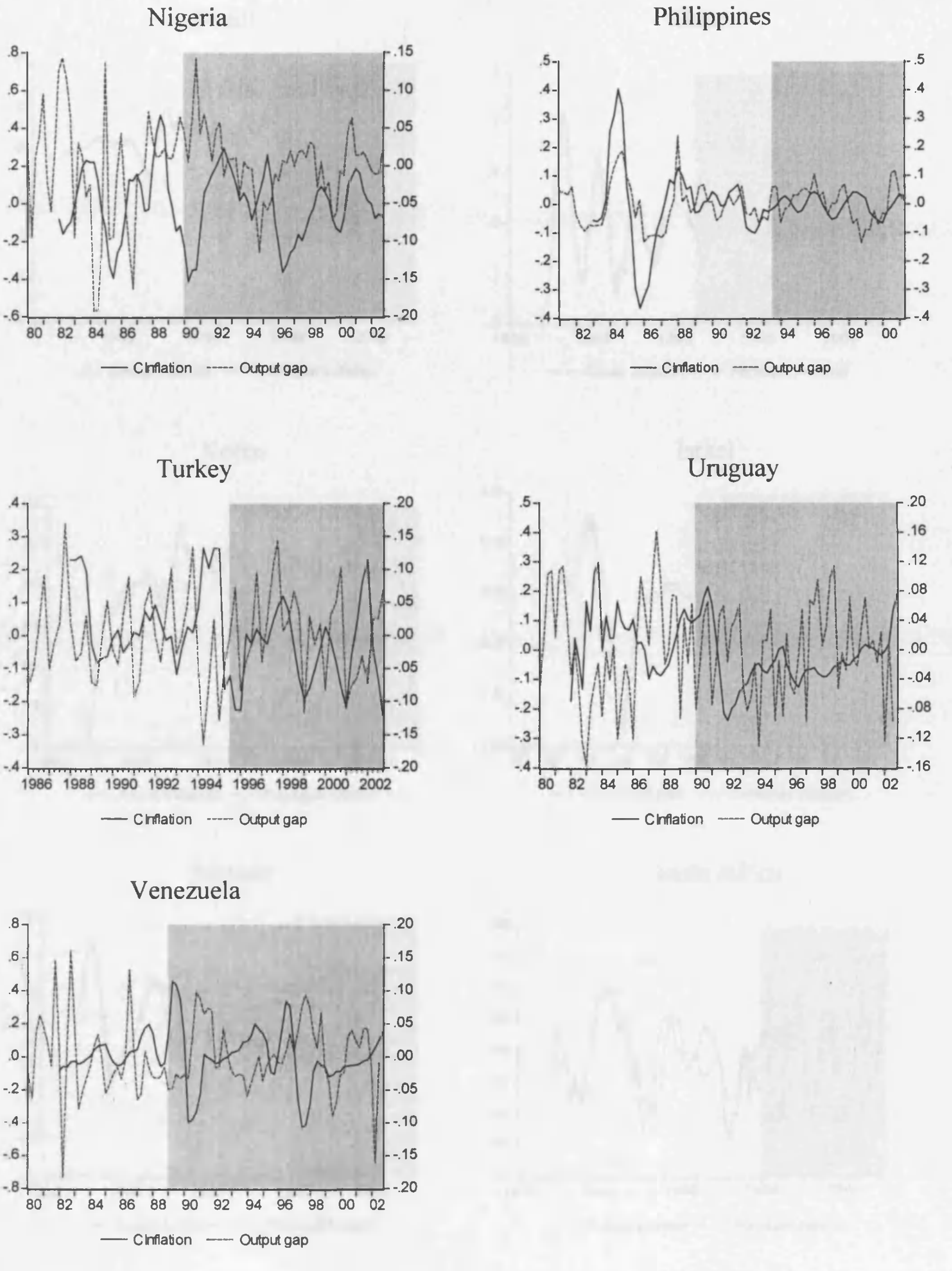
Appendix

Figure 2.1A.
Change in Inflation and Output Gap in IT Countries*
1980-2002



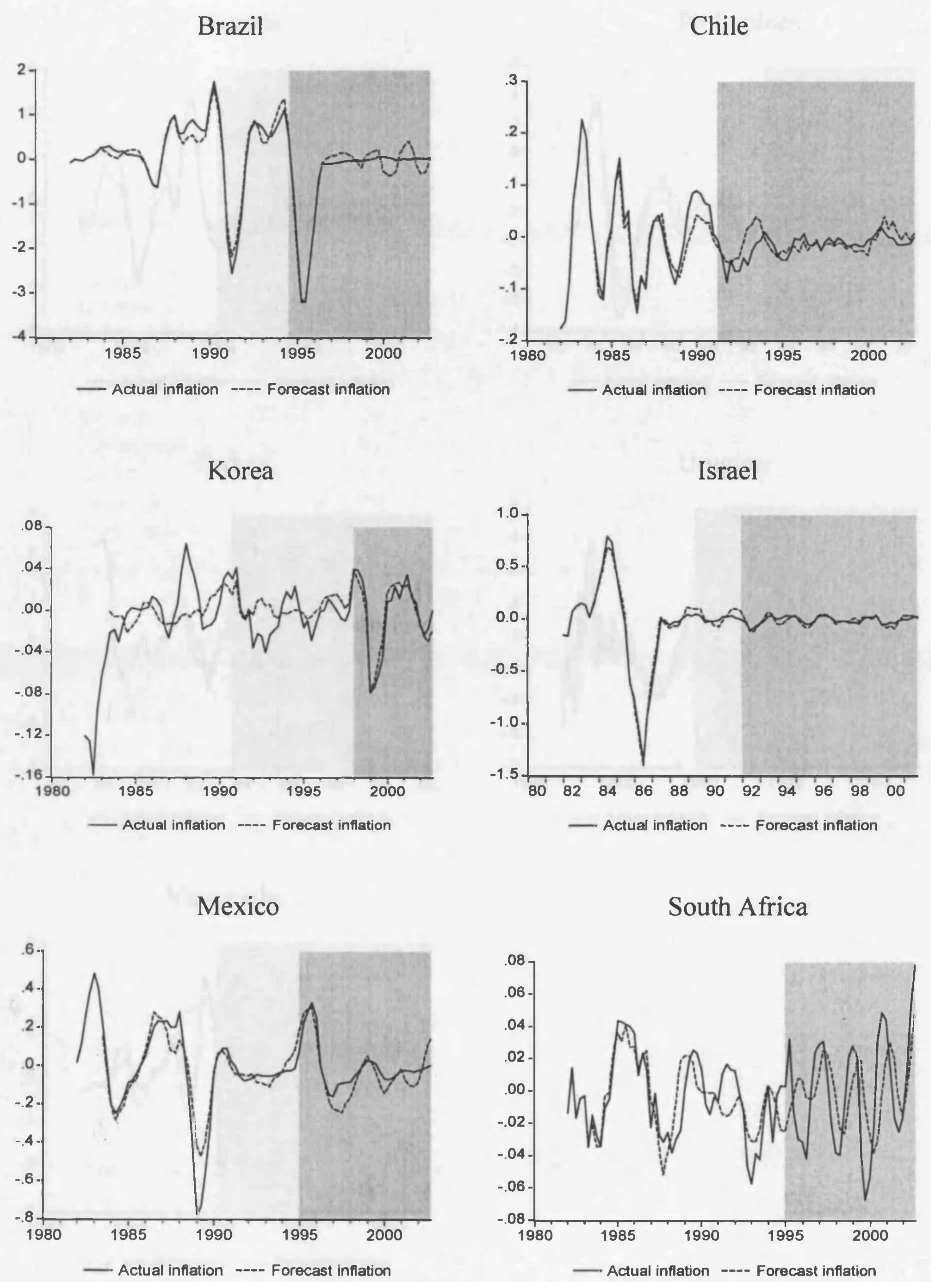
(*) The highlighted area marks the adoption of the IT regime or the date when the countries have implemented important stabilisation programmes. Inflation is change in inflation.

Figure 2.1A. (Cont.)
Change in Inflation and Output Gap in non-IT Countries*
1980-2002



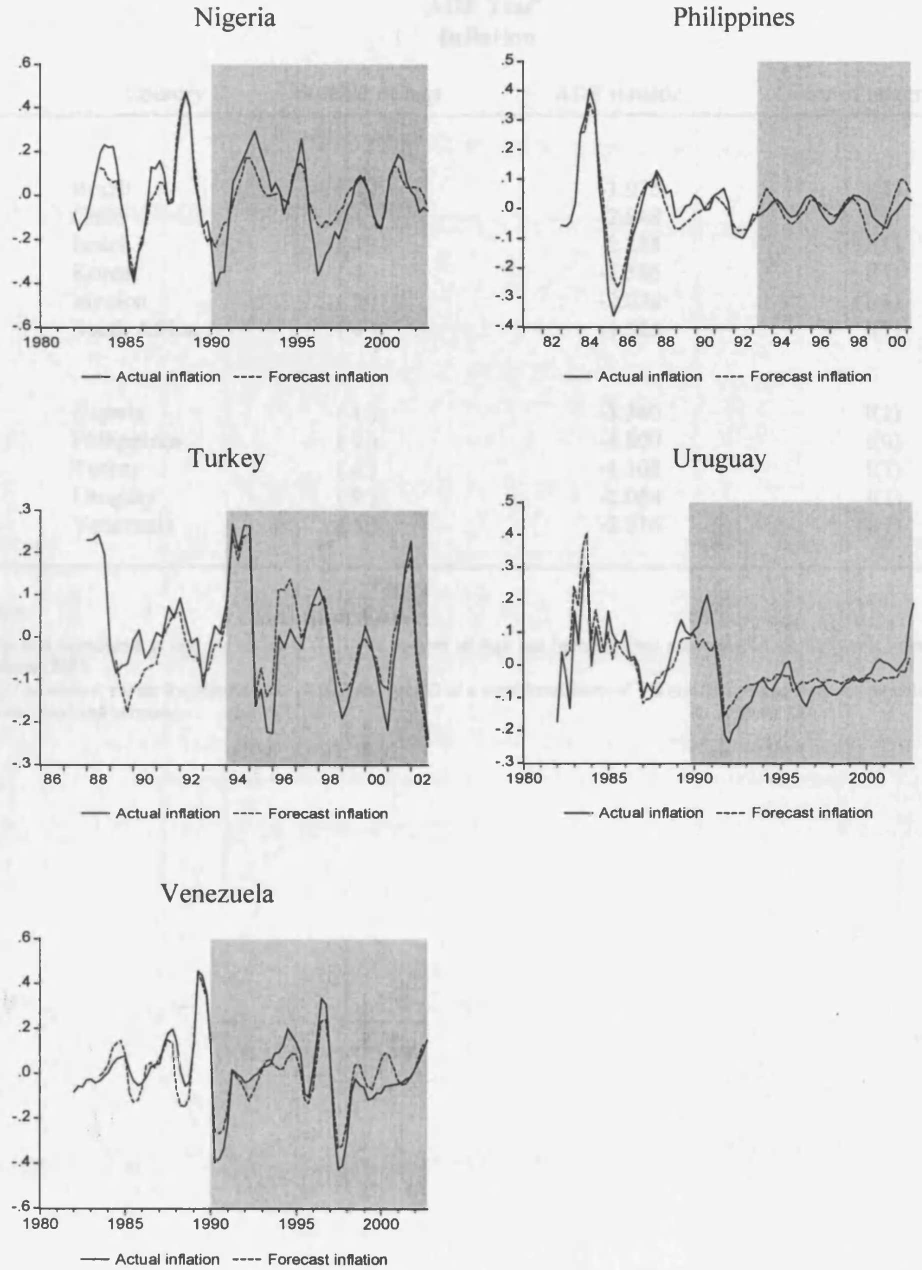
(*) The highlighted area marks the adoption of the IT regime or the date when the countries have implemented important stabilisation programmes. Inflation is the change in inflation.

Figure 2.2.A
Inflation Forecast in IT Countries*



(*)The highlighted area represents the onset of forecasting and the dashed line is the forecast for inflation.

Figure 2.2A. (cont.)
Inflation Forecast in non-IT Countries*



(*)The highlighted area represents the onset of forecasting and the dashed line is the forecast for inflation.

Table 2.1A.
Unit Root Test

ADF Test[a]
Inflation

Country	Number of lags	ADF statistic	Order of integration
Brazil	(2)	-1.975	I(1)
Chile	(4)	-2.948	I(1)
Israel	(4)	-2.288	I(1)
Korea	(4)	-3.586	I(1)
Mexico	(5)	-2.036	I(1)
South Africa	(4)	-1.525	I(1)
Nigeria	(1)	-3.360	I(1)
Philippines	(9)	-4.809	I(0)
Turkey	(4)	-1.102	I(1)
Uruguay	(9)	-2.084	I(1)
Venezuela	(5)	-2.016	I(1)

Notes:

The null hypothesis is that the series is I(1). The number of lags has been selected according to the Schwartz information criteria (SIC).
(a) The critical values for rejection are -4.072 and –3.463 at a significant level of 1% and 5% respectively for models with a linear trend and constant.

Table 2.2A.
Estimation of Phillips Curve Equations:
Full Sample Period
1980-2002

IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Brazil		Chile		Israel		Korea		Mexico		South Africa	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.12	11.32	0.72	4.81	1.18	12.68	0.99	7.26	1.41	9.17	0.95	6.97
$\Delta\Pi_{t-2}$	-0.28	-2.10	0.31	1.88	-0.62	-5.23	-0.03	-0.19	-0.51	-3.01	-0.28	-1.69
$\Delta\Pi_{t-3}$	-0.07	-0.52	-0.04	-0.40	0.19	2.10	-0.07	-0.59	0.00	0.03	0.04	0.37
$\Delta\Pi_{t-4}$	-0.39	-3.17	-0.66	-6.43	-0.47	-6.62	-0.50	-3.60	-0.74	-3.73	-0.65	-7.42
$\Delta\Pi_{t-5}$	0.56	4.96	0.31	2.12	0.64	7.38	0.42	3.47	1.07	5.02	0.70	5.45
$\Delta\Pi_{t-6}$	-0.23	-3.38	0.16	1.15	-0.29	-5.28	-0.06	-0.71	-0.49	-4.67	-0.11	-0.96
gap_t	0.75	2.48	-0.10	-1.15	-0.12	-0.71	0.00	0.06	-0.15	-1.00	-0.01	-0.14
gap_{t-1}	0.29	0.53	0.09	1.42	0.37	1.24	-0.03	-0.60	0.46	2.14	0.11	1.12
gap_{t-2}	-0.54	-0.94	0.11	1.78	-0.53	-2.11	-0.01	-0.10	-0.39	-1.63	0.02	0.36
gap_{t-3}	0.54	0.95	0.04	0.51	0.55	2.68	0.07	1.43	-0.22	-1.34	---	---
gap_{t-4}	-1.23	-2.31	0.16	1.77	-0.30	-1.51	-0.02	-0.48	0.16	0.78	---	---
gap_{t-5}	---	---	---	---	0.12	0.52	-0.06	-1.32	-0.60	-2.17	---	---
gap_{t-6}	---	---	---	---	-0.39	-1.76	0.04	0.85	0.66	2.80	---	---
Jarque Bera	3.96 (0.13)		2.02 (0.36)		1.42 (0.49)		0.21 (0.89)		17.98 (0.00)		7.69 (0.02)	
LM(4)	2.19 (0.08)		1.26 (0.29)		1.73 (0.15)		2.17 (0.08)		1.25 (0.29)		1.96 (0.11)	
ARCH(1)	0.17 (0.67)		3.48 (0.05)		0.02 (0.87)		0.59 (0.44)		1.52 (0.22)		0.01 (0.91)	
No. of observations	78		76		74		77		77		77	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

Table 2.2A. (cont.)
Estimation of Phillips Curve Equations:
Full Sample Period
1980-2002

Non-IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Nigeria		Philippines		Turkey		Uruguay		Venezuela	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.25	11.61	0.93	7.62	0.85	7.78	0.79	6.25	1.30	9.67
$\Delta\Pi_{t-2}$	-0.40	-2.19	-0.13	-0.50	0.03	0.27	0.00	-0.03	-0.52	-4.26
$\Delta\Pi_{t-3}$	0.04	0.20	0.00	0.01	-0.07	-0.76	---	---	0.09	1.02
$\Delta\Pi_{t-4}$	-0.68	-2.68	-0.25	-2.14	-0.37	-3.44	---	---	-0.51	-4.23
$\Delta\Pi_{t-5}$	0.97	4.11	---	---	0.32	3.83	---	---	0.71	5.20
$\Delta\Pi_{t-6}$	-0.57	-6.64	---	---	---	---	---	---	-0.27	-3.30
gap_t	-0.07	-0.48	0.18	2.37	0.15	1.34	-0.07	-0.88	-0.09	-0.84
gap_{t-1}	-0.07	-0.42	-0.06	-0.67	-0.10	-1.10	0.08	0.96	-0.13	-1.19
gap_{t-2}	-0.16	-1.17	-0.06	-0.88	0.09	0.82	0.01	0.10	0.04	0.22
gap_{t-3}	0.35	3.46	0.00	-0.03	0.03	0.37	-0.07	-0.84	---	---
gap_{t-4}	0.07	0.51	---	---	-0.23	-1.82	0.07	0.79	---	---
gap_{t-5}	---	---	---	---	---	---	---	---	---	---
gap_{t-6}	---	---	---	---	---	---	---	---	---	---
Jarque Bera	42.7 (0.00)		20.33 (0.00)		1.85 (0.39)		15.09 (0.00)		4.01 (0.13)	
LM(4)	0.62 (0.51)		1.52 (0.20)		0.23 (0.91)		1.75 (0.15)		1.86 (0.12)	
ARCH(1)	0.74 (0.39)		0.00 (0.95)		4.38 (0.04)		2.95 (0.08)		5.08 (0.02)	
No. of observations	77		69		54		80		77	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

Table 2.3A.
Estimation of Phillips Curve Equations:
Pre-Reform Period

IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Brazil		Chile		Israel		Korea		Mexico		South Africa	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.09	7.86	0.42	5.05	1.18	6.88	1.03	7.72	1.41	10.31	0.84	4.75
$\Delta\Pi_{t-2}$	-0.36	-2.24	0.16	1.71	-0.81	-4.37	-0.24	-1.40	-0.48	-3.09	-0.18	-0.83
$\Delta\Pi_{t-3}$	0.20	1.54	0.09	0.99	0.20	1.63	0.18	1.20	-0.06	-0.43	0.10	0.67
$\Delta\Pi_{t-4}$	-0.58	-4.52	-0.38	-4.47	-0.37	-4.12	-0.84	-4.86	-0.73	-3.29	-0.69	-6.02
$\Delta\Pi_{t-5}$	0.56	4.03	---	---	0.72	6.22	0.57	3.70	1.09	4.76	0.59	3.57
$\Delta\Pi_{t-6}$	-0.21	-2.00	---	---	-0.42	-4.38	-0.08	-0.72	-0.50	-4.33	-0.10	-0.61
gap_t	0.56	2.10	-0.32	-3.19	-0.31	-0.75	0.04	0.60	-0.04	-0.09	0.00	-0.05
gap_{t-1}	-0.74	-1.50	0.46	6.45	0.65	1.59	0.04	0.64	0.69	1.92	0.11	0.94
gap_{t-2}	0.81	1.62	0.41	4.18	-0.48	-1.26	-0.06	-1.17	-0.53	-1.65	0.00	0.00
gap_{t-3}	-0.60	-1.39	0.26	3.92	1.18	2.80	0.02	0.31	-0.53	-1.99	---	---
gap_{t-4}	-0.16	-0.37	0.68	6.76	-0.97	-2.04	-0.03	-0.50	0.05	0.18	---	---
gap_{t-5}	---	---	---	---	-0.34	-0.69	-0.05	-0.96	-0.40	-1.01	---	---
gap_{t-6}	---	---	---	---	-0.39	-0.72	0.09	1.75	0.88	2.82	---	---
Jarque Bera	0.45 (0.79)		0.25 (0.88)		0.26 (0.87)		0.67 (0.71)		10.17 (0.00)		0.46 (0.79)	
LM(4)	0.41 (0.80)		0.44 (0.77)		1.53 (0.28)		1.37 (0.26)		0.47 (0.75)		2.19 (0.09)	
ARCH(1)	6.62 (0.01)		1.47 (0.23)		0.00 (0.94)		1.72 (0.19)		0.00 (0.99)		2.93 (0.09)	
No. of observations	44		47		33		55		45		51	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

Table 2.3A. (cont.)
Estimation of Phillips Curve Equations:
Pre-Reform Period

Non-IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Nigeria		Philippines		Turkey		Uruguay		Venezuela	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.27	4.55	0.78	5.91	0.19	1.65	0.26	1.59	1.15	6.69
$\Delta\Pi_{t-2}$	-0.52	-1.45	-0.06	-0.30	-0.22	-1.65	0.45	3.64	-0.52	-3.44
$\Delta\Pi_{t-3}$	0.42	1.06	-0.02	-0.09	-0.04	-0.34	---	---	0.03	0.28
$\Delta\Pi_{t-4}$	-1.63	-2.78	-0.26	-2.12	-0.25	-3.34	---	---	-0.53	-3.70
$\Delta\Pi_{t-5}$	1.99	3.00	---	---	---	---	---	---	0.63	4.07
$\Delta\Pi_{t-6}$	-0.98	-2.73	---	---	---	---	---	---	-0.29	-2.92
gap_t	0.08	0.43	0.43	2.55	-0.29	-2.87	-0.24	-1.81	-0.12	-0.68
gap_{t-1}	0.10	0.57	-0.02	-0.17	-0.06	-0.41	-0.03	-0.13	-0.51	-2.05
gap_{t-2}	-0.05	-0.22	-0.02	-0.23	-0.23	-2.14	0.13	0.67	0.14	0.46
gap_{t-3}	0.41	2.13	0.10	0.70	---	---	---	---	-0.33	-1.09
gap_{t-4}	0.22	1.05	-0.17	-1.87	---	---	---	---	---	---
gap_{t-5}	---	---	---	---	---	---	---	---	---	---
gap_{t-6}	---	---	---	---	---	---	---	---	---	---
Jarque Bera	1.01 (0.60)		2.02 (0.36)		1.76 (0.41)		0.42 (0.80)		0.43 (0.80)	
LM(4)	0.65 (0.66)		0.80 (0.53)		1.81 (0.23)		0.042 (0.99)		0.49 (0.74)	
ARCH(1)	1.44 (0.24)		0.32 (0.57)		0.52 (0.47)		0.03 (0.85)		0.00 (0.97)	
No. of observations	25		37		23		29		49	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

Table 2.4A.
Estimation of Phillips Curve Equations:
Post-Reform Period

IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Brazil		Chile		Israel		Korea		Mexico		South Africa	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.22	18.98	0.89	5.06	1.15	6.44	-0.09	-0.45	1.00	6.52	1.06	8.66
$\Delta\Pi_{t-2}$	-0.52	-6.26	0.13	0.66	-0.32	-1.82	0.24	2.77	-0.25	-2.69	-0.94	-6.92
$\Delta\Pi_{t-3}$	0.23	4.16	0.11	0.62	-0.32	-1.79	-0.06	-0.35	---	---	---	---
$\Delta\Pi_{t-4}$	-0.51	-14.06	-0.83	-5.07	-0.33	-1.78	-0.48	-3.29	---	---	---	---
$\Delta\Pi_{t-5}$	0.53	10.14	0.47	2.67	0.42	2.20	---	---	---	---	---	---
$\Delta\Pi_{t-6}$	-0.19	-5.23	-0.03	-0.22	-0.37	-3.05	---	---	---	---	---	---
gap_t	-0.28	-0.90	0.03	0.38	0.07	0.56	-0.04	-0.26	-0.23	-1.84	-0.07	-0.47
gap_{t-1}	-0.47	-1.38	-0.04	-0.53	0.06	0.32	-0.17	-1.72	-0.08	-0.83	0.29	1.63
gap_{t-2}	-0.25	-0.86	-0.01	-0.09	0.08	0.41	0.00	0.02	0.05	0.49	-0.12	-0.69
gap_{t-3}	-0.37	-1.40	0.11	1.67	-0.25	-1.20	0.05	0.54	0.02	0.19	0.36	1.80
gap_{t-4}	-0.07	-0.29	-0.08	-0.90	-0.50	-2.29	0.26	3.02	0.33	2.42	-0.20	-1.33
gap_{t-5}	---	---	0.05	0.66	0.14	0.57	---	---	---	---	---	---
gap_{t-6}	---	---	0.07	0.79	0.51	3.44	---	---	---	---	---	---
Jarque Bera	4.25 (0.12)		1.79 (0.40)		0.48 (0.78)		0.75 (0.68)		0.29 (0.86)		2.09 (0.35)	
LM(4)	0.56 (0.68)		1.11 (0.36)		2.33 (0.11)		0.50 (0.74)		1.60 (0.23)		0.53 (0.71)	
ARCH(1)	4.29 (0.04)		0.02 (0.88)		0.02 (0.86)		0.83 (0.37)		0.22 (0.63)		4.87 (0.03)	
No. of observations	44		46		39		20		31		23	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

Table 2.4A. (cont.)
Estimation of Phillips Curve Equations:
Post-Reform Period

Non-IT Countries
Dependent variable $\Delta\pi$

Independent varaible	Nigeria		Philippines		Turkey		Uruguay		Venezuela	
	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic	Coeff.	t-statistic
$\Delta\Pi_{t-1}$	1.26	6.66	1.09	5.99	0.83	4.34	1.60	17.12	1.23	8.60
$\Delta\Pi_{t-2}$	-0.39	-1.36	-0.48	-2.45	-0.08	-0.63	-0.90	-10.29	-0.38	-1.58
$\Delta\Pi_{t-3}$	0.02	0.09	-0.12	-0.62	---	---	---	---	0.14	0.80
$\Delta\Pi_{t-4}$	-0.46	-1.66	-0.38	-1.68	---	---	---	---	-0.67	-4.05
$\Delta\Pi_{t-5}$	0.50	1.93	0.61	2.38	---	---	---	---	0.81	5.36
$\Delta\Pi_{t-6}$	-0.38	-3.26	-0.29	-1.65	---	---	---	---	-0.32	-4.14
gap_t	-0.28	-0.74	0.00	-0.07	0.21	2.03	0.09	2.15	-0.06	-0.71
gap_{t-1}	0.02	0.05	0.11	2.44	-0.18	-1.17	0.03	0.62	0.30	3.26
gap_{t-2}	-0.14	-0.57	0.02	0.49	0.06	0.40	-0.06	-1.26	-0.13	-1.16
gap_{t-3}	-0.34	-0.83	-0.01	-0.35	-0.16	-1.48	0.12	1.99	---	---
gap_{t-4}	-0.34	-1.06	0.00	-0.04	-0.26	-1.44	---	---	---	---
gap_{t-5}	0.24	0.85	---	---	---	---	---	---	---	---
gap_{t-6}	0.42	1.76	---	---	---	---	---	---	---	---
Jarque Bera	0.18 (0.91)		1.41 (0.49)		1.33 (0.51)		0.60 (0.73)		1.78 (0.41)	
LM(4)	0.60 (0.66)		2.11 (0.13)		1.66 (0.21)		2.15 (0.09)		2.46 (0.12)	
ARCH(1)	0.92 (0.34)		0.00 (0.94)		2.46 (0.12)		0.48 (0.49)		0.40 (0.53)	
No. of observations	51		31		31		50		26	

Notes:
While not shown, dummies are included in the regressions when necessary to improve the estimations.
For the diagnostic tests, the probability is reported in parenthesis.

CHAPTER THREE

Monetary Policy Rules and Inflation Targets in Emerging Economies: Evidence from Mexico and Israel*

3.1. Introduction

High levels of inflation characterised many emerging economies at the beginning of the nineties. As a result different mechanisms that aim to reduce inflation were set in place. Consequently, a variety of monetary policy frameworks have been suggested. Three options are the most studied ones; the exchange rate, the monetary 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

* This chapter has received beneficial comments from Panicos Demetriades, Anthony Garratt, Sourafel Girma, Hashem Pesaran and seminar participants at the University of Westminster (October, 2004); University of Leicester (December, 2004) and for the Money, Macro and Finance Research Group (MMF) Conference (September 2005).

targeted rate. Several studies have focused mainly on either individual countries or regional experiences (see Amato and Gerlach, 2002; Bar-Or and Leiderman, 2000; Corbo, 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 by incorporating additional variables to the traditional central bank reaction function. Corbo (2000) 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 when this framework has been adopted in these countries. Different criteria are observed with regard to the main prerequisites that should be considered at the time of IT adoption (see Agenor, 2000; Schaechter *et al.,* 2000; Masson *et al.,* 1998).

The present study analyses the process, by 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. Israel is a good example of how IT has been adopted during a process of disinflation along with a crawling exchange rate band whilst 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 IT system. The stance regarding the exchange rate policy emerges as the most important difference. Overall, the results suggest that when setting monetary policy, central banks in these countries look beyond inflation and take into account other variables such as foreign reserves. Moreover, 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 IT principles along with policies based on fixed or managed exchanges rates.

The rest of the chapter is organised as follows. Section 3.2 briefly reviews the main features of different monetary policy regimes. This provides a critical evaluation, as to which of these strategies might be best suited to emerging economies. Section 3.3 examines how monetary policy has been conducted in Mexico and Israel in their transition to a fully-fledged IT regime. Section 3.4 introduces the concept of monetary policy rules, specifies a baseline interest rate rule and describes the estimation procedure. Then, section 3.5 presents the dataset and empirical results and the final section contains the conclusions.

3.2. The Choice of a Monetary Policy Regime

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. A useful way to classify possible systems is according to the instrument used by the policy-maker. According to Mishkin (1998), there are three basic strategies that central banks have used to control and reduce inflation: exchange rate pegs; monetary targeting; and inflation targeting. These strategies are analysed below.

3.2.1. Exchange-Rate Targeting

Targeting the exchange rate can take the form of fixing the value of the domestic currency to a commodity such as gold or fixing the value of the domestic currency to that of a large, low inflation country. Another alternative is the adoption of a crawling or peg in which the domestic currency is allowed to depreciate at a constant rate. This approach has several advantages. First, an exchange rate target fixes the inflation rate for internationally traded goods contributing to keeping that part of inflation under control. Second, if the exchange rate is credible, it anchors inflation expectations to the inflation rate of the anchor country. Third, this kind of regime provides an automatic rule for the conduct of monetary policy that avoids the time inconsistency problem.[23] In other words, monetary policy no longer has the discretion that can result in the periodic use of an expansionary policy. Finally, the public easily understands an exchange-rate targeting regime.

International experience, however, shows that several problems with this monetary policy regime can emerge, especially in the case of developing and emerging economies. One of these is the possibility of speculative attacks on the currencies. As Krugman (1979) suggests, under a fixed exchange rate regime, domestic credit creation in excess of money demand growth, may lead to a sudden speculative attack against the currency. Moreover, if there is any uncertainty about the future value of the domestic currency, an exchange rate target regime may encourage domestic firms and financial institutions to issue foreign denominated debt. With debt contracts denominated in foreign currency, devaluation leads to a deterioration in firms' balance sheets and lowers their net worth.[24]

An additional drawback of an exchange-rate target in emerging market countries is that a successful speculative attack (see Obsfeld and Rogoff, 1996) may

23 The policy credibility problem, known also as the time inconsistency problem, has been analysed by Kydland and Prescott (1977), Calvo (1978) and Barro and Gordon (1983) among others.

24 For most developed countries devaluation has little direct effect on the balance sheets of households, firms and banks since their debts are denominated in domestic currency. Indeed, devaluation in developed countries can stimulate economic activity because it makes the country's goods more internationally competitive, increasing its net exports and, therefore, aggregate demand. This topic will be discussed in the following chapter.

undo all the initially favourable results regarding inflation. A financial crisis can dramatically shift a path of reasonable growth, to a sharp decline in economic activity (i.e., Mexico in 1994-1995 and East Asian countries and Russia in 1997-1999). Finally, the problem of lack of accountability of the central bank under this regime makes it more difficult to know the stance of monetary policy. Increasing the accountability of the central bank implies a more clear, simple and understandable policy, as well as frequent communication with the public. This distinctive feature has been particularly emphasised in the inflation-targeting regime discussed later.

3.2.2. Monetary Targeting

In many countries, an exchange-rate regime is not even an option because the country is too large, or has no country to the currency of which it can anchor its currency. Monetary targeting is an alternative anti-inflation mechanism that depends on the ability of the central bank to carry out an independent monetary policy aimed at achieving and maintaining low inflation. One of the main advantages of monetary targeting is the capability of the central bank to adjust its monetary policy to changing domestic considerations. Additionally, as Mishkin (1998) points out monetary targets almost immediately send signals to both the public and markets, about the intentions of the policymakers to keep inflation down. Another convenience of using monetary targeting is that it avoids the time-inconsistency problem, promoting almost immediate accountability for monetary policy.[25]

25 The most successful example of this kind of regime was that of Germany which had engaged in monetary-targeting for over twenty years until it joined the Euro system in 1999.

The above advantages however depend on two main assumptions. Firstly, there must be a strong and reliable relationship between the goal variable (i.e., the inflation rate) and the targeted or monetary aggregate. A weak relationship implies that hitting the target will not produce the desired outcome on the goal variable. Secondly, the targeted monetary aggregate must be well controlled by the central bank. Otherwise, the monetary aggregate may not provide clear signals about the intentions of the policy-makers. In particular, the demand for money becomes very unstable in an economy that has experienced periods of high and variable inflation as economic agents develop ways to economize their use of money balances. On the other hand, stabilisation programmes in conjunction with financial reforms have increased the instability of money demand making traditional monetary targeting procedures less effective (see Masson *et al.,* 1998).

3.2.3. Inflation Targeting

The third strategy that has become increasingly popular in recent years is inflation targeting. This involves the public announcement of medium term numerical targets for inflation with an institutional commitment by the monetary authorities to achieve these targets.[26] Inflation targeting enables monetary policy to focus on domestic considerations and to respond to shocks in the domestic economy. Moreover, it uses all available information to identify the best settings for monetary policy. An inflation target has the capacity to reduce political pressure on the central bank, avoiding the time inconsistency problem. If actual inflation and expected

26 Detailed analyses of experiences with inflation targeting can be found in Haldane, 1995; Bernanke *et al.*, 1999 and Schaechter *et al.*, 2000.

inflation are the same then the result is that the society experiences a better economic outcome. Another benefit of IT is that it can embrace the pursuit of traditional stabilisation goals like fluctuations in output and employment, the maintenance of financial stability and the ability to respond to some short-run stabilisation goals. [27] In other words, inflation targeting involves an institutional commitment to price stability as the primary goal of monetary policy to which other goals are subordinated (see Mishkin, 1998).

Despite all of the strengths mentioned above, IT is not a panacea. The difficulty of controlling inflation, in particular when inflation is being brought down from relatively high levels creates several problems. Inflation forecast errors are likely to be large, inflation targets may be missed and it might be more difficult for the central bank to gain credibility (see Agenor, 2000; Mishkin, 2000). Additionally, IT cannot prevent fiscal dominance or ensure fiscal discipline and the exchange rate flexibility required by this framework might cause financial instability. Nonetheless, central banks in some emerging economies are not allowed to provide direct financing to the government and financial markets are reasonably well developed. Furthermore, low inflation and flexible exchange rates in the recent experience of some emerging economies highlight the ability to achieve moderate levels of inflation following consistent macroeconomic policies supported by discretionary actions (see Mishkin and Savastano, 2000).

27 This is an important issue in emerging economies, which are more vulnerable to shocks (i.e., capital flows).

3.3. The Practice of Monetary Policy in Emerging Economies

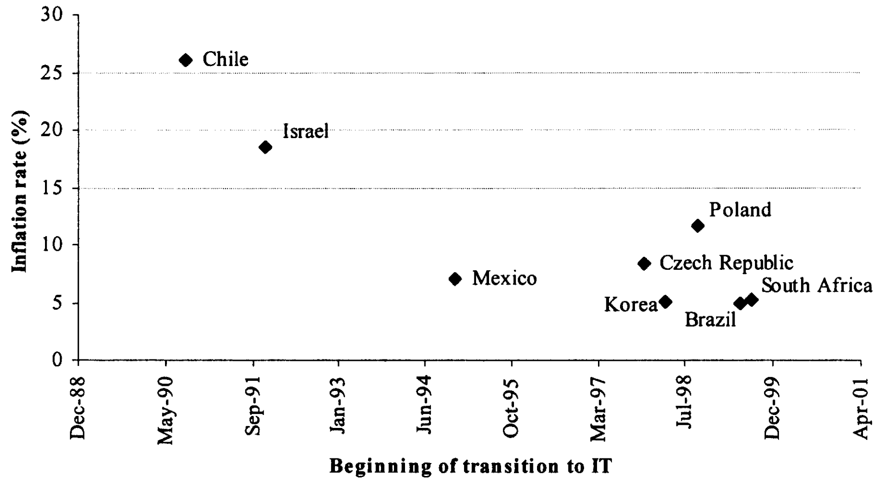
In recent years, several emerging economies have been forced to adopt more flexible exchange rates as a consequence of serious financial or currency crises. Therefore, they have had to find a different nominal anchor to guide domestic monetary policy over the medium and long term. As a result, some of these countries have introduced inflation targets and since then they have followed successful strategies for disinflation during their transition towards a fully-fledged IT regime.[28] 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. Mexico has been regarded as one of the few cases of a Latin American country, which is 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 important 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 (see Agenor, 2000; Schaechter *et al.,* 2000).

It is important to note that although more emerging economies have recently introduced IT principles (see Figure 3.1) their short experience constitutes a restriction in carrying out reliable econometric analysis. Nonetheless, the experiences of Israel and Mexico may be considered as pioneering cases for

28 This seems not to be the case for industrialised countries where disinflation had largely been completed by the time of the IT adoption. This issue is discussed in chapter 2.

emerging economies in their effort to reduce high levels of inflation along with the implementation of IT. [29] Furthermore, the different stances concerning the exchange rate policy in these two countries constitute an interesting field for analysis. The following sections briefly introduce how monetary policy has recently been practised in the two selected countries in their effort to reduce inflation.

Figure 3.1.
Inflation Rate at Adoption of IT in Emerging Economies



3.3.1. 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

29 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 on the practice of developed countries.

exchange rate was fixed and became the main anchor of an anti-inflationary policy. As the reforms advanced and became consolidated the country was subject to large capital inflows.[30] This contributed to a real exchange rate appreciation which helped to finance a rising current account deficit. This exceeded 7% of the GDP in 1992 and 1993. Thus, 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 (see 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 was also committed to increased transparency of its own actions by making more timely information available on its balance sheets, as well as other monetary and fiscal indicators. Low international reserves and the uncertainty prevailing in financial markets after the collapse of the currency reinforced the decision to formally adopt a floating exchange rate policy.

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 (see Figure 3.2). Gross Domestic Product grew 5.6 percent on average for the period 1996-1998, while consumption and investment

30 Between 1990 and 1993 Mexico received more than one half of all of the capital inflows that moved into Latin America.

also improved. Inflation declined from 51.7 percent in 1995 to 12.3% in 1999. Moreover, in 1999, for the first time, the central bank announced a 10% inflation target for the year 2000 before the Ministry of Finance submitted the economic programme for the year to the Congress. This movement contributed to the increase of accountability of the central bank regarding its inflation objectives. Also, for the first time, the Central Bank announced a multiyear target for inflation by stating that it intended to lower inflation to 'international levels', by 2003. 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 *et al.*, 2001; Schmidt-Hebbel and Werner, 2002).

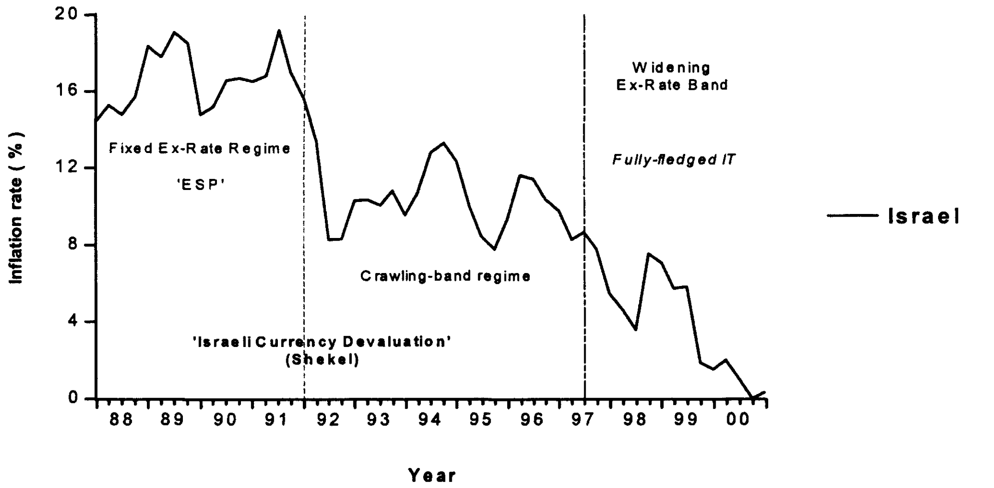
3.3.2. Israel

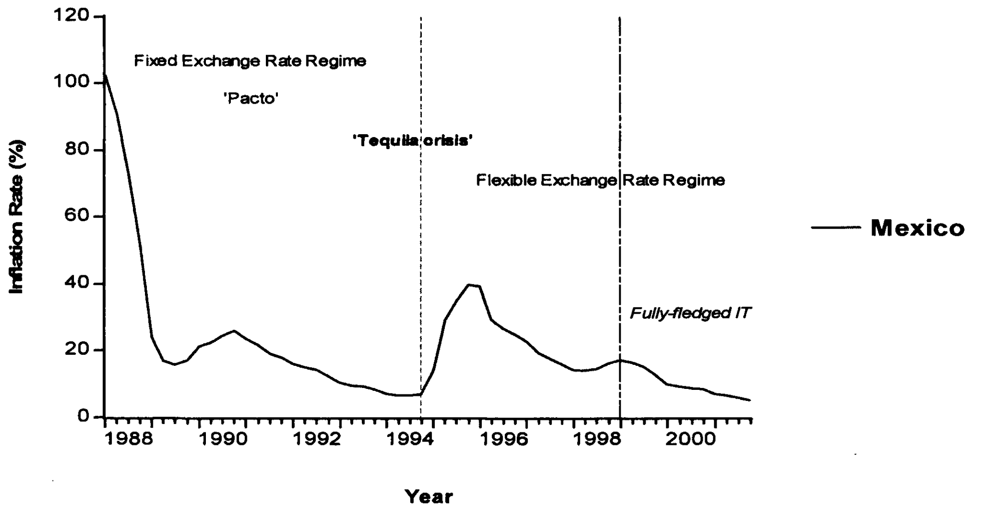
Inflationary developments in Israel are closely linked to exchange rate policy and demand pressure. At the beginning of the 1980s, the rate of inflation rose persistently and at an increasing rate, reaching three-digit levels. This continued until mid-1985, when the Economic Stabilization Programme (ESP) was introduced. The principal role of monetary policy under the ESP was to defend the exchange rate policy (see Haldane, 1995). The exchange rate against the dollar was set as the nominal anchor for prices. Nevertheless, the Israeli currency 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 towards inflation targeting (see Bufman and Leiderman, 2000).[31]

Israel began its transition towards inflation targeting in conjunction with the announcement of a crawling exchange rate band in December 1991 and can be said to have moved to a fully-fledged inflation-targeting framework with the widening of the exchange rate band to 28 percent in June 1997. 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 (see Figure 3.2). In 1999, the Ministry of Finance announced two-year targets of 3-4 percent for 2000 and 2001. The Bank of Israel started publishing semi-annual inflation reports in March, 1998 but it refrained 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, the inflation targets have since 1992, 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's inflation targeting provides an important example of how monetary policy can be made more flexible, with no apparent loss of credibility and effectiveness.

31 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.

Figure 3.2.
Inflation Rates in Israel and Mexico
(1988-2000)





3.3.3. Inflation Targeting and the Role of the Exchange Rate

The role of the exchange rate under IT has been a debatable issue in the case of emerging economies. A country that chooses a fixed exchange rate system subordinates its monetary policy to the exchange rate objective and consequently the 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 a nominal anchor of the economy. In theory, an exchange rate target could coexist with an inflation target as long as the monetary authorities make clear that the latter objective has priority if a conflict arises (see Masson *et al.*, 1998).

The conduct of monetary policy in Mexico and Israel suggests that IT can become a successful medium-term strategy for monetary policy in emerging economies, independently of the stance towards the exchange rate. But, has monetary policy indeed become the nominal anchor of the economy? In both countries, while credibility was being built and inflation was gradually being 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 the industrial countries' levels. Afterwards, these countries started using 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 Mexico was forced to adopt a floating exchange rate as a result of severe pressure on its currency. The following section introduces a baseline specification and the estimation technique used in this study to empirically evaluate the importance of the exchange rate among other variables, at the time monetary authorities set interest rates. This specification allows us to answer the above question as to the monetary policy stance.

3.4. A Monetary Policy Rule: Baseline Specification and Estimation Technique

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 the interest rate, exchange rate, other asset price effects and the so-called credit channel. The second approach – the one this study focuses on evaluates the conditions under which monetary authorities react to changes in 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, 2000).

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 increased attention on this kind of 'feedback rules' for IT (see Table 3.1A in the Appendix). Amato and Gerlach (2002), for example, evaluate IT in emerging and transition economies and find that an important distinguishing feature of inflation targeting is that it leads to a more systematic interest rate response to inflation by the central bank.

3.4.1. 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:

$$r_t = \alpha \cdot r_{t-1} + \gamma[E_t(\pi_{t+k}) - \pi^*] \qquad (3.1)$$

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. 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: [32]

$$r_t = r^* + \alpha(\pi_t - \pi^*) + (1-\alpha)(y_t - y^*) \qquad 0 < \alpha < 1 \qquad (3.2)$$

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

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

output response. Conversely, when inflation or output falls below its target, the central bank should reduce interest rates.

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

$$i_t^* = \bar{i} + \beta \cdot [E(\pi_{t+n} \mid \Omega_t) - \pi^*] + \gamma \cdot [E(y_{t+k} \mid \Omega_t) - y_{t+k}^*] \tag{3.3}$$

where $\bar{i}$ denotes the long run equilibrium nominal interest rate, 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 i^* is the interest rate set by the central bank; π^* 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.

Empirically, this reaction function offers a reasonably good description of the way major central banks have performed recently. Clarida *et al.* (1998), for instance, estimate various reaction functions 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, evaluate central banks' interest rate setting behaviour in a group of 13 emerging economies. They found that in most of these countries the interest rate responds strongly to the exchange rate and that in some cases the response was higher than 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 only Chile uses monetary policy with a clear commitment to achieve the target inflation.[33]

Theoretically, policy implications given by equation (3.3) 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, r_t^*, given by:

$$r_t^* = \bar{r} + (\beta - 1) \cdot [E(\pi_{t,k} \mid \Omega_t) - \pi^*)] + \gamma \cdot [E(y_{t+k} \mid \Omega_t) - y_{t+k}^*] \qquad (3.4)$$

where $r_t^* \equiv i_t - E(\pi_{t,k} \mid \Omega_t)$ and $\bar{r} \equiv i^* - \pi^*$ 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, $\bar{r}$ is a constant and is independent of monetary policy.[34] As equation (3.4) 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.

33 The other countries are: Colombia, Costa Rica, El Salvador, Nicaragua and Peru.

34 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.

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 $\beta \leq 1$ are likely to be destabilizing or, at best, accommodative of shocks to the economy. 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. Accordingly, the coefficient β turns out to be a key parameter in assessing central bank's response. If a monetary policy rule like equation (3.4) with $\beta > 1$ 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 equation (3.4) with $\gamma > 0$ 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 (see Torres, 2002). In addition, this specification allows the control of inflation and the stabilisation of output to be identified as independent objectives and considers all the information available at the time the central bank set interest rates.[35]

3.4.2. Interest Rate Smoothing

The policy reaction function given by equation (3.3) assumes an immediate adjustment of the actual interest rate to its target level. It treats all changes in interest rate over time as reflecting the central bank's systematic response to

35 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.

economic conditions. It also assumes that the monetary authorities have perfect control over interest rates. In other words, it does not allow for any uncertainty in policy actions other than that associated with incorrect forecasts. Central banks, however, adjust interest rates more cautiously towards their desired levels than standard models predict (see Goodfriend, 1991). To allow for this possibility, a partial adjustment equation is considered as follows: [36]

$$i_t = (1-\rho)\cdot i_t^* + \rho \cdot i_{t-1} + \upsilon_t \qquad (3.5)$$

where the parameter $\rho \in (0,1)$ reflects the degree of lagged dependence of the interest rate or the degree of interest rate smoothing. Each period the central bank adjusts the interest rate to eliminate a fraction $(1-\rho)$ of the gap between its current target level and its past value.

The interest rate target i_t^* is given by equation (3.3) and υ_t is an exogenous random shock that is assumed to be *i.i.d* (0,1). In particular, Clarida *et al.* (1998, 2000), combine the partial adjustment equation (3.5) with the target model (3.3) to yield the following policy reaction function:

$$i_t = (1-\rho)\cdot\{\alpha + \beta\cdot E[\pi_{t+n} \mid \Omega] + \gamma \cdot E[x_t \mid \Omega]\} + \rho\cdot i_{t-1} + \upsilon_t \qquad (3.6)$$

where $\alpha \equiv \bar{i} - \beta\pi^*$ and $x_t \equiv y_t - y_t^*$. Finally, assuming that expectations are rational expected values, they are replaced by realised values in order to obtain the following estimable equation:

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

$$i_t = (1-\rho)\cdot\alpha + (1-\rho)\cdot\beta\cdot\pi_{t+n} + (1-\rho)\cdot\gamma\cdot x_t + \rho\cdot i_{t-1} + \varepsilon_t \qquad (3.7)$$

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.

3.4.3. Estimation Technique

The estimation of equation (3.7) 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 $\text{cov}(x_t, \varepsilon_t) \neq 0$. To obtain unbiased and consistent estimators the model is estimated using the General Method of Moments (GMM).[37] In this respect, let U_t symbolize a vector of instruments known when the interest rate, i_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. This 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 equation (3.7) gives us the explicit set of restrictions used by GMM:

$$E[i_t - (1-\rho)\cdot\alpha - (1-\rho)\cdot\beta\cdot(\pi_{t+n}) - (1-\rho)\cdot\gamma\cdot(x_t) - \rho\cdot i_{t-1} | U_t] = 0 \qquad (3.8)$$

37 For a detailed description of this method see Greene (2003) and Enders (1995).

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

3.4.4. Additional Variables

So far, the discussion has not considered the inclusion of additional variables to the baseline equation (see equation 3.7). In practice, the output gap and inflation are not the only relevant objectives. Ball (1999) and Svensson (2000), for instance, argue that monetary policy rules should take into account other variables, such as foreign interest rates or the exchange rate which might reflect uncertainties about future inflation faster than expected inflation or the output gap. In addition, some central banks in emerging economies, such as the central bank of Chile, the 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. For each alternative specification, the following equation is estimated:

$$i_t = (1-\rho)\cdot\{\alpha + \beta\cdot[\pi_{t+n} - \pi^*_{t+n}] + \gamma\cdot[x_{t+k}] + \varphi\cdot[z_{t+j} - z^*_{t+j}]\} + \rho\cdot i_{t-1} + \varepsilon_t \qquad (3.9)$$

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

3.4.4.1 Money and the Exchange Rate

It is plausible to expect that a variable that would be important in the context of small open economies that have experienced currency crisis would be the exchange rate (see section 3.3.3). Recent work by Ball (1999) and Svensson (2000) on small open economies' models has examined the role of the 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. Furthermore, 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. Nonetheless, other authors, such as Taylor

(2001), argue that although the exchange rate is important, particularly in emerging economies, any reaction of interest rates to this variable would be indirect through its effect on inflation and the output gap. As discussed earlier, the role of the exchange rate under IT has been a debatable issue in the case of emerging economies. 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 and positive coefficients. This issue makes the case of Israel particularly interesting since the authorities have underlined their priority to price stability in case of conflict.

On the other hand, the inclusion of a measure for the money supply (*m*) allows us to evaluate the response of the monetary authorities to fluctuations in the aggregate demand and, therefore, on prices. 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. Nevertheless as it was earlier discussed (see Section 3.2.2) the demand for money becomes very unstable in an economy that has experienced periods of high and variable inflation as economic agents develop ways to economize their use of money balances. On the other hand, stabilisation programmes in conjunction with financial reforms have increased the instability of money demand making traditional monetary targeting procedures less effective (see Masson *et al.,* 1998).

3.4.4.2 Current Account Deficit, Foreign Reserves and the Lending Boom Indicator

Three more variables are considered in the augmented interest rate rule. The first one 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 economies. Corbo (2000), for example, finds that central banks in Latin America show an important preference to stabilise current account deficits in the balance of payments, even though this is not announced explicitly. The deficit represents the excess of expenditure over income so that if it increases this means that aggregate demand goes up, intensifying inflationary pressures and enlarging the balance of payments deficit (see Medina and Valdes, 2002; Weitzman, 2002).

The second variable 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 countries have been accumulating reserves even though they have adopted more flexible exchange rates. This strengthening of reserves may be seen as a method of building up credibility and, therefore, it may be related to the process of having more stability. The more the reserves, the greater the credibility attained by the monetary authorities and the less the need to modify the stance of the monetary policy. 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 third variable is constructed as the logarithm of the ratio of the claims on private sector to gross domestic product (GDP). This 'lending boom' variable indicator has been mainly used to explain 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 for economic growth. Therefore, there is more pressure on future inflation and, consequently, the need to raise interest rates.

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. In this respect, although optimal reactions functions are estimated, these are not necessarily the best policy for day-to-day policy-making. Setting interest rates resembles a rule-like behaviour and any model, by definition, is an incomplete description of reality. Table 3.1A 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.

3.5. Data and Empirical Results

3.5.1. Data

This study uses quarterly time series data, spanning the period 1982Q1-2001Q4 in the case of Mexico, and 1988Q1-2001Q4 in the case of Israel. The dataset 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 as follows:

- *Gross Domestic Product:* Seasonally Adjusted (SA) Gross Domestic Product code 99.. rzf of the IFS catalogue.
- *Inflation:* Consumer prices, code 60..zf of the IFS catalogue.
- *Interest Rate (short term):* Treasury Bill rate code b..zf for Mexico and the Overall Cost of Unindexed Credit, code 60 p..zf for Israel.
- *Nominal Exchange rate:* The Market rate code ..rf..zf for Israel and the Principal rate, code ..rf..zf for Mexico.
- *Money:* Money, code 34..zf + Quasi-Money, code 35..zf from the IFS catalogue.
- *Foreign reserves*: Foreign assets code 11..zf of the IFS catalogue.
- *Current account*: Current account in million of US dollars code 78 ..zf . of the IFS catalogue.

All variables are in natural logarithms. Inflation, depreciation and money growth are calculated as annual percentage changes. The output gap is constructed following the Hodrick-Prescott procedure and the analysis is based on the primary assumption, that within short samples all variables are stationary (see Tables 3.2A and 3.3A in the Appendix). [38]

38 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. The series is constructed as the deviation of the natural logarithm of the GDP from its potential value.

3.5.2. Empirical Results

In the following the results of alternative estimates of equation (3.7) are presented for each country. Three different specifications are considered. The first one uses actual values instead of expected or forecasted ones (Baseline model). The main reason is the lack of reliable data for the entire sample period in the absence of official and commonly accepted forecast figures. This, however, assumes perfect foresight. In the second specification, actual values of the explanatory variables are replaced by their deviations from trend values (Gap model). Finally, a third specification is carried out for the robustness of the analysis, with data on inflation expectations available in each country (Forward-looking model). This implies, however, the estimation of equation (3.7) for a shorter sample period. The model is estimated using the generalised method of moments and the instrument set includes lagged values (up to four lags) of the output gap, the inflation rate, the interest rate, the depreciation rate and a measure of the money supply. [39]

3.5.2.1 The Case of Mexico

3. 5.2.1.1. Baseline Model

The case of Mexico offers the possibility of evaluating the main determinants of monetary policy, setting interest rates with and without the implementation of IT principles. In this respect, a dummy variable is used for important monetary policy reforms, without the need to break the sample up which would be problematic,

39 The weighting matrix is chosen so that the GMM estimations are robust to heteroskedasticity and autocorrelation of unknown form. The bandwidth selection criterion is set to be the fixed Newey and West and the autocovariances in computing the weighted matrix are weighted according to a Bartlett Kernel.

given the short sample period.[40] In the case of Mexico, the year 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 announcement for the first-time of inflation annual objectives.[41] The dummy variable equals 0 for the pre-reform period; that is, before 1994 and takes the value of one otherwise. Thus, the following 'interest rate rule' is estimated:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\delta \cdot dummy95 \cdot \pi_{t+3} + \rho \cdot i_{t-1} + \varepsilon_t \tag{3.10}$$

The results of this baseline equation are presented in the first row of Table 3.1. As mentioned before, β turns out to be a key parameter in assessing the central bank's response (see Section 3.4.1). In this case, the parameter β is positive and statistically greater than one. 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%. Although parameter γ has the expected sign, it is not statistically

40 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 (2000), however, as it is the case of this study, arguing sufficient variability in their estimations, estimate policy rules within short samples.

41 A dummy variable for 1988 to account for the oil-price shock is also considered. Nevertheless only in few cases is this significant and the results do not improve considerably.

significant. The dummy variable turns out to be positive ($\delta = 2.56$) 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 (β coefficient) when the monetary authorities made their commitment to price stability explicit (1.80 vs. 4.36 respectively).

Overall, our findings suggest that monetary policy in Mexico has been consistent with the objective of achieving lower levels of inflation. The following section, 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.

Table 3.1.
Monetary Policy Rules: Baseline and Augmented Estimations[1]
Mexico: 1982-2001

	α	β pre-reform	γ	δ	φ	ρ	*J-test*
Base specification	**5.42**	**1.80**	35.96	**2.56**	---	**0.83**	10.59
	[3.85]*	**[5.28]***	[0.34]	**[2.26]***		**[13.55]***	[0.78]
Backward-looking	**7.84**	**0.25**	17.5	**-0.76**	**0.84**	**0.67**	10.52
	[2.09]*	**[2.12]***	[0.30]	**[2.85]***	**[5.54]***	**[10.93]***	[0.72]
Depreciation rate	**8.43**	-0.50	52.74	0.61	**6.38**	**0.75**	10.53
	[1.73]^	[0.74]	[0.45]	[1.04]	**[2.06]***	**[8.35]***	[0.72]
Money growth	-2.73	**1.83**	79.7	0.02	**-0.29**	**0.81**	9.28
	[0.42]	**[6.26]***	[0.61]	[0.06]	**[2.70]***	**[13.41]***	[0.81]
Foreign reserves	-4.18	**1.41**	-38.76	**1.15**	**-0.88**	**0.80**	10.34
	[0.65]	**[8.01]***	[0.42]	**[2.14]***	**[3.71]***	**[21.06]***	[0.92]
Lending boom indicator	-47.81	**1.15**	-4.25	0.39	34.5	**0.78**	12.09
	[1.15]	**[5.87]***	[0.08]	[1.22]	[1.18]	**[13.36]***	[0.84]
Current account	**-22.76**	**1.65**	-37.88	**0.84**	**-0.0003**	**0.63**	13.34
	[2.62]*	**[9.71]***	[0.82]	**[3.49]***	**[3.16]***	**[13.57]***	[0.92]

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

3.5.2.1.1.1 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:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\delta \cdot d95 \cdot \pi_{t+3} + (1-\rho)\varphi \cdot z_t + \rho \cdot i_{t-1} + \varepsilon_t \quad (3.11)$$

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**

To check whether interest rates are determined more in a forward-looking than a 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 (φ>1) rather than when inflation is generated in a forward-looking form. The results presented in Table 3.1 suggest that there is a significant contribution of the lagged value of inflation in the determination of interest rates in Mexico. However, its value is 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 (see Torres, 2002; Taylor, 2001).

- **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.[42] Results reported in Table 3.1 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.

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 (first log difference).[43] 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.

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

43 Including the quarterly change in the estimation of this variable does not alter the results.

- **Current Account Deficit, Foreign Reserves and the Lending Boom Indicator**

After several attempts to reduce inflation to stable rates Mexico has eventually achieved this goal despite experiencing profound economic crises. 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 3.1. As in the baseline case, parameter β is statistically greater 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.

3. 5.2.1.2. 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).[44] In this respect the Hodrick-Prescott filter is used to measure the trend values and a shorter period is considered: 1988Q1-2001Q4. [45]

The results presented in Table 3.2, in general, support our previous findings. Parameter β is always greater than one and statistically significant, suggesting the commitment of the monetary authorities to stabilise the economy. Two exceptions arise when the depreciation rate and the lending boom indicator are added suggesting that these variables contain information already given in the main

44 Deviations from trend values are mainly used for the inflation and output gap variables.

45 Poor results are obtained from the estimation considering the full sample period.

variables. In all the augmented policy rules the signs of all estimated parameters are the expected ones and statistically significant, except for the output gap (parameter γ). Finally, parameter ρ decreases in this sample period, suggesting that approximately half of the initial adjustment is achieved in one quarter.

3.5.2.1.3. 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.[46] 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).[47]

46 In this sense the Lucas critique that the parameters of traditional macro econometric models depend implicitly on agents' expectations of the policy process and are unlikely to remain stable as policy makers change their behaviour is considered.

47 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. 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).

Table 3.2.
Gap model : Baseline and Augmented Policy Rule [1]
Mexico: 1988-2001

	α	β	γ	φ_1	ρ	*J-test*
Base specification	**23.35**	**2.23**	19.20	---	**0.53**	9.47
	[14.64]*	**[9.75]***	[0.42]		**[14.43]***	[0.89]
Backward-looking	**26.67**	**1.91**	-46.39	**0.89**	**0.34**	6.94
	[10.89]*	**[6.25]***	[0.76]	**[6.36]***	**[5.79]***	[0.95]
Depreciation rate	**16.02**	**0.29**	10.50	**0.54**	**0.16**	9.34
	[19.41]*	**[2.78]***	[0.68]	**[13.76]***	**[4.44]***	[0.85]
Money growth	**22.9**	**2.55**	-8.16	**0.25**	**0.52**	7.61
	[10.01]*	**[8.38]***	[0.14]	**[2.09]***	**[11.58]***	[0.94]
Foreign reserves	**22.1**	**2.71**	25.02	**0.0002**	**0.53**	7.63
	[9.68]*	**[6.84]***	[0.61]	**[2.44]***	**[11.74]***	[0.97]
Lending boom indicator	**10.68**	**0.53**	17.90	**0.21**	**0.81**	9.34
	[3.75]*	**[2.64]***	[0.29]	**[3.19]***	**[33.55]***	[0.85]
Current account	**25.93**	**2.49**	-38.77	0.002	**0.66**	9.17
	[23.86]*	**[6.05]***	[0.96]	[1.61]	**[23.86]***	[0.95]

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

The results shown in Table 3.3 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 as in previous specifications suggesting that the Bank of Mexico has been concerned with inflation stabilization. Interesting is the comparison of the values obtained from this sample period (post-reform period) and the ones obtained from the pre-reform period using the baseline model (see Table 3.1). The coefficients are quantitatively very similar and statistically significant but in the case of the post-reform parameter β is always greater than one. The introduction of the backward-looking component and the depreciation rate into the forward-looking specification not longer affects the value of the β coefficient as it was observed in the baseline model. The coefficient of the output gap for this sample period (1996-2002) turns out to be statistically significant and it demonstrates the expected value in all the estimations. The monetary authorities seem to be also concerned with output fluctuations. In particular, the results imply that the authorities increase interest rates when a rise in the gap between GDP and its trend is expected. The smoothing parameter decreases substantially using this specification (post-reform 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 for this sample period suggest that monetary policy in Mexico has been consistent with IT principles. Monetary policy has become the nominal anchor of the economy. 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, the most significant being the one of the lending boom indicator. Another interesting result emerges from the inclusion of changes in the nominal exchange rate. Although significant, its small contribution suggests that a flexible exchange rate has indeed contributed to reduce inflation. Furthermore, the inclusion of lagged values of the inflation in our estimation suggest that setting interest rates in Mexico has become more forward than backward-looking (see Mehra, 1999; Clarida *et al.*, 1998, 1999).

Table 3.3
Forward-Looking Model : Baseline and Augmented Policy Rule [1]
Mexico: 1996-2002

	α	β	γ	φ_1	ρ	*J-test*
Base specification	**15.50**	**1.86**	**18.77**	—	**0.12**	5.81
	[138.03]*	**[151.47]***	**[7.79]***		**[15.31]***	[0.92]
Backward-looking	**15.46**	**1.80**	**20.17**	0.06	**0.12**	5.34
	[114.84]*	**[36.15]***	**[6.52]***	[1.64]	**[10.54]***	[0.91]
Depreciation rate	**15.89**	**1.78**	**20.41**	**0.02**	**0.12**	6.58
	[355.14]*	**[170.91]***	**[16.17]***	**[2.62]***	**[35.47]***	[0.96]
Money growth	**15.87**	**1.70**	**11.70**	**0.03**	**0.15**	6.93
	[443.69]*	**[97.95]***	**[12.91]***	**[11.07]***	**[40.17]***	[0.96]
Foreign reserves	**15.66**	**1.88**	**17.81**	**8.6E-0.6**	**0.11**	6.41
	[239.55]*	**[75.28]**	**[12.17]***	**[3.03]***	**[15.64]***	[0.97]
Lending boom indicator	**15.58**	**2.08**	**21.43**	**8.11**	**0.05**	6.33
	[186.87]	**[38.35]***	**[13.57]***	**[5.03]***	**[3.32]***	[0.97]
Current account	**15.91**	**1.76**	**16.92**	0.0002	**0.15**	6.29
	[291.76]*	**[47.37]***	**[8.86]***	[1.14]	**[7.94]***	[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 brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

3.5.2.2 The Case of Israel

3.5.2.2.1. Baseline Model

Following the same procedure as in the case of Mexico, a monetary policy rule is estimated using quarterly data for the period 1988:Q1-2001Q4. Hence, the 'interest rate rule' is given by:[48]

$$i_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + \rho \cdot i_{t-1} + \varepsilon_t \qquad (3.12)$$

The results of this estimation are shown at the top of Table 3.4. The coefficient associated to inflation is positive but less than one, suggesting that monetary

48 A dummy variable was 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 in 1992. The estimated parameter, however, was not significant suggesting the absence of significant changes affecting the structure of the Israeli economy at that time.

authorities are not particularly determined to control inflation shocks. In other words, it seems that nominal interest rates are not responding by more than one-for-one to changes in inflation in order to control the economy (see Rudebusch, 2005). The estimated parameter of the partial adjustment process for interest rates seems to be particularly high (ρ = 0.84), suggesting concern about smoothing adjustments and the coefficient of the output gap is positive but statistically insignificant.

3.5.2.2.1.2 Augmented Monetary Policy Rules for Israel

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

$$i_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\varphi \cdot z_t + \rho \cdot i_{t-1} + \varepsilon_t \qquad (3.13)$$

where z_t represents any variable, other than inflation and output that may influence the process, through which the 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 on 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 are presented in Table 3.4. All variables are statistically significant at the five-percent level and have the expected signs. The coefficient associated with the backward-looking component suggests 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 sum of these values is statistically less than one which validates the results from the baseline model regarding the lack of a clear commitment to reduce inflation. 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 GDP is 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 percent of the change.

Table 3.4.
Monetary Policy Rule: Augmented Estimation[1]
Israel: 1988-2001

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

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
[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

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 better influence and describe the process through which interest rate is determined.

- **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).[49] As in the baseline model the parameter β is statistically less than one and the parameter γ is positive but statistically insignificant (see Table 3.4). The coefficient associated to the money growth (parameter φ) is positive and statistically different from zero at the 10 percent level of significance

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 (decrease) means depreciation (appreciation). As discussed, inflation targets in Israel coexist with another nominal policy commitment, the crawling exchange rate band for the NIS (new Israeli shekel) against a basket of foreign currencies. The results presented in Table 3.4 (case 1) suggest an important contribution of this variable at the time monetary authorities set interest rates. Israel policy seems to react similarly to both changes in exchange rates and inflation. To analyse this issue in more detail,

49 Empirical studies undertaken in the Bank of Israel (Weitzman, 2002) 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.

current and lagged values of the change in the nominal exchange rate are considered in the augmented policy rule as follows:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta \cdot \pi_{t+3} + (1-\rho)\gamma \cdot x_{t+2} + (1-\rho)\varphi_1 \cdot z_t + (1-\rho)\varphi_2 \cdot z_{t-1} + \rho \cdot i_{t-1} + \varepsilon_t \tag{3.14}$$

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 and positive coefficients on both current and lagged values of the depreciation rate. The results presented as case 2 in Table 3.4 provide evidence on central bank reaction to exchange rate movements. It seems that the interest rate response to the lagged value of the change in the exchange rate exceeds that for the inflation rate. The parameter φ is statistically different from zero and positive. This result suggests the possibility of a discrepancy between exchange rate and price stability for emerging economies when there is not a clear commitment to one of the objectives.

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 3.4 confirm previous findings, particularly regarding the value of β, which remains statistically less than one as well as the importance of movements of the exchange rate when monetary authorities set interest rates.

- **Current Account Deficit, Foreign Reserves and the Lending Boom Indicator**

As in the case of Mexico, three more variables are considered as potential indicators of 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 the formulation of monetary policy. Results reported in Table 3.5 show that with the exception of the lending boom indicator the estimated coefficients are statistically significant and demonstrate 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 ($\rho = 0.80$). On average, eighty percent of the level of the short-term interest rate is explained by its lagged value.

Table 3.5.
Monetary Policy Rule: Augmented Estimation (cont.)[1]
Israel: 1988-2001

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

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

To look for any possible change in the way monetary policy is performed after the adoption of inflation targets, the baseline equation is estimated for the 1992Q1-2001Q4 sample period. The results are shown in Table 3.4A in the Appendix. All variables are statistically significant at the five-percent level and have the expected signs. The evidence supports the findings for the whole sample period. In particular, the coefficient associated to inflation is in all cases significantly less than one suggesting that, during this period, the authorities tended to accommodate rather than to stabilise expected shocks to inflation.

3.5.2.2.2. 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. As in the case of Mexico the Hodrick-Prescott filter is used to measure the inflation and output trend values. The results are presented in Table 3.6. The results are quite remarkable. 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 with the output gap is statistically insignificant. These results suggest that the central bank in Israel does not accommodate inflation pressures – contrary to previous estimations. It seems that monetary policy has effectively stabilised the economy. In as far as output stabilisation is concerned; the evidence is mixed when compared with the baseline model. 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. 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.

Table 3.6.
Gap Model : Baseline and Augmented Policy Rule [1]
Israel: 1988-2001

	α	β	γ	φ_1	ρ	*J-test*
Base specification	**11.45**	**2.72**	**-171.80**	---	**0.90**	10.09
	[9.02]*	**[3.37]***	**[3.45]***		**[180.5]***	[0.86]
Backward-looking	**9.97**	**9.08**	15.41	**1.81**	**0.92**	8.98
	[4.57]*	**[7.98]***	[0.22]	**[4.38]***	**[121.1]***	[0.87]
Depreciation rate	**10.52**	**3.58**	**-26.29**	0.003	**0.91**	10.23
	[5.09]*	**[5.75]***	**[4.41]***	[0.02]	**[124.5]***	[0.80]
Money growth	4.39	**7.55**	34.48	**0.62**	**0.88**	8.09
	[1.54]	**[5.63]***	[0.61]	**[4.66]***	**[61.07]***	[0.91]
Foreign reserves	**10.82**	**2.14**	**-199.2**	0.07	**0.90**	11.20
	[9.54]*	**[3.73]***	**[3.25]***	[1.94]^	**[165.4]***	[0.92]
Lending boom indicator	**4.34**	**5.23**	**262.90**	**406.9**	**0.87**	12.02
	[2.83]*	**[9.68]***	**[4.00]***	**[12.54]***	**[125.2]***	[0.88]
Current account	**8.50**	**5.35**	**-113.2**	**-0.02**	**0.91**	10.81
	[7.92]*	**[9.57]***	**[2.02]***	**[4.83]***	**[200.1]***	[0.96]

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

Regarding the results from the augmented policy rules, the signs of all estimated parameters are both expected and statistically significant. The only exception is when the current account deficit is considered.

3.5.2.2.3. Inflation Targeting in Israel

To explore in 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 inflation expectations has been 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 3.7. It is important to note that the forward-looking policy function confirms most of the findings from the gap model. Parameter β continues above unity, suggesting that the Bank of Israel has been concerned with inflation stabilization. The coefficient of the output gap becomes significant, but just with the expected sign, 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.

Table 3.7.
Forward-Looking Model : Baseline and Augmented Policy Rule [1]
Israel: 1993-2001

	α	β	γ	φ_1	ρ	*J-test*
Base specification	14.56	3.29	-37.83	---	0.66	7.38
	[48.56]*	[12.39]*	[3.27]*		[22.69]*	[0.96]
Backward-looking	8.74	4.32	-116.2	1.30	0.85	6.47
	[5.14]*	[5.23]*	[3.55]*	[5.45]*	[27.56]*	[0.97]
Depreciation rate	17.02	2.46	-86.38	-0.83	0.68	16.6
	[71.12]*	[14.91]*	[7.17]*	[8.63]*	[36.30]*	[0.96]
Money growth	13.00	3.71	10.79	15.64	0.60	7.18
	[28.58]*	[9.26]*	[1.08]	[2.07]*	[18.41]*	[0.95]
Foreign reserves	14.73	1.39	-19.98	0.06	0.49	7.60
	[85.41]*	[21.16]*	[6.52]*	[11.58]*	[14.76]*	[0.99]
Lending boom indicator	12.98	3.13	126.10	406.9	0.80	7.22
	[28.01]*	[10.94]*	[13.05]*	[12.54]*	[59.40]*	[0.90]
Current account	15.17	1.63	-17.39	0.001	0.70	8.54
	[259.8]*	[75.32]*	[23.11]*	[2.56]*	[112.8]*	[0.99]

[1] The numbers in brackets are white consistent adjusted t-statistic values, except in the J-test column where they represent the 'p' value for the overidentification test.
* Statistically significant at 95% confidence level
^ Statistically significant at 90% confidence level

The results obtained from the forward-looking model reflect the concern by the monetary authorities in matters related to financial stability. Positive contributions are observed in all additional variables, the most significant one being from the lending boom indicator. The results in the backward-looking estimation are notable. 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.

On the whole, the empirical evidence with regard to the stance of monetary policy in Israel is mixed. Different conclusions can be derived from the baseline model in comparison with the other two specifications: the gap and the forward-looking model. In the former there is not a clear commitment to inflation targeting whereas the opposite is observed in the latter. A possible explanation can be the announcement of inflation targets in the context of formulating exchange rate target paths (see Schaechter *et al.*, 2000). Although, conflicts between the inflation target and the exchange rate band have been solved in favour of the former over time (see Bernanke *et al.*, 1999), Israel used foreign exchange rate intervention to keep the exchange rate within the pre-announced crawling band. The Bank of Israel refrained from intervening in foreign currency trading in mid-1997. Since then, the exchange rate has been determined by market forces, with the interest rate serving as the sole tool for the attainment of the inflation target (see Elkayam, 2003). It seems that the credibility of monetary policy increased following the transition to the use of the interest rate tool for the purpose of restricting inflation. This credibility has been enhanced by the increased flexibility in the exchange rate as reflected in our results.

The above discussion leads us to the question of why a flexible exchange rate regime was not used earlier if the interest rate is an effective tool. This is an interesting issue to look at for future research, particularly for the case of Israel.

The implementation of IT in emerging economies depends on the different needs of each country, such as their political, cultural and economic characteristics.

3.6 Conclusions

This study analyses the main determinants of monetary policy in Mexico and Israel. The case of Mexico suggests that it is feasible to reduce inflation within a flexible exchange rate regime when an appropriate monetary policy is adopted. The empirical evidence shows that monetary policy in Mexico has performed the role of the nominal anchor of the economy. 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 principles and when inflation expectations are included in the estimations. In the case of Israel, on the other hand, the evidence presented is mixed. There is not a clear commitment to stabilise inflation when the rate of inflation rather than its deviation from some target value is used. In other words, it is not clear that the response in nominal interest rates from the central bank has been sufficient to induce the real interest rate to rise, in order to stabilise the economy. Some sign reversals are observed when the results from the gap and the forward-looking specifications are considered. The value of the parameter β turns out to be statistically significant and greater than one which implies that monetary policy has indeed become the nominal anchor of the economy. It seems that the coexistence of a crawling exchange rate band with the adoption of IT principles make the conduct of monetary policy more challenging than otherwise. The credibility of monetary policy increased using only the interest rate tool for the purpose of restricting inflation.

The inclusion of additional variables in the policy rule seems to contribute to the process through which interest rates are determined in both countries. These variables could be used as good indicators for external disturbances. Particularly interesting in this study is the inclusion of the change in the exchange rate due to the different stance in each country regarding this issue. In the case of Mexico, this coefficient always has the expected sign and it is statistically different from zero. In the forward-looking model, its value is marginally significant and parameter β (i.e., inflation) is statistically greater than one. This is a notable result in the context of a floating exchange rate where the central bank seems to react to effectively maintain price stability instead of defending a specific level of the exchange rate. By contrast, in Israel the results indicate that the central bank reacts to changes in the exchange rate and, in some cases, this response exceeds that of the inflation rate. Its contribution becomes smaller when more flexible exchange rates are in place.

Another interesting result emerges from the analysis of the possible persistence of inflation in our estimations. Inflation 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. On the contrary, in Israel the significant contribution of the lagged value of inflation is observed in all estimations. Concerning the value of the smoother parameter ρ, this remains practically the same in all specifications for the case of Israel. Its high value suggests that the Central Bank is concerned about smoothing adjustments. In the case of Mexico, the most recent 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.

To sum up, 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. This has involved the introduction of inflation targeting principles where monetary policy has become the nominal anchor of the economy.

Appendix

Table 3.1A.
Selected Studies on Monetary Policy Rules*

Distinguishing features	Author(s)	Method
I. Additional Variables		
Backward-Looking Component	Clarida, *et al.* (1998,2000) Mehra (1999) Bar-Or & Leiderman (2000) Torres (2002)	Generalised Method of Moments (GMM)
Nominal Exchange Rate	Taylor (2001) Torres (2002)	
Unemployment Rate	Clarida, *et al.* (1998) Corbo (2000) 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 (2000) Torres (2002) Mohanty & Klau (2004)	
Foreign Interest Rate	Taylor (1993) Clarida, *et al.* (1998) Corbo (2000) Torres (2002)	
Foreign Reserves	Kamin & Rogers (1996)	
Current Account	Corbo (2000) Medina & Vales (2002)	
II. Forward-looking rules	Taylor (1993) Clarida, et. al. (1998, 2000) Mehra (1999) Bar-Or & Leiderman (2000) Corbo (2000) Torres (2002) Eleftheriou (2003) Mohanty & Klau (2004)	Generalised Method of Moments (GMM)

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

Table 3.2A.
Results of Unit Root Tests
Case of Mexico: 1982Q1-2001Q4

Variables	ADF Test (Constant and linear trend model)[a] 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)

Notes:
The null hypothesis is that the series is I(1). The number of lags has been selected according to the Schwartz information criteria (SIC).
(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 shorter sample periods there is strong evidence of stationarity.
All variables are computed in growth rates except for the interest rate.

Table 3.3A.
Results of Unit Root Tests
Case of Israel: 1988Q1-2001Q4

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

Notes:
The null hypothesis is that the series is I(1). The number of lags has been selected according to the Schwartz information criteria (SIC).
(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.

Table 3.4A.
Monetary Policy Rules[1]
Baseline Specification
Israel: 1992-2001

	α	β	γ	φ_1	φ_2	ρ	*J-test*
Base specification	**11.84**	**0.58**	**43.63**	---	---	**0.45**	7.92
	[42.36]*	**[18.64]***	**[5.26]***			**[46.34]***	[0.89]
Backward-looking	**12.28**	**0.23**	**12.42**	**0.34**	---	**0.32**	7.53
	[31.51]*	**[4.45]***	**[2.71]***	**[7.01]***		**[8.52]***	[0.87]
Depreciation rate	**12.08**	**0.22**	**38.23**	**0.42**	**0.22**	**0.56**	8.58
	[49.36]*	**[6.79]***	**[5.83]***	**[13.91]***	**[2.82]***	**[41.07]***	[0.96]
Money growth	**11.72**	**0.64**	**25.42**	**0.06**	---	**0.46**	7.78
	[23.81]*	**[8.66]***	**[2.60]**	**[2.44]***		**[18.64]***	[0.93]
Foreign reserves	**13.69**	**0.39**	**146.35**	**0.12**	---	**0.33**	8.14
	[51.55]*	**[9.78]***	**[20.05]***	**[5.50]***		**[22.58]***	[0.96]
Current account	**12.43**	**0.52**	**29.78**	0.000	---	**0.45**	8.7
	[24.45]*	**[9.87]***	**[6.61]***	[0.82]		**[18.44]***	[0.94]

[1] The numbers in parenthesis are white consistent adjusted 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

CHAPTER FOUR*

The Effect of Exchange Rates on Investment in Mexican Manufacturing Industry

4.1. Introduction

In the last decade, several countries such as Mexico (1994-1995), Russia (1998) and more recently, Argentina (2001), have experienced currency and financial crises causing severe economic downturns. Many studies have focused on the reasons leading to currency crises but only few of them have paid attention on the post-crises period to analyse the effectiveness of different measures that were adopted. In this respect, the impact of exchange rate movements in emerging economies has become one of the core issues. Exchange rate movements can affect the real side of the economy through different channels. A real depreciation can have expansionary effects through increasing the operating profits in the export sector as well as increasing the cost of the imported goods favouring tradable activities in the economy. The overall effect, however, depends on the price elasticity of both sectors.[50] In contrast, large currency depreciations may deteriorate the firm's net worth through the 'balance-sheet-effect', where depreciation of the currency may

* The findings of this chapter are the source of the joint paper with Mustafa Caglayan.

50 Evidence of this channel is mixed. Ghei and Prittchett (1999), for example provide evidence of how exports increase after currency depreciation. Contrarily, Agenor and Montiel (1996) found evidence of the contractionary effects of real exchange rate depreciation due to the cost-of-input channel.

increase the burden of the dollar-denominated debt (see Aguiar, 2004; Patrap and Urrutia, 2004).[51]

Although the importance of exchange rate movements for investment activity has been recognised there are no conclusive results that one can draw from the existing empirical work. Investment activity is an important component of GDP and also is the greatest source of aggregate fluctuations in which exchange rate variability may affect the long-term growth rate of the economy (see Leonida *et al.*, 2003). A large body of empirical research deals with the implications of exchange rate movements for the real economy. Nevertheless, the majority of these studies have been focused on macroeconomic comparisons or country-level evidence for industrialised countries with little attention to the effect that flexible exchange rates may have in emerging economies. The issue is particularly important for countries that switched from a fixed to a flexible exchange rate due to expected higher degree of variability associated with flexible exchange rates. Moreover, few studies have been conducted using industry or firm-level data in these countries to analyse the impact of exchange rate fluctuations on the performance of the economy.[52] In particular, this chapter contributes to the literature, by providing new evidence on the relationship between exchange rate variability and industry investment. The specific question that we address is the extent to which exchange rate movements in Mexico may have affected the investment in the Mexican Manufacturing Sector over the 1994-2002 period.

51 For most developed countries devaluation has little direct effect on the balance sheets of households, firms and banks due to their debts being denominated in domestic currency.

52 A good review of the literature on exchange rate uncertainty on investment can be found in Byrne and Davis (2003).

The case of Mexico is interesting since the evolution of the Mexican economy in the last two decades has allowed access of Mexican firms to investment funds. The economy practically went from a fixed exchange rate regime, during the 1980s and first half of the 1990s, to a fully-fledged floating exchange rate regime after the mid-1990s. An improvement in the Mexican firms' ability to access foreign capital was expected due to the greater flexibility of the exchange rate. Nonetheless, the change in the exchange rate regime along with other economic reforms was the result of the Mexican currency crisis at the end of 1994. In this respect, the period under study 1994-2002 permits us to evaluate both the response of investment to exchange rate variability and to distinguish between the external exposures of the firms in the face of exchange rate movements.

The empirical analysis targets two main objectives. First, it considers both changes and volatility of exchange rates in the empirical estimation. Second, we also consider the external exposure and the market structure of industry. The results support the view that movements in exchange rates have affected investment decisions in Mexico. Specifically, currency depreciation has stimulated investment through increasing the operating profits in the export sector, but an overall contractionary effect has been observed. In contrast to prior results, the empirical evidence shows that volatility also matters for investment decisions. Volatility has negatively (positively) influenced domestic investment through the export (import) channel. In addition, the results suggest a stronger effect in those industries with low markup ratios.

Our results are, on the whole, consistent with the scant evidence on the relationship between exchange rate variability and investment. In particular, Golberg (1993) and Campa and Golberg (1995) found evidence of distinct investment patterns across industries with different price-over-cost markup ratios. Investment in high-markup industries with an oligopolistic market structure is less responsive to exchange rates. They also found that volatility depresses investment but the effect is quite small. In addition, Nucci and Pozzolo (2001) reported results from firm-level data where variations of the exchange rate affect investment according to the external exposure of the firm. More recently, Harchaohui *et al.* (2005), using industry-level data for the Canadian Manufacturing Industry, highlight the importance of making a distinction between low and high volatility environments. The positive effect that depreciation may have on investment is considerable smaller as volatility increases.

The rest of the chapter is organised as follows. In section 4.2, a brief overview of the empirical literature on investment and exchange rate uncertainty is provided. In section 4.3 the recent economic developments in the Mexican Economy are presented. Section 4.4 includes the data, empirical specification and methodology used for our estimation. Section 4.5 discusses the empirical results and section 4.6 concludes.

4.2. Real Exchange Rate Uncertainty and Investment: A Brief Overview

There is a growing interest on the effects of economic uncertainty on investment behaviour of firms.[53] However, no clear evidence arises from these studies. While

53 An extensive survey of the literature on investment and uncertainty is provided in Carruth et al., 2000. Recent empirical evidence is provided by Beaudry *et al.*, 2001; Leonida *et al.*, 2003; Serven, 2002; Atella *et al.*, 2003; Carranza *et al.*, 2003; Baum and Caglayan 2005 and Bond *et al.*, 2005 among others.

Hartman (1972) and Abel (1983) emphasised a positive impact from uncertainty on investment, Dixit and Pindyck (1994), indicate a negative relationship between the two. The former studies suggest that increased uncertainty may increase investment because of its positive effect on the value of a marginal unit of capital. This result requires that the marginal product of capital is convex in price, so that an increase in the variance of price raises the expected return on a marginal unit of capital and, therefore, investment becomes more attractive (see Carruth *et al.*, 2000; Bond *et al.*, 2005). On the contrary, the latter empirical work of the impact of uncertainty on investment highlights the importance of the timing of investment decisions. These studies argued that irreversibility may lead to the postponing of investment decisions. These models assume imperfect competition and/or decreasing returns to scale (see Darby *et al.*, 1999; Baum and Caglayan, 2005).

In the stream of this empirical literature several issues such as the variable used to measure uncertainty and how to measure it have arise (see Byrne and Davis, 2003; Carruth *et al.*, 2000). One source of uncertainty, particularly important for a small open economy, is exchange rate volatility. Furthermore, empirical evidence suggests that emerging economies are more vulnerable to fluctuations in the exchange rate. Therefore, not only changes but also the volatility of exchange rates should differently affect investment decisions accordingly to the external exposure of the firm. Specifically, the literature that concentrates on the role of exchange rate uncertainty, relates it to both domestic and foreign investment. The link between foreign direct investment (FDI) and exchange rate uncertainty is rather mixed, as exchange rate uncertainty can both discourage foreign investment (see Barrel *et al.*, 2003; Cuhsman, 1998) and produce an incentive to hedge against exchange rate shocks through foreign location (see Goldberg and Kolstad, 1995; Aizenman, 1992). Overall, empirical studies point out to a negative influence of exchange rate volatility on FDI.

The evidence of the impact of exchange rate volatility on domestic investment (the focus of this chapter) is sporadic and relatively inconclusive. Goldberg (1993), using quarterly data, concluded that exchange rate variability had a week depressing effect on investment in sectors of US industry in both the 1970s and the 1980s. Campa and Goldberg (1995) explored the linkage between exchange rates and investment in the US industry using a measure of exposure to external markets both through export sales and imported inputs. Their results emphasize the importance of considering these external exposures which have altered most US manufacturing industries. They also found that, although exchange rate volatility depressed investment, the effects are small. More recently Campa and Goldberg (1999) estimate a model for the two-digit manufacturing sectors of the United States, the United Kingdom, Canada, and Japan. They found that, across countries, exchange rates tend to have insignificant effects on investment rates in high markup sectors. However, investment responsiveness to exchange rates was fairly strong in low markup sectors. Darby *et al.*, (1999) found that whereas exchange rate uncertainty has a significant and negative impact on investment in Europe this effect depends on the industry under study. Finally, Serven (2002) found some evidence of threshold effects where the negative impact of real exchange rate uncertainty on investment is significantly larger in economies that are highly open and in those with less developed financial systems. Table 4.1 summarises the key features and results of these empirical studies.

Table 4. 1.
Studies on Exchange Rate Uncertainty and Investment

Study	Country	Level of desegregation	Uncertainty proxy	Uncertainty effect
Golberg, 1993	US	Two-digit industrial time- series	Exchange rate volatility from ARMA model residuals	None/weak negative
Campa and Golberg, 1995	US	Two-digit pooled time-series cross-section manufacturing industries	Exchange rate volatility from ARMA model residuals	None/small negative effects
Darby, *et al.*, 1999	France, Germany, Italy, UK and US	Cross-country time-series data	Misalignment and volatility of the real exchange rate	Negative depending on the industry/Threshold effects
Serven, 2002	61 Developing Countries	Cross-country time-series data	Exchange rate uncertainty from GARCH specification	Negative/Not uniform/Threshold effects
Disaggregate studies				
Nucci and Pozzolo, 2001	Italy	1000 firms Manufacturing sector	Variations in the real exchange rate	Depending on the external exposure
Carranza *et al.*, 2003	Peru	163 non-financial listed firms	Variation of the real exchange rate	Negative
Leonida, *et al.*, 2003	UK	1,162 non-financial firms	Variation of the exchange rate	Depending on the external exposure
Aguiar, 2004	Mexico	169 firms with listed debt or equity	Variation of the exchange rate	Negative/Recessionary impact of devaluation
Harchaoui *et al.*, 2005	Canada	22 manufacturing industries	Variation and volatility of the exchange rate	Depending on the volatility environment

Recent studies have extended the above-mentioned literature by using more disaggregated data. Nonetheless, the industry or firm-level impact of depreciations on investment has not been well examined and the basic stylized facts have not yet been documented. Papers that have used disaggregated data include Nucci and Pozzolo, 2001; Leonida *et al.*, 2003; Carranza *et al.*, 2003; Aguiar, 2004 and; Harchaoui *et al.*, 2005 (see Table 4.1). Nucci and Pozzolo (2001) investigate the relationship between exchange rate fluctuations and the investment decisions of a sample of Italian manufacturing firms. Their results support the view that depreciation of the exchange rate has a positive effect on investment through the revenue channel and a negative effect through the cost channel. Carranza *et al.* (2003) analyse the impact of the exchange rate volatility on the performance of the Peruvian economy using financial information from 163 non-financial listed firms. Their results show that investment decisions are negatively affected by real exchange depreciations in firms holding dollar-denominated debt. Leonida *et al.* (2003) analysing data for 1,162 non-financial firms in the UK show that investment responsiveness is not uniform across all firms responding positive to a depreciation of the exchange rate through the revenue channel and negative through the cost channel. Their results also highlight the importance of financial constraints facing the firms in determining investment. Aguiar (2004) using a sample of Mexican firms finds that, after the 1994 Mexican peso crisis, there was a contraction on investment driven by the week balance sheet position of the firms. Harchaoui *et al.* (2005) based on data for 22 Canadian manufacturing industries show the importance of distinguishing between environments that have low and high exchange rate volatilities. Depreciations would have a positive (negative) effect on total investment when the exchange rate volatility is low (high).

In sum, several empirical studies have examined the impact of real exchange rate variations on aggregate investment (e.g., Golberg, 1993 and Darby *et al.*, 1999) and more recently, these studies have been extended considering more disaggregated data (e.g., Nucci and Pozzolo, 2001). Sporadic studies, however, offer an assessment on both the level and the volatility of the exchange rate which become an important aspect for those economies under flexible exchange rates. This study incorporates the behaviour of external exposure through export and import channels in the manufacturing sector and explores the relationship between variations in the real exchange rate and investment. The existing empirical work focuses on the effects on changes in exchange rates (i.e., depreciation) rather than on the volatility of the exchange rate. Our results suggest a detrimental effect on investment through the export channel which may reflect the presence of irreversibilities in investment. Under these circumstances, higher uncertainty tends to lower investment. The analysis also includes the possible influence of the market structure by using sectoral markups. Lower levels of markup increase the responsiveness of investment to variations in the exchange rate.

4.3. Recent Economic Developments in the Mexican Economy

During the past two decades Mexico has implemented a series of broad-based structural reforms. These reforms have focused on economic and financial liberalization, leading Mexico from a closed, heavily regulated, economy with high government intervention to an open and market-driven economy (SHCP, 1999). Deregulation, internationalization and bank privatization were the three main aspects of this process of stabilization and structural reforms.

The Mexican authorities liberalised the trade sector in 1985, adopted an economic stabilisation programme at the end of 1987, and gradually introduced market-oriented institutions. A fixed exchange rate regime was adopted at the beginning of 1988 and it became the main anchor of an anti-inflationary policy.[54] All of these measures were reinforced by restrictive fiscal and monetary policies

54 In January of 1989 the controlled exchange rate was subject to a pre-announced daily depreciation of 16.8 percent. The rate of depreciation was gradually reduced as inflation fell until it reached an annual rate of five percent in 1991.

and by the announcement of a programme called the 'Economic Solidarity Pact' later know as the *Pacto*.[55] It was a challenging agreement among the government, the business sector, the labour unions and the agricultural producers which gave more credibility to the Mexican authorities (Aspe, 1993). The latter allowed the government to pursue other goals such as the renegotiation of the foreign government debt under the Brady plan, the integration of Mexico with OECD and the negotiation of trade agreements.[56] As a result of these measures, inflation fell to 19.7 percent in 1989 (after reaching 159 percent in 1987) and the primary fiscal surplus reached 8 percent of GDP. Investment, however, was still discouraged by high nominal interest rates and a limited access to international capital markets (Sanchez, 2001).

Despite higher growth in 1994, the problems accumulated by the years of large capital inflows and financial liberalisation, combined with the negative external and domestic shocks to the economy, led to the currency and financial crisis at the end of the year. The central bank, under severe pressure in the foreign exchange rate market, decided to let the peso float (Carstens and Gil Diaz, 1996). The Mexican economy experienced a sharp contraction after the devaluation of the peso in December 1994. Inflation reached 51.7% and output growth was -6.2% in 1995.

55 On an annual basis, and partially based on forward-looking expectations, the 'Pacto' established guidelines for price, wage and exchange rate changes.

56 In 1993 Mexico entered into the North American Free Trade Agreement (NAFTA) with the United States and Canada. NAFTA has had a significant impact on the Mexican economy by providing greater security of access to the largest world market; by increasing attractiveness of Mexico to foreign direct investment flows; by promoting national productivity and the use of new technologies; and by boosting the export of Mexican products. Simultaneously, NAFTA provided and additional major impulse to the opening of the financial sector to foreign investment (see Schwartz, 2002).

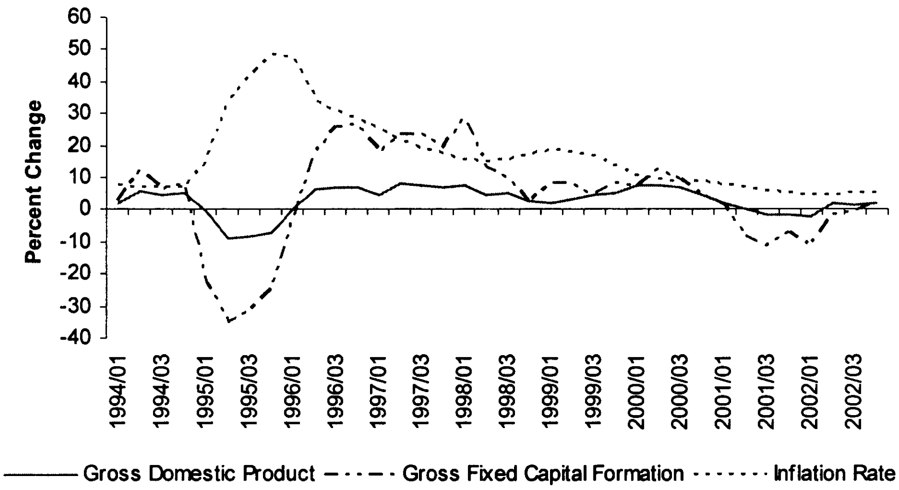
Mexico launched a comprehensive stabilization programme in 1995. With the adoption of the floating exchange rate regime, monetary policy became the nominal anchor of the economy. The challenge for the autonomous central bank was to reduce inflation and to confront the credibility crisis that it was facing. 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. The uncertainty about Mexico's ability to fulfil its financial commitments led the government to negotiate and to obtain a US$52 billion international package supplied by the IMF and the U.S. Treasury. To deal with the banking sector problem, the central bank opened credit lines denominated in foreign currency at a penalty rate and introduced legal reforms to allow more foreign participation.[57] Low international reserves and the uncertainty prevailing in financial markets after the collapse of the currency reinforced the decision to formally adopt a floating exchange rate policy (Carstens and Werner, 1999).

Following the measures taken by the government, the peso became more stable, interest rates began to fall, the inflation rate came down to manageable levels and economic activity recovered rapidly. During 1995-2000, Mexico continued to gear its industrial sector towards exports. Thus, during the second half of the 1990s,

57 Additional programmes were implemented with the objective to strengthen financial sector regulation and supervision, to combat moral hazard and to reduce the need for the central bank to act as the lender of last resort.

the share of exports in GDP doubled. Investment and consumption recovered with GDP averaging 5.5% from 1996-2000 and the inflation rate fell from 51.7 percent in 1995 to 4.1 in 2003 (see Figure 4.1). Core inflation has followed similar trend.

Figure 4.1.
Inflation, Gross Fixed Capital Formation and GDP
1994-2002



Source: National Institute of Geography, Statistics and Computer Science (INEGI) and Bank of Mexico.

Notwithstanding these important achievements major problems remain in several areas. Two of these are particularly worth looking at. First, despite the improved financial situation of banks, the enhanced efficiency of the banking system and the measures implemented to strengthen the legal framework within which banks operates, bank credit failed to recover. Total bank credit to the private sector fell from 42.9 percent of GDP in 1994 to 15.6 percent in 2002. The possible factors explaining such behaviour include: uncertainty, resulting from the weakness of the economy; an adverse external environment; and institutional constraints such as incomplete changes to the legal framework for the recovery of guarantees that contributed to banks' reluctance to grant credit. Second, the long standing efforts of financial reform were unable to foster financial intermediation in Mexico. The latter remains stagnant since 1994. The ratio of M4 to GDP which reach a peak of 50.9 percent in 1994 fell to 44.6 percent in 2000 and to -51.2 percent in 2002 (Schwartz, 2002).

In sum, the structural change that began in 1986 and ended in 1994 with NAFTA, transformed Mexico's economy by making it more outward-looking and allowing economy recovery to be stimulated by export growth (Messmacher, 2002). Macroeconomic authorities were able to focus on reducing inflation as well as increasing the rate of economic growth. This process was successful up to the time of the 1994 crisis. After the crisis and within a flexible exchange rate, monetary policy has been focused on the reduction of inflation which is considered critical to achieving higher levels of domestic savings and investment and a gradual decline in interest rates. In this new context, the role of a floating exchange rate has been largely highlighted because it has modified the composition of capital flows towards longer tenors in the form of foreign direct investment and also it has reduced the possibility of speculative attacks (Güemez, 1996). Few studies, however, have analysed either the effect of movements of exchange rates on investment in the Mexican economy (see Lederman *et al.*, 2003; Pratap and Urrutia, 2004) or the behaviour of investment by Mexican firms (see Sanchez, 2001; Gelos and Werner, 2002; Martinez and Werner, 2002). This chapter provides empirical evidence on this issue by analysing the effect of exchange rate movements on domestic investment in the Mexican manufacturing industries. In the next section, the data and the empirical implementation used in this study are presented. The chosen specification provides us with an answer regarding the possible association between movements in the exchange rate and investment.

4.4. Data, Empirical Implementation and Methodological Issues

4.4.1. Data

This study uses annual panel data of Mexican manufacturing industries covering the period 1994-2002. The dataset is obtained mainly from the Annual Industry Survey conducted by the National Institute of Statistics, Geography and Computational Science (INEGI) and the central bank in Mexico. The survey covers on average 6,224 firms grouped into 205 three-digit level manufacturing sectors and is a balance panel in the sense that exiting plants were discarded from the sample by the collecting agency.[58] The firms in the data set accounts for almost 80 percent of the value added in manufacturing since the Annual Industry Survey is used as an input for the Industrial Census and annual GDP calculations.

The unit of observation of the survey is the manufacturing firm. However, since INEGI does not provide with information at this level of disaggregation, the three-digit sector level is used. The survey contains information on a large number of variables such as production, input use, labour force, sales, inventories, investment expenditures and capital stocks. The variables that are utilized in this study are defined as follows:

- *Investment* (I_{it}): Purchases minus sales of used and new assets plus improvements on existing assets plus capital produced for own use.

58 According to INEGI the number of exiting plants or firms was small.

- *Sales* (S_{it}): Annual sales per industry or sector level. The survey provides information on foreign and national sales.
- *Inputs*: Total inputs per industry or sector. The survey provides information on imported inputs.
- *Real Exchange Rate* (e_t): It is the real exchange rate of the domestic currency (peso) against a trade-weighted basket of currencies. The real exchange rate index is very broad as it measures the value of the peso against more than one hundred trading partners of Mexico. A rise in the index indicates a real depreciation of the domestic currency.
- *Interest rate* (r_t): The annual interest rate (Treasury Bill –CETES).
- *Price Index*: The producer price index measured at the end of the corresponding year.

All variables are reported in real pesos with 2003 serving as the base year and the producer price index serving as deflator.

4.4.1.1. Export and Import Exposure Measures (γ_t^i)

Recent literature distinguishing between export and import exposure suggest that firms that are primarily export-oriented may behave quite differently from import-oriented firms in the face of exchange rate movements. For instance, depreciation is likely to increase profitability of an export-exposed firm while it reduces the profitability of an import-exposed firm. To compute the exposure measures used in our analysis (γ_t^i), information from the Annual Industry Survey on imported inputs and foreign sales is used. Thus, to measure the export share or revenue channel in sector *i* (*expm*), the ratio of foreign sales to total revenues is considered whereas the ratio of imported inputs to total inputs accounts for the imported-input share or cost channel of the manufacturing sector (*impm*).[59]

Table 4.2 summarises information on both the share of export sales in total revenues and the share of imported inputs in total inputs grouped into 9-manufacturing industries. This information allows us to understand the evolution of the structure of the industries used in our study. As is clear from the table, external orientation has increased over time and sectors like Metal Products, Basic Metal Industries and Textiles exhibit a faster development of their foreign exposure. On the other hand, the sectors relying more on imported inputs into production are Chemicals, Petroleum and Plastic Products and Textile and Leather Products.

Table 4.2.
Trade Orientation of Firms by Industries
1994-2002

	1994		2002		1994-2002*	
	Export-share	Imported–input share	Export-share	Imported–input share	Export-share	Imported–input share
1. Food, Beverages and Tobacco	0.0398	0.1105	0.0617	0.1093	0.0623	0.1214
2. Textile, Apparel and Leather Industries	0.0644	0.1403	0.1655	0.2210	0.1590	0.1762
3. Lumber and Wood Products. Including Furniture	0.1238	0.1412	0.1291	0.1186	0.1846	0.0875
4. Paper and Allied Products, Printing and Publishing	0.0204	0.2139	0.0354	0.2559	0.0344	0.2253
5. Chemicals, Petroleum, Coal, Rubber and Plastic Products	0.1350	0.2397	0.1544	0.3058	0.1711	0.2799
6. Non-Metallic Mineral Products, except Petroleum and Coal Products	0.0759	0.0562	0.1099	0.0706	0.1227	0.0749
7. Basic Metal Industries	0.1591	0.1307	0.2184	0.1758	0.2272	0.1572
8. Metal Products, Machinery and Equipment. Including Surgical and Precision Instruments	0.3544	0.4841	0.6053	0.4838	0.5661	0.5246
9. Other Manufacturing Industries	0.1118	0.2910	0.2373	0.2387	0.2218	0.3106
Total Manufacturing	0.1612	0.2547	0.2861	0.3015	0.2747	0.3030

(*) Mean values over the period 1994-2002

59 The terms 'export' and 'revenue' channel are used interchangeably in this chapter. Likewise, 'import' and 'cost' channel are taken as synonymous.

4.4.2. Estimation and Methodological Issues

Campa and Goldberg (1995, 1999) have analyzed how exchange rate movements could affect the investment and pricing behaviour of manufacturing firms in the United States and other major economies. Their basic framework is a model of investment with adjustment costs that takes into account export sales and the use of imported inputs in production both of which expose producers to exchange rate movements. Investment is a function of the marginal profitability of capital. Exchange rate changes can affect profitability by passing through into home and export market prices and imported input prices. The impact of exchange rate movements on profitability and investment decisions depends on the firm's international orientation and the competitive structure of the industry.

4.4.2.1 A Simple Investment Model

In this section, a simple model is presented to illustrate the links between exchange rate variations and investment activity. In particular, Campa and Goldberg (1995, 1999) and Nucci and Pozzolo (2001), consider a firm that chooses investment I_t to maximise its present expected value:

$$Vt = E\left[\sum_{j=0}^{\infty}(1+\rho)^{-j}\pi^{*}_{t+j}(K_{t+j}, I_{t+j})\right] \tag{4.1}$$

subject to : $K_t = (1-\delta)\, K_{t-1} + I_t$ (4.2)

where $\pi^{*}_{t}(K_t, I_t)$ represents the maximized value of net cash flow at time t, ρ is the discount factor, K_t is the current capital stock of the firm, and δ is the depreciation rate of capital. In a certain world, the optimal investment choice will only be a function of values known at time t. Introducing uncertainty, however, the amount of investment is a function of the future marginal profitability of capital. From the assumption that the cost of adjustment is increasing and convex in the level of investment, the marginal cost of investment is a positive and increasing function of I_t. In this respect, following Abel and Blanchard's (1986) and Campa and Goldberg's (1995) model, the expected profitability of capital is modelled as a function of the cost of capital, r, and the firm's exposure of exchange rates is introduced. Thus, investment in sector *i,* is a function of expected profits for the sector net of capital costs, yielding the following reduced form relationship:

$$I^i = \phi(E(\pi^i(e, p_{i,} p_i^*, w, w^*)), r), \tag{4.3}$$

where *e* represents the real exchange rate, defined in terms of domestic currency per unit of foreign exchange rate; p_i and p_i^*, denote the real price of good *i* in domestic and foreign markets, respectively; and *w* and w^* indicate domestic and foreign input costs. In order to characterize the effect of exchange rate on investment, an explicit expression for the marginal profitability of capital has to be derived. In particular, Campa and Goldberg (1995, 1999) assume that both domestic and foreign markets are imperfectly competitive. In each period the firm maximises profits, taking as given the quantity of the quasi-factor, capital as:

$$\pi(K_t, e_t) = \max_{p,p^*,L,L^*} x(p_t)p(e_t) + e_t x^*(p_t^*)p^*(e_t) - w_t L_t - e_t w_t^* L_t^*$$

$$\text{subject to : } x_t + x_t^* = F(K_t, L_t, L_t^*) \tag{4.4}$$

where $x(p_t)$ and $x^*(p_t^*)$ represent the demand functions faced by the firm in the domestic and the foreign market; with p_t and p_t^* being the price levels set by the firm in those markets; w_tL_t and $e_tw_t^*L_t^*$ denote the expenditure for the domestic and imported inputs, L_t and L_t^*, respectively and $F(\cdot)$ is a constant returns-to-scale production function.

The domestic and foreign demand functions for the firm's product depend on both the respective quantities supplied by the firm to each market and the exchange rate. Solving the maximization problem in equation (4.4) and combining the first-order conditions derived from this problem, an expression for the marginal profitability of capital is obtained:

$$\frac{\partial \pi(\cdot)}{\partial K_t} = \frac{1}{K_t}\left[p_t x_t MKUP^{-1} + e_t p_t^* x_t^* MKUP^{-1} - (w_t + e_t w_t^* L_t^*)\right] \qquad (4.5)$$

where $MKUP_t$ and $MKUP_t^*$ stand for the firm's price-cost margins prevailing in the domestic and foreign market. To understand the effects of exchange rate movements on investment, Campa and Goldberg (1999) have derived the specific elasticity of a producer's investment with respect to exchange rates as proportional to:

$$\frac{\partial I_t}{\partial e_t} = \frac{A_t^1}{A \cdot MKUP_t}\left[(\eta_{p,e} - \eta_{MKUP,e})(1 - X_t) + (1 + \eta_{p*,e} - \eta_{MKUP*,e})X_t - (1 + \eta_{w*,e})\alpha_t\right]\frac{\partial e_t}{e_t}$$

where TR stands for total revenues, $A_t^1 = A \cdot TR / K_t$; $\eta_{p,e}$ and $\eta_{p*,e}$ are exchange-rate pass-through elasticities in domestic and foreign markets; $\eta_{MKUP,e}$ and

$\eta_{MKUP^*,e}$ are markup elasticities with respect to exchange rate changes and $A \cdot MKUP$ is the average markup across domestic and foreign sales. X_t represents the share of total revenues associated with foreign sales $[(1 - X_t)$ is the share associated with domestic sales]; and α_t, the share of imported inputs in production costs, is multiplied by the elasticity of these input costs with respect to exchange rates, $(1 + \eta_{w^*,e})$.[60] This equation provides a useful framework to analyze the key determinants of the change in profitability and, therefore, in investment induced by movement in exchange rates. The relationship between exchange rates and investment (through the profitability channel) will vary over time to the extent that *net* external orientation varies. Here, producer net external orientation is the difference between revenue exposure and cost exposure (*netm*). An absence of a relationship between investment and the exchange rate should be the exception, rather than the rule, for an externally exposed economy.

4.4.2.2. Estimation

In order to test the existence of an investment exchange–rate linkage, the following empirical equation is used:

$$\frac{I_t^i}{I_{t-1}^i} = \beta_0^i + \beta_1 \cdot \frac{sales_t^i}{sales_{t-1}^i} + (\beta_2 + \beta_3 \gamma_t^i) \cdot \frac{rer_{t-1}}{rer_{t-2}} + (\beta_4 + \beta_5 \gamma_t^i) \cdot \frac{vol_{t-1}}{vol_{t-2}} + \beta_6 \cdot \frac{irate_t}{irate_{t-1}} + \lambda^i + \varepsilon_t^i \qquad (4.6)$$

60 For more details of the model derivation see Campa and Golberg (1995, 1999) and Nucci and Pozzolo (2001).

where I_t^i represents investment defined as the ratio of gross domestic investment in sector *i* in year *t* over gross investment in year *t-1*. Similarly, *sales* represent sector sales and are introduced to control for differences in sales across sectors; rer_t is the real exchange rate defined as pesos per US dollar; vol_t represents real exchange rate variability and; $irate_t$ is the annual interest rate. We consider the interaction of the exchange rate with firm-specific variables γ_t^i which varies according to different measures of external exposure. Specifically, exchange rates and their volatility are allowed to influence investment with a constant term (through β_2 and β_4, respectively) or can vary over time with industrial external exposure, γ_t^i which alternatively represents the export share (*expm*) and the imported input share of the sector (*impm*) described in the data section. These interacted relationships between exchange rates and sectoral exposure are captured by the β_3 and β_4 parameters. The specification contains a firm-specific effect, λ^i, which is assumed to be constant over time and ε_t^i is an error term.

Our specification includes both changes in exchange rates and volatility of the exchange rate. The lagged values of these ratios have been used because a change in exchange rates takes up to a year to affect firm behaviour (see Baum *et al.*, 2004). Also, this strategy is useful to avoid potential bias that may be induced by their possible correlation with current investment (see Campa and Golberg, 1995). Moreover, the current interest rate affects the overall manufacturing investment as well as investment in particular industries and, therefore, may be correlated with the error term. The violation of this condition, that is, $\text{cov}(x_t, \varepsilon_t) \neq 0$ is known to result in biased and inconsistent ordinary least squares

(OLS). In order to account for the endogeneity of interest rates an instrumental variable (IV) estimation method is suggested where endogenous regressors are instrumented using an appropriate set of instrumental variables. This study employs the two stage least square (2SLS) method of estimation which provides consistent parameter estimates. The instrument set includes additional lagged values of sales, exchange and interest rates. All equations are estimated using fixed effects to eliminate any unobserved permanent specific firm-specific effect.

4.4.3. Volatility of the Real Exchange Rate

There are a number of ways of modelling the impact of uncertainty on investment. Nonetheless, as Baum and Caglayan (2005) point out, the choice of a particular specification to generate uncertainty may have a considerable impact on the empirical findings. Most of the existing research uses either a moving average standard deviation or the coefficient of variation of the past monthly exchange rates to measure exchange rate volatility (see Campa, 1993; Campa and Goldberg, 1995; Amuedo and Pozo, 2001 and Harchaoui *et al.*, 2005). These measures, however, give rise to substantial serial correlation in the measure and although they capture the variability of the exchange rate it is not the best proxy for uncertainty (defined as the expected variability in the exchange rate). To avoid this shortcoming, this study uses the autoregressive conditional heteroskedastic (ARCH) model of Engle (1982) later on generalised as GARCH (generalised ARCH) by Bollerslev (1986). This method is presumed to capture risk in each period more sensitively than simple moving standard deviations, which give equal weight to correlated shocks and single large outliers (see Byrne and Davis, 2003).

In our empirical specification, monthly observations of the real exchange rate from 1988 to 2002 have been used. The model considers the change in the log of the real exchange rate denoted by Δx_t. The specification is estimated by the maximum likelihood method assuming that the conditional distribution of the errors is normal. The best fitting model for the mean equation (Δx_t) was provided by an AR (2) process and the conditional variance (h_t) is best described as an ARCH (1) model. The results from these estimations along with the diagnostic of the standardised residuals in the variance equation are displayed in Table 4.3. The estimated model for the change in the log of the real exchange rate is:

$$\Delta x_t = \beta_0 + \beta_2 \Delta x_{t-1} + \beta_3 \Delta x_{t-2} + e_t \qquad (4.7)$$

where $e_t | I_{t-1} \sim N(0,h_t)$ and $h_t = \alpha_0 + \alpha_1 e_{t-1}^2$ denotes the conditional variance. The results for the ARCH (1) specification show a significant and positive effect for the lagged value. Moreover, the value of the coefficient ($\alpha_1 = 0.556$) indicates that volatility shocks are not persistent. Diagnostic statistics show that the variance equation has been correctly specified. Specifically, Q-statistics and the Lagrange Multiplier (LM) test ensure no remaining ARCH effects. Figure 4.2 displays both investment and our estimate of the lagged conditional variance of inflation, $\hat{h}_{t-1}$, against time to illustrate the relationship between these two variables. Their correlation coefficient equals 0.538. As the results from the ARCH model are estimated using monthly data 12-month averages of the estimated conditional variances are computed and the associated standard deviations are included in equation (4.6).

Table 4.3.
Exchange Rate Volatility
ARCH Model*

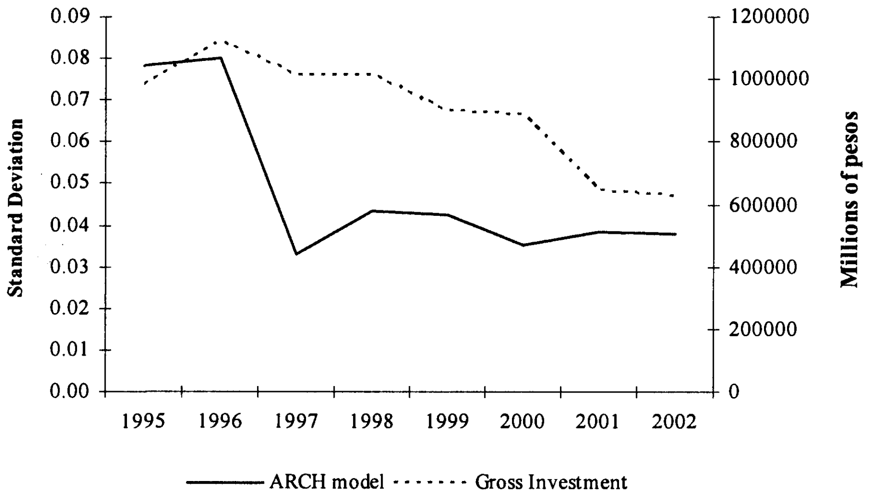
$$\Delta x_t = \underset{(0.003)}{-0.002984} + \underset{(0.07)}{1.355682}\Delta x_{t-1} - \underset{(0.07)}{0.394525}\Delta x_{t-2} + e_t$$

$$h_t = \underset{(0.0002)}{0.000915} + \underset{(0.22)}{0.556000}\, e_{t-1}^2$$

Statistics for the Standardised Residuals
Q^2-statistic(6) = 2.74
Skewness = 0.33
Kurtosis = 6.50
ARCH-LM(6) = 0.44 (0.84)
N=180

*Standard errors are in parenthesis except in the ARCH-LM test where the 'p' value is reported.

Figure 4.2.
Exchange Rate Volatility and Gross Investment
1994-2002



4.5. Empirical Results

In the following, the results of alternative estimates of equation (4.6) of the investment ratio on sales, movements of exchange rates and interest rates are presented. The investment series reflect the total amount of gross domestic investment by sector or industry. In all specifications, the interest rate is treated as endogenous and the set of instruments for the 2SLS estimations using fixed effects includes lagged values of the sales, volatility and interest rate ratios. Estimations consist of 205 three-digit level manufacturing sectors, for the 1994-2002 sample period.

4.5.1. Baseline Specification

The results from the two-stage regression of equation (4.6) are presented in Table 4.4. All sectors are pooled together and the results from non-interacted regressions (*non-γ*) and from regressions in which the external industry exposure is considered are reported. In the latter case, variations in exchange rate and its volatility depend on the two measures of external exposure outlined before (see Section 4.4.1.1). First, exchange rate depreciation is expected to increase investment through the export to sales ratio (*expm*) so that the coefficient β_3 in equation (4.6) is expected to be positive. The opposite effect is expected through the imported-input or cost channel (*impm*). That is, β_3 is expected to be negative. A depreciation of the exchange rate stimulates investment by increasing demands in both the domestic and export markets but it reduces investment because of the increasing cost of imported intermediate goods. Second, there is no prediction regarding the sign of the parameters involving volatility and its interaction with the exposure measures. As it was outlined before there is no consensus in the literature with regards to which effect should be predominant.

Table 4.4.
Two-Stage Least Squares Results from the Pooled Sample

$$\frac{I_t^i}{I_{t-1}^i} = \beta_0^i + \beta_1 \cdot \frac{sales_t^i}{sales_{t-1}^i} + (\beta_2 + \beta_3 \gamma_t^i) \cdot \frac{rer_{t-1}}{rer_{t-2}} + (\beta_4 + \beta_5 \gamma_t^i) \cdot \frac{vol_{t-1}}{vol_{t-2}} + \beta_6 \cdot \frac{irate_t}{irate_{t-1}} + \lambda^i + \varepsilon_t^i$$

	non-γ	expm	impm
β1	0.278	0.230	0.515
	[0.14]	[0.11]	[0.26]
β2	**-30.336**	**-33.562**	**-30.966**
	[2.1]*	**[2.32]***	**[2.09]***
β3	---	**14.159**	1.883
		[1.7]**	[0.17]
Overall effect Exchange rate	---	**-30.748**	**-30.573**
		[2.13]*	**[2.12]***
β4	7.678	9.584	6.181
	[1.28]	[1.59]	[1.00]
β5	---	-8.224	6.236
		[1.57]	[1.05]
Overall effect Volatility	---	7.950	7.484
		[1.33]	[1.25]
β6	4.534	4.652	4.341
	[1.01]	[1.04]	[0.97]

Notes: 1230 observations (205 sectors). Absolute value of t statistics in brackets.
All estimations include industry dummies.
γ varies according to the different external exposure measures.
* significant at 5% level; ** significant at 10%

The results suggest a positive but insignificant relationship with sales in all estimations, depreciation of the real exchange rate seems to reduce investment and the interest rate has an insignificant effect on investment decisions. In particular, exchange rate depreciations are strongly associated with reductions in investment. This finding is in line with those found by Aguiar (2004), Lederman *et al.*, 2003 and

Pratap and Urrutia, 2004 for the Mexican Manufacturing Industry. The results from the estimated coefficients on the interacted terms reveal dissimilarities across industries. The coefficient associated with the export measure is positive (β_3) implying that after a depreciation the firm's revenues (and via this channel its investment) tend to grow at a rate which increases with the share of foreign sales in total revenues. An overall contractionary effect however is observed. Correspondingly, volatility has a positive although not significant impact on investment. The coefficient of volatility, depending on the industry's external orientation (β_5), reveals a detrimental effect on investment through the export channel while the opposite occurs through the cost channel. These findings, however, turn out to be statistically insignificant.

4.5.2 Market Power

To examine further the effect of exchange rate variations on profits and hence on investment, a measure of the degree of the market power by sector is included in the estimations (see Campa and Golberg, 1995; Nucci and Pozzolo, 2001). In this respect, for a given exposure to foreign markets, if market power is weak (i.e., competitive firms), the effect of exchange rate variations on total revenues should be stronger (see Dornbusch, 1987). Consequently, the influence of exchange rate movements depends also on the market structure under which the firm operates (see equation (4.5)). In order to measure the degree of the sectoral-specific market power, a time varying measure of profits margins on unit price is constructed according to the procedure suggested by Domowitz *et al.*, 1986 as follows: [61]

$$mkup = \frac{Value\ of\ sales + \Delta Inventories - Payroll - Cost\ of\ materials}{Value\ of\ sales + \Delta Inventories} \tag{4.8}$$

which also can be calculated as (Value added – Payroll)/(Value added + Cost of materials), given the Census' definition of value added. The resulting mark-up ratios using the latter formula are shown in Table 4.5 for a subset of years of our entire period and with data aggregated by manufacturing industry.

Table 4.5.
Industry Markup Ratios^

	1994	2002	1994-2002*	Coef. of variation
1. Food, Beverages and Tobacco	0.2768	0.2941	0.2824	0.0284
2. Textile, Apparel and Leather Industries	0.1478	0.1829	0.1912	0.1077
3. Lumber and Wood Products. Including Furniture	0.1529	0.1532	0.1691	0.0884
4. Paper and Allied Products, Printing and Publishing	0.2446	0.2419	0.2568	0.0370
5. Chemicals, Petroleum, Coal, Rubber and Plastic Products	0.2454	0.2870	0.2699	0.0444
6. Non-Metallic Mineral Products, except Petroleum and Coal Products	0.3874	0.4268	0.4183	0.0532
7. Basic Metal Industries	0.2096	0.1982	0.2294	0.0906
8. Metal Products, Machinery and Equipment. Including Surgical and Precision Instruments	0.2129	0.2817	0.2269	0.1020
9. Other Manufacturing Industries	0.2022	0.2435	0.2481	0.1059

(^) Using the following measure: (Value added - payroll)/(value added+total inputs)
(*) Mean values over the period 1994-2002

The results show relatively high variability of the markup ratios in only a few sectors: Textile and Leather Industries; Metal Products, Machinery and Equipment; and Other Manufacturing Industries. To incorporate these markups in

61 The data used to construct this variable is taken from the Annual Industry Survey described earlier.

the estimations the two measures of external exposure are adjusted yearly by sectoral markups. So, the following specification is estimated:

$$\frac{I_t^i}{I_{t-1}^i} = \beta_0^i + \beta_1 \cdot \frac{sales_t^i}{sales_{t-1}^i} + (\beta_2 + \beta_3 \gamma_t^i (1 - mkup_t^i)) \cdot \frac{rer_{t-1}}{rer_{t-2}} +$$

$$+ (\beta_4 + \beta_5 \gamma_t^i (1 - mkup_t^i)) \cdot \frac{vol_{t-1}}{vol_{t-2}} + \beta_6 \cdot \frac{irate_t}{irate_{t-1}} + \lambda^i + \varepsilon_t^i \qquad (4.9)$$

The estimated coefficients for these interacting variables indicates that the effect of an exchange rate depreciation on investment increases on both the export and imported-input channel, the lower is the monopoly power. In other words, investment in sectors with low markups reacts more strongly to exchange rate variations.[62] Finally, an indicator of net exposure (*netm*) is added to the two exposure measures already defined. The idea is to have an indicator of the exposure of a sector to exchange rates through reliance on imported inputs into production and through sales to external markets. To construct this indicator the measure of the imported-input channel is subtracted from the export one. This indicator, therefore, depends on the size of the external orientation of the manufacturing sectors.

The results reported in Table 4.6 refer to the estimation of equation (4.9) adjusting the two measures of external exposure by the sectoral markups. As it is clear from the table, investment is positive correlated with sales in all cases although not statistically significant. Once again a strong and negative effect is observed in investment with a depreciation of the exchange rate. Moreover, the results are consistent with the theoretical predictions of a positive relationship

62 Denoting δ = (1-markup) ; δ=1 describes a perfectly competitive market whereas δ=0 denotes a monopolistic industry. Details can be found in Campa and Golberg, 1995 and Nucci and Pozzolo, 2001.

between investment and changes in exchange rates through the revenue channel. This effect is also observed using the net exposure measure.

Table 4.6.
Two-Stage Least Squares Results from the Pooled Sample
Regressions Adjusted by Sectoral Markups

$$\frac{I_t^i}{I_{t-1}^i} = \beta_0^i + \beta_1 \cdot \frac{sales_t^i}{sales_{t-1}^i} + (\beta_2 + \beta_3 \gamma_t^i (1 - mkup_t^i)) \cdot \frac{rer_{t-1}}{rer_{t-2}} + (\beta_4 + \beta_5 \gamma_t^i (1 - mkup_t^i)) \cdot \frac{vol_{t-1}}{vol_{t-2}}$$
$$+ \beta_6 \cdot \frac{irate_t}{irate_{t-1}} + \lambda^i + \varepsilon_t^i$$

	expm	impm	netm
β1	0.57	1.078	0.554
	[0.28]	[0.54]	[0.28]
β2	**-34.498**	**-32.410**	**-30.408**
	[2.37]*	**[2.18]***	**[2.12]***
β3	**24.685**	14.544	**23.048**
	[2.49]*	[1.02]	**[2.43]***
Overall effect	**-30.711**	**-30.075**	**-30.573**
Exchange rate	**[2.13]***	**[2.10]***	**[2.13]***
β4	**9.829**	5.661	7.728
	[1.61]**	[0.92]	[1.30]
β5	**-12.539**	6.216	**-19.926**
	[1.88]**	[0.81]	**[2.94]***
Overall effect	7.905	6.659	7.871
Volatility	[1.32]	[1.14]	[1.32]
β6	4.648	3.649	4.614
	[1.04]	[0.84]	[1.04]

Notes: 1230 observations (205 sectors). Absolute value of t statistics in brackets.
All estimations include industry dummies.
γ varies according to the different external exposure measures.
* significant at 5% level; ** significant at 10%

On the other hand, volatility seems to have an important role in the investment-exchange rate link. The constant term associated with volatility (*β_4* coefficient) is positive and statistically significant through the export channel when a conditional variance is employed. More interestingly, when volatility varies over time with industrial external measures (β_5 coefficient), the effect of volatility on investment is negative and statistically significant through the revenue and net exposure channel and positive when the imported-input channel is taken into account. Interest rates are in all cases positive even though statistically insignificant. Overall, the empirical evidence suggests that not only the level but also the volatility of the exchange rate play a crucial role in the investment decision. Moreover, the results also suggest a stronger response when a measure of the market power of the firm is introduced.

4.5.3. High and Low Markup Manufacturing Sectors

To explore more in detail the possible influence of market structures on the effect of exchange rate movements on domestic investment, the sample is split by their mean markup value into 'high-markup' and 'low-markup' manufacturing sectors. The aim is to investigate empirically the role of market or monopoly power in determining the relationship between investment and movements in the exchange rate. The results presented in Table 4.7 reveal that the effects of exchange rates on investment are not uniform. In sectors with high markups, the investment response to exchange rate movements seems to be quantitatively weaker in all estimations even though they are not statistically significant. By contrast, investment in the low-markup group of industries is highly responsive to changes in the exchange rate and its volatility. These results are consistent with those found in Campa and Golberg (1995, 1999), Nucci and Pozzolo (2001) and more recently Harchahoui *et al.* (2005) where the effect of the real exchange rate on investment is stronger for industries or firms with low price-cost margin than for firms with high markups. These findings suggest that low markup industries absorb more variations in the exchange rate through investment decisions while the high markup sectors pass more the effect of exchange rate movements into their pricing and markup behaviour.

The basic findings are similar to those reported before. Depreciation has reduced industry investment in Mexico. Nonetheless, when the exchange rate is interacting with the two exposure measures, it is clear that depreciation has increased the competitiveness for domestic exporting sectors. Firms' profitability rises and consequently more investment is expected. The overall effect of the exchange rate on total investment is negative. In terms of volatility, its effect is positive through the constant term (β_5 *coefficient*) in all cases but statistically significant only when the export exposure measure is included in the estimation.

The sign of the interacting term (β_5 *coefficient*) shows evidence of the importance of considering the external orientation of a firm. Negative effects on investment emerge from the revenue channel, while positive ones are obtained from the cost side. Thus, the more export-oriented a sector is, the greater is the expansionary effect with a real depreciation while less incentive to invest arises when volatility of the exchange rate is considered. Similar conclusion can be derived from the net exposure measure (*netm*).

Moreover, and most importantly, these findings are mainly determined by industries with weaker market power that are more likely to be affected by exchange rate movements. Overall, our results suggest that in Mexico not only the level of the exchange rate but also its volatility matters for investment decisions in the manufacturing sector.

Table 4.7.
Two-Stage Least Squares Results from High and Low Manufacturing Sectors

High Markup sectors N=498(83 sectors)	**expm**	Adjusted by mk	**impm**	Adjusted by mk	**netm**	Adjusted by mk
β1	3.025	2.946	3.284	3.748	3.218	3.222
	[1.10]	[1.07]	[1.18]	[1.35]	[1.16]	[1.16]
β2	-18.822	-18.529	-20.988	-22.829	-20.913	-21.079
	[0.87]	[0.85]	[0.96]	[1.03]	[0.97]	[0.98]
β3	-9.532	-8.43	4.756	18.197	-5.137	-7.601
	[0.66]	[0.4]	[0.25]	[0.67]	[0.4]	[0.41]
Overall effect	-20.532	-19.574	-20.014	-20.236	-20.783	-20.939
exchange rate	[0.96]	[0.92]	[0.93]	[0.95]	[0.97]	[0.98]
β4	5.358	4.897	4.574	4.667	5.954	5.94
	[0.58]	[0.53]	[0.48]	[0.49]	[0.65]	[0.65]
β5	3.079	3.358	5.417	5.868	-2.453	-4.044
	[0.35]	[0.26]	[0.57]	[0.43]	[0.29]	[0.33]
Overall effect	5.910	5.314	5.683	5.503	6.017	6.015
volatility	[0.65]	[0.59]	[0.62]	[0.61]	[0.66]	[0.66]
β6	4.841	4.36	4.729	4.559	4.911	4.871
	[0.70]	[0.64]	[0.68]	[0.66]	[0.71]	[0.71]

Low Markup sectors N=732(122 sectors)	**expm**	Adjusted by mk	**impm**	Adjusted by mk	**netm**	Adjusted by mk
β1	-2.296	-1.724	-2.011	-1.295	-1.959	-1.888
	[0.79]	[0.59]	[0.69]	[0.46]	[0.68]	[0.65]
β2	**-48.722**	**-49.324**	**-42.145**	**-43.372**	**-42.368**	**-42.478**
	[2.51]*	**[2.52]***	**[2.10]***	**[2.16]***	**[2.20]***	**[2.21]***
β3	**24.548**	**34.928**	2.253	15.578	**25.26**	**32.262**
	[2.34]*	**[2.97]***	[0.16]	[0.90]	**[2.61]***	**[2.82]***
Overall effect	**-43.519**	**-43.267**	**-41.668**	**-40.679**	**-42.365**	**-42.459**
exchange rate	**[2.25]***	**[2.23]***	**[2.14]***	**[2.11]***	**[2.20]***	**[2.20]***
β4	**15.636**	**15.78**	9.555	8.713	12.114	12.228
	[1.99]*	**[1.96]****	[1.18]	[1.09]	[1.58]	[1.59]
β5	**-13.993**	**-18.99**	6.386	5.562	**-20.442**	**-26.078**
	[2.08]*	**[2.32]***	[0.84]	[0.59]	**[2.96]***	**[3.12]***
Overall effect	**12.670**	12.487	10.907	9.675	12.112	12.212
volatility	**[1.63]****	[1.58]	[1.39]	[1.28]	[1.58]	[1.59]
β6	6.892	6.809	5.690	4.683	6.553	6.629
	[1.20]	[1.17]	[0.99]	[0.84]	[1.16]	[1.17]

Notes: 1230 observations (205 sectors)
Absolute value of t statistics in brackets
* significant at 5% level; ** significant at 10%
All estimations include industry dummies

4.5.4. External Exposures

This section analyses the data by introducing both exposure measures in the same regression. The aim is to evaluate whether investment responds more effectively to variations in the exchange rate either through the export exposure or through the imported-input one. Moreover, this model allows us to verify whether it is appropriate to use an indicator of net exposure like the one created in section 4.5.2 or if the two external measures (i.e., imported-input and export channels) should be entered separately into regression analysis. The following equation is tested:

$$\begin{aligned} \frac{I_t^i}{I_{t-1}} &= \beta_0 + \beta_1 \cdot \frac{sales_t^i}{sales_{t-1}^i} + (\beta_2 + \beta_3 \cdot \exp m_t^i + \beta_4 \cdot impm_t^i) \cdot \frac{rer_{t-1}}{rer_{t-2}} \\ &+ (\beta_5 + \beta_6 \cdot \exp m_t^i + \beta_7 \cdot impm_t^i) \cdot \frac{vol_{t-1}}{vol_{t-2}} + \beta_8 \cdot \frac{irate_t}{irate_{t-1}} + \lambda^i + \varepsilon_t^i \end{aligned} \tag{4.10}$$

On the whole, the results presented in Table 4.8 are consistent with preceding findings. Sales have a positive but insignificant effect on investment. The effect of changes in the real exchange rate is negative and significant (*β_2 coefficient*) and its effect on the full sample in mainly driven by industries with low markup ratios. When the effect of depreciation is split into different measures of external exposure, beneficial effects are observed through the revenue channel (*β_3 coefficient).* Volatility of exchange rates clearly becomes important as well and depends on the external orientation of the sector. It reduces investment with the exposure to export markets and stimulates investment in relation to the imported-input channel. Moreover, this pattern is stronger for those sectors with low markups (i.e., competitive markets) and when coefficients are adjusted by sectoral markups.

As mentioned before, there is no consensus in the literature about the overall effect that volatility may have on investment. Our results, however, can be compared with those obtained by Harchahoui *et al*., (2005). These authors divide exchange rate movements into two regimes: low and high volatility. They found that in high (low) volatility environments depreciations tend to have a negative (positive) impact in total investment. Their findings are important for this study since exchange-rate movements in Mexico for the sample-period under consideration correspond to a high-variability regime due to the adoption of a flexible scheme confirming the results found by Harchahoui *et al*., (2005).

Wald-statistics reported at the end of Table 4.8 are used to test the validity of using the two external exposures measures in the same regression (see Campa and Golberg, 1995). It would be unsuitable to use a net exposure measure in the empirical analysis if the null hypothesis that the coefficients should be the same is rejected. The first test restricts only the coefficients in the exchange rate level variables; the second test refers to the volatility coefficients; and the last one restricts all exchange rate parameters. The results suggest that the use of both export and imported-input exposures are appropriate in the same regression analysis in most of the cases. In other words, the response of investment from both exposure channels is the same. Similar findings are found in Campa and Golberg (1995) where the use of an aggregate measure is not problematic for the pooled sample and low markup sectors.

Table 4.8.
Two-Stage Least Squares Results using both Export and Imported-Input Exposure

	Full Sample		High Markup		Low Markup	
		Adjusted by mk		Adjusted by mk		Adjusted by mk
	expm & impm	expm & impm	expm & impm	expm & impm	expm & impm	expm & impm
β1	0.571	1.408	3.385	3.77	-1.951	-0.789
	[0.28]	[0.71]	[1.22]	[1.36]	[0.68]	[0.28]
β2	**-33.832**	**-35.699**	-20.196	-21.879	**-48.949**	**-49.997**
	[2.29]*	**[2.39]***	[0.92]	[0.98]	**[2.46]***	**[2.51]***
β3	**19.786**	**31.333**	-7.177	5.923	**32.414**	**42.759**
	[2.26]*	**[2.99]***	[0.48]	[0.27]	**[2.92]***	**[3.43]***
β4	-5.598	2.244	4.459	17.827	-9.174	-1.053
	[0.48]	[0.15]	[0.22]	[0.64]	[0.62]	[0.06]
β5	7.889	7.525	4.619	4.388	**13.345**	12.586
	[1.29]	[1.23]	[0.49]	[0.46]	**[1.68]***	[1.59]
β6	**-13.753**	**-20.247**	0.508	-0.647	**-21.599**	**-27.854**
	[2.34]*	**[2.71]***	[0.05]	[0.05]	**[2.83]***	**[3.04]***
β7	**12.738**	**16.073**	5.856	6.866	**16.866**	**19.039**
	[1.92]**	**[1.87]****	[0.56]	[0.46]	**[1.95]****	**[1.79]***
β8	4.487	3.833	4.863	4.334	6.476	5.497
	[1.01]	[0.88]	[0.70]	[0.64]	[1.15]	[1.00]
Wald Test Statistic						
β3+β4 = 0	1.16 [0.28]	4.45 [0.04]	0.01 [0.90]	0.14 [0.71]	1.99 [0.16]	4.85 [0.03]
β6 + β7 = 0	0.02 [0.87]	0.24 [0.62]	0.34 [0.56]	0.16 [0.69]	0.32 [0.57]	0.72 [0.39]
β3+β4 = 0 β6 + β7 = 0	0.93 [0.39]	3.47 [0.03]	0.25 [0.78]	0.54 [0.58]	1.17 [0.31]	3.14 [0.04]
Observations:	1230 (205 sectors)		498 (83 sectors)		732 (122 sectors)	

Absolute value of t statistics in brackets except in the Wald Test statistic where they represent the 'p' values
All estimations include industry dummies
* significant at 5% level; ** significant at 10%

4.6. Conclusions

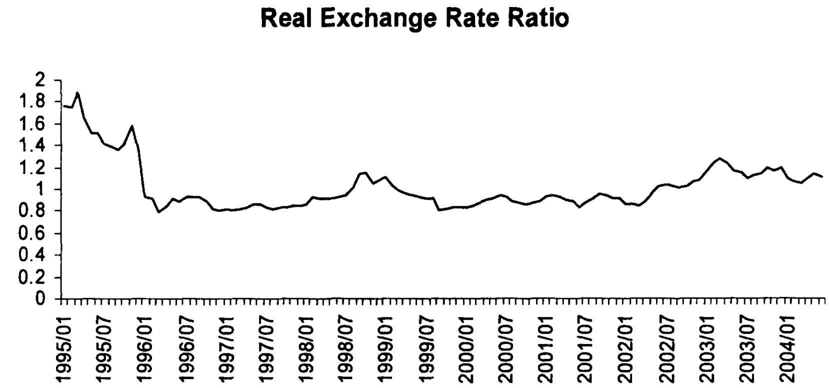
This chapter analyses the importance of exchange rate variations on domestic investment for a sample of 205 three-digit level manufacturing sectors in Mexico between the years 1994 and 2002. Our empirical evidence support the results from previous studies regarding the importance of considering exchange rate movements and their interaction with external exposure measures on models dealing with investment decisions (see Campa and Golberg, 1995, 1999; Nucci and Pozzolo, 2001 and; Leonida *et al.*, 2003). An important distinction from these studies, however, lies on the significance of the response of investment to volatility in addition to just changes of exchange rates. A depreciation of the exchange rate has a positive effect on investment through the export channel. On the other hand, volatility has a detrimental effect of investment with the exposure to export markets and stimulates investment in relation to the imported-input channel. These results suggest that not just the level but also the volatility of the exchange rate can play a crucial role in investment decisions. Our findings also suggest a stronger response to movements in exchange rates when a measure of the market power of the firm is introduced. Moreover, the effects of exchange rates on investment are not uniform when the sample is split into 'high-markup' and 'low-markup' manufacturing sectors. Investment in the low-markup sectors is highly responsive to changes and volatility of exchange rates and its overall pattern seem to be the one driven our general results.

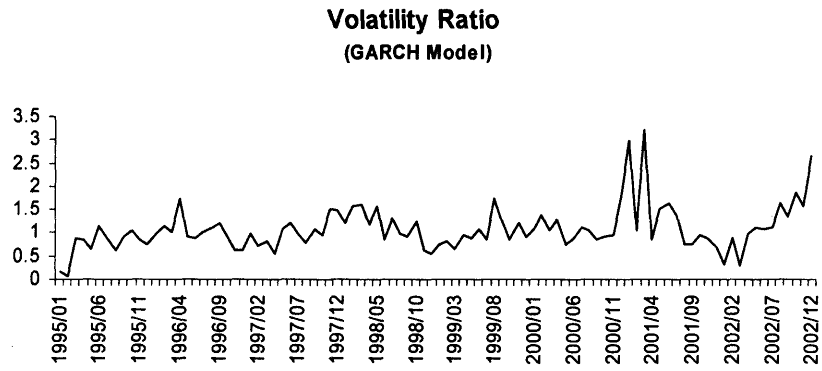
An interesting result emerges from export-oriented industries which seem to be more affected by both changes and volatility of the exchange rate. The more export-oriented a sector is the greater is the expansionary effect with a real depreciation whilst less incentive to invest arises if volatility is considered. Higher uncertainty tends to lower investment. In this respect, a key policy implication is that to encourage the investment response from this particular group of industries, the Mexican government should reduce the volatility of the exchange rate. It is worth noting the asymmetry of the effect between the export and import channel in our results. This finding emerges clearly when the sample is divided according to its market structure. Low-markup industries with more competitive market structures are more responsive to exchange rates particularly through its export channel. A possible explanation may be related to the time it takes for the firm to react to unexpected changes in the exchange rate. A response through the imported-input channel may take more time to be adjusted. The possible use of inventories may explain why imports seem to be statistically insignificant. This outcome constitutes an interesting area for future research and discussion.

To conclude, it is also worth nothing that our results are limited by the nature of the dataset. It is possible that even at the sector level some information has been aggregated away. Firm level data, for instance, would allow us to examine other channels that may be important to investment decisions such as the financial situation. Finally, it should be mention that the effect of volatility on investment could have been influenced by large shifts in the level of the exchange rate such as structural breaks. It was expected to have in our sample period greater variation in the exchange rate with respect to the previous period of a fixed exchange rate regime. Nevertheless, structural breaks are not considered in our sample. This constitutes another issue for future research which may include alternative econometric techniques.

Appendix

Figure 4.1A.
Real Exchange and Volatility Ratios
1994-2002





CHAPTER FIVE

CONCLUSIONS

This final chapter presents the major findings drawn from the empirical results. This thesis examines the feasibility of IT in emerging economies which have been forced to look for a new monetary policy framework as a result of currency and financial crises. Three main aspects are examined. First, sacrifice ratios are computed, to analyse whether disinflation has been achieved at lower cost. Second, interest rate rules are estimated to evaluate the central bank response to inflation in the context of IT principles. Third, the importance of exchange rate fluctuations on investment decisions is investigated. On the whole, the empirical results suggest the importance of studying the experience of emerging economies further in their attempt to achieve macroeconomic stability which differs in several aspects from the experience of industrialised countries.

In Chapter 2, sacrifice ratios which typically measure the aggregate loss in output associated with a one-percent fall in inflation, are estimated and compared both across time and countries. Three different techniques have been used to overcome any possible shortcoming of each approach. First, disinflationary episodes of inflation are calculated. The results show, on average, a lower cost of disinflation for those countries that have adopted IT. Moreover, the higher the initial levels of inflation, the lower the sacrifice ratio. This finding supports the view that high levels of inflation reduce the extent of nominal rigidities (see Ball et al. 1988). Another finding accounts for the change in inflation and speed of disinflation. Both indicators have reduced more in those countries that adopted IT during the nineties. These results may reflect the efficacy of this regime to converge to stable and low values of inflation. Further analysis is done from the estimation of Phillips curves to capture the output-inflation trade-off for a given period of time. The estimation of the short-run and long-relationship is analysed. Taking into consideration the short-run average estimates, the results indicate an increase in the value of the sacrifice ratio in the post-reform period for both groups of countries. The long-run estimations generate similar results even though the value of the sacrifice ratio is quantitatively smaller. The results suggest that for countries where the process of disinflation has been accompanied by the implementation of explicit inflation targets, sacrifice ratios have increased less over time. The last approach employs an estimated structural VAR system to analyse the dynamic responses of variables to a monetary policy shock. Estimations of the sacrifice ratio are based on the impact over time of structural shocks to output and inflation. Looking at the average values, it is clear that the sacrifice ratio is higher in non-IT countries. If the sacrifice ratio is computed for one year, the value of the sacrifice ratio is 0.32 in countries with IT and 0.69 in non-IT countries. As the horizons lengthens (i.e., up to five years) the estimation of the sacrifice ratio suggests relatively constant values for the case of IT countries. The results are also examined for the post-reform period. Sacrifice ratios are relatively constant, as the horizon lengthens, but the value of the sacrifice ratio is higher in non-IT countries. This pattern is clearer when one-year is considered. Overall, the empirical evidence from this chapter suggests that emerging economies with IT are better able to achieve lower and stable levels of inflation. In addition, the cost of disinflation to achieve this result seems to be less in these countries. IT, however, may be accompanied by other important structural and institutional developments which have not been considered in our analysis.

In Chapter 3, a forward-looking version of the rule proposed by Taylor (1993) is estimated, in two emerging economies – Israel and Mexico, to verify whether monetary policy has indeed become the nominal anchor of the economy. In other words, if the central bank, through its effect on interest rates, has effectively stabilised the economy. Three alternative specifications are considered: the baseline model; the gap model; and the forward looking specification and several issues related to policy formulation are explored. These include: the output-inflation variability; interest rate smooth preferences; and the inclusion of additional variables to the baseline specification. Overall, the empirical evidence in the case of Mexico offers consistent results in all the specifications. Monetary policy in Mexico has performed the role of the nominal anchor of the economy. The results are more evident, however, when the analysis is carried out purely for the period under IT and with data on inflation expectations (i.e., forward-looking specification). In this case, not only inflation deviations from its target but also output deviations from its trend are important in setting interest rates in the economy. On the other hand, the results in the case of Israel are mixed. There is not a clear commitment to stabilise inflation. The results from the baseline specification disagree with the ones from the gap and the forward-looking ones.

Furthermore, 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. Alternatively, in Israel, the significant contribution of the lagged value of inflation is observed in all estimations. Particularly interesting is the analysis of the inclusion of changes in the exchange rate in all the specifications. This is due to the different stance in each country as regards the exchange rate policy. The case of Mexico suggests that it is feasible to reduce inflation within a flexible exchange rate regime when an appropriate monetary policy is adopted. Particularly, in the forward-looking model, it is notable the result that in the context of a floating exchange rate the central bank seems to react to effectively maintain price stability instead of defending a specific level of the exchange rate. Alternatively, in Israel, the results indicate that the Central Bank reacts to changes in the exchange rate and, in some cases, that this response exceeds that of the inflation rate. Its contribution becomes smaller when more flexible exchange rates are in place. It seems that the coexistence of a crawling exchange rate band with the adoption of inflation targeting principles make the conduct of monetary policy more challenging than otherwise. Overall, both countries have achieved lower and more stable levels of inflation however it seems that the exchange rate policy adopted in each country has played an important role to achieve that objective.

Taken into account the importance of the exchange rate in Chapter 4 panel data estimations are used to evaluate the relationship between movements in exchange rates and investment in the Mexican Manufacturing industry. In particular, standard investment equations are considered to incorporate export and imported-input exposure measures and to explore the possible influence of market structures. The results support the view that movements in exchange rates have affected investment decisions in Mexico (see Aguiar, 2004). An important distinction however, lies in the significance of the response of investment to exchange rate volatility, in addition to changes of exchange rates. The overall effect of depreciation seems to reduce investment and the effect of volatility varies according to the external exposure of the sector.

The empirical evidence also supports the importance of considering exchange rate movements and their interaction with external exposure measures on models dealing with investment decisions. The results support the view that a depreciation of the exchange rate has a positive effect through the export channel. On the other hand, volatility also matters for investment decisions in Mexico and its effect is also mainly observed in those sectors that rely more on exports. To further analyse our findings, a measure of the degree of the market power by sector is included in the estimations. The results suggest that effects of exchange rates on investment are not uniform when the sample is split into 'high-markup' and 'low-markup' manufacturing sectors. Investment is more sensitive in sectors with less market power and sectors that rely more on export-oriented industries seems to be more affected by variations in the exchange rate. Overall, the empirical evidence for the Mexican Manufacturing Industry suggests that volatility and changes in the exchange rate have influenced investment decisions mainly through the export channel. Exchange rate depreciations have reduced investment and volatility has been detrimental for investment. In this respect, to encourage the investment response from this particular group of industries the government should reduce uncertainty. More research on this topic, however, should be considered since the empirical findings may be sensitive to the country and period selected in our estimations.

References

Abel, Andrew B., 1983, 'Optimal Investment under Uncertainty', *American Economic Review*, 73, pp. 228-233

Abel, A. and O. Blanchard, 1986, 'The Present Value of Profits and Cyclical Movements in Investment', *Econometrica,* 54, pp 249-73

Agenor, Pierre-Richard, 2000, 'Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting', *The World Bank,* Washington DC

Agenor, P. and P. Montiel, 1996, *Development Macroeconomics,* Pricenton University: Princenton, N.J.

Aguiar, Mark, 2004, 'Investment, Devaluation, and Foreign Currency Exposure: The Case of Mexico', *Federal Reserve Bank of Boston,* mimeo

Aizenman, J., 1992, 'Exchange Rate Flexibility, Volatility and the Patterns of Domestic and Foreign Direct Investment', *IMF Staff Papers,* December

Amato, J. D. and S. Gerlach, 2002, 'Inflation Targeting in Emerging and Transition Economies: Lessons After a Decade', *European Economic Review,* 46, pp 781-90

Amuedo Dorantes, C. and S. Pozo, 2001, 'Foreign Exchange Rates and Foreign Direct Investment in the United States', *The International Trade Journal,* XV(3), pp 323-43

Andersen, P., 1992, 'OECD Country Experiences with Disinflation', in *Inflation, Disinflation and Monetary Policy,* Sydney: Reserve Bank of Australia, pp. 104-73

Andersen and Wascher, 1999, 'Sacrifice Ratios and the Conduct of Monetary Policy in Conditions of Low Inflation', *BIS Working Papers* 82

Aspe, Pedro, 1993, *Economic Transformation: The Mexican Way,* the MIT Press Cambridge, Massachusetts, London

Atella, V., G. E. Atzeni and P. Belvisi, 2003, 'Investment and Exchange Rate Uncertainty', *Journal of Policy Modelling,* 25, pp 811-824

Ball, Laurence, 1994, 'What determines the Sacrifice Ratio', *NBER Working Paper* 4306

Ball, L., 1999, 'Policy Rules for Open Economies', in *Monetary Policy Rules,* ed. by J. Taylor, University of Chicago Press, pp 127-56

Ball, L., G. Mankiw and D. Romer, 1988, 'The New Keynesian Economics and the Output-Inflation Trade-off', *Brooking Papers on Economic Activity,* 1, pp. 1-65

Baum, C., M. Caglayan and N. Ozkam, 2004, 'Nonlinear Effects of Exchange Rate Volatility on the Volume of Bilateral Exports', *Journal of Applied Econometrics*, 19(1), pp 1-23

Baum, C. and M. Caglayan, 2005, 'Investment and Uncertainty', *mimeo*

Barrell, R., S. Gottschalk and S. Hall, 2003, 'Foreign Direct Investment and Exchange Rate Uncertainty in Imperfectly Competitive Industries', *NIERS Discussion Paper* 220

Bar-Or, H. and Leiderman, L., 2000, 'Monetary Policy Rules and Transmission Mechanisms under Inflation Targeting in Israel', *Bank of Israel*, Discussion Paper

Barro, R.J. and D. Gordon, 1983, 'Rules, Discretion and Reputation in a Model of Monetary Policy', *Journal of Monetary Economics*, 12(1), pp 101-122

Beaudry, P., M. Caglayan and F. Schiantarellli, 2001, 'Monetary Instability, the Predictability of Prices, and the Allocation of Investment: An Empirical Investigation using UK Panel Data', *American Economic Review*, 91(3), pp 648-62

Bernanke B. and F. Mishkin, 1997, 'Inflation Targeting: A New Framework for Monetary Policy?', *The Journal of Economic Perspectives*, 11(2), pp. 97-116

Bernanke B., T. Laubach, F. Mishkin and A. Posen, 1999, *Inflation Targeting: Lessons from International Experience,* Princeton University: Princeton, N.J.

Bernanke, B. and M. Woodford, 1997, 'Inflation Forecasts and Monetary Policy', *NBER Working Paper* 6157, September

Blanchard, O. J., 1984, 'The Lucas Critique and the Volcker Deflation', *American Economy Review*, 74(2), pp.211-215

Blanchard, O. J. and D. Quah, 1989, 'The Dynamic Effects of Aggregate Demand and Supply Disturbances', *American Economic Review*, 79, pp. 655-73

Blejer, M., A. Ize, A. Leone and S. Werlang, eds., 2000, *Inflation Targeting in Pratice: Strategic and Operational Issues and Application to Emerging Economies*, Washington: International Monetary Fund

Bogdanski, J., A. Tombini and S. Ribeiro C. Werlang, 2000, 'Implementing Inflation Targeting in Brazil', *Bank of Brazil*, Working Papers, July

Bollerslev, T., 1986, 'Generalised Autoregressive Conditional Heterokedasticity', *Journal of Econometrics*, 31(3), pp 307-27

Bond, S., R. Moessner, H. Mumtaz and M. Syed, 2005, 'Microeconometric Evidence on Uncertainty and Investment', *Institute for Fiscal Studies,* mimeo

Bruno, M. and W. Easterly, 1998, 'Inflation Crises and long-run Growth', *Journal of Monetary Economics*, 41, pp. 3-26

Bufman, G. and L. Leiderman, 2000, 'Inflation Targeting Under a Crawling Band Exchange Rate Regime: Lessons from Israel', in *Inflation Targeting in Practice: Strategic and Operational Issues and Application to Emerging Market Economies*, ed. by Mario I. Blejer, Alain Ize, Alfredo M. Leone, and Sergio Werlang, Washington: International Monetary Fund

Byrne, Joseph and E. Philip Davis, 2003, 'Panel estimation of the Impact of exchange rate Uncertainty on Investment in the major Industrial Countries', *NIESR*, mimeo

Calvo G., 1978, 'On the Time Consistency of Optimal Policy in the Monetary Economy', *Econometrica,* 46(6), pp 1411-28

Calvo, G. and C. Reinhart, 2002, 'Fear of Floating', *Quarterly Journal of Economics*, CXVII(2), pp 379-408

Campa, Jose M., 1993, 'Entry by Foreign Firms in the United States under Exchange Rate Uncertainty', *Review of Economics and Statistics*, 75(4), pp 614-22

Campa, J. and L. Golberg, 1995, 'Investment in Manufacturing, Exchange Rates and External Exposure', *Journal of International Economics*, 38, pp 297-320

Campa, J. and L. Golberg, 1999, 'Investment, Pass-through, and Exchange Rates: A Cross-Country Comparison', *International Economic Review*, 40(2), pp. 287-314

Carranza, L., J.M. Cayo and J.E. Galdon Sanchez, 2003, 'Exchange Rate Volatility and Economic Performance in Peru: A Firm Level Analysis', *Facultad de Ciencias Economicas y Empresariales*, Working Paper 12/03, University of Navarra

Carruth, A., A. Dickerson and A. Henley, 2000, 'What do we know about Investment under Uncertainty?', *Journal of Economic Surveys*, 14(2), pp. 119-153

Carstens, A. and Gil Diaz, 1996, 'Some hypothesis Related to the Mexican 1994-95 Crisis', *Banco de Mexico*, Working Paper 9601

Carstens, A. and A. Werner, 1999, 'Mexico's Monetary Policy Framework under a Floating Exchange Rate Regime, *Banco de Mexico*, Research Paper 9905

Cecchetti, S., 1998, 'Policy Rules and Targets: Framing the Central Bankers Problem', *Economic Policy Review,* Federal Reserve Bank of New York, 4, pp 1-14

Cecchetti, S., 2000, 'Making Monetary Policy: Objectives and Rules', *Oxford Review of Economic Policy*, 16(4), pp 43-59

Cecchetti, S. and M. Ehrmann, 1999, 'Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers' Preferences and Outcomes', *NBER Working Paper* 7426, December

Cecchetti, S., and R. Rich, 2001, 'Structural Estimates of the U.S. Sacrifice Ratio', *Journal of Business and Economics Statistics*, 19(4), pp. 416-427

Charemza, W. and D. Deadman, 1997, *New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression*, Edward Elgar, Second edition

Chuecos, Alicia, 2003, 'Existen Condiciones para Implementar una Meta de Inflaci6n en Venezuela? Una Guia utilizando la Funcion Reaccion', *Universidad de los Andes*, Venezuela, mimeo

Clarida, Gali and Gertler, 1998, 'Monetary Policy Rules in Practice: Some International Evidence', *European Economic Review*, 42, pp 1033-1067

Clarida, Gali and Gertler, 1999, 'The Science of Monetary Policy: A New Keynesian Perspective', *Journal of Economic Literature*, pp 1661-1707

Clarida, Gali and Gertler, 2000, 'Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory', *Quarterly Journal of Economics*, February

Corbo, Vittorio, 2000, 'Monetary Policy in Latin America in the 90s', *Central Bank of Chile,* Working Paper 78

Corbo, V., O. Landerretche and K. Schmidt-Hebbel, 2001, 'Assessing Inflation Targeting after a Decade of World Experience', *International Journal of Finance and Economics* 6(4), October, pp. 343-368

Corbo, V., O. Landerretche and K. Schmidt-Hebbel, 2002, 'Objetivos de Inflaci6n en Am6rica Latina', *Gaceta de Economía, ITAM,* Numero especial

Cozier Barry and G. Wilkinson, 1991, 'Some Evidence on Hysteresis and the Costs of Disinflation in Canada', *Bank of Canada,* Technical Report 55

Cuñado, J. and Perez de Gracia, F., 2003, 'Sacrifice Ratios: Some Lessons from EMU Countries, 1960-2001', *International Review of Applied Economics*, 17(3), pp 327-337

Cushman, David O., 1998, 'Exchange Rate Uncertainty and Foreign Direct Investment in the United States', *Weltwirtschaftliches Archiv*, 124(2), pp 322-36

Darby, J., A. H. Hallet, J. Ireland and L. Piscitelli, 1999, 'The Impact of Exchange Rate Uncertainty on the Level of Investment', *The Economic Journal*, 109, pp 55-67

Debelle, Guy, 1997, 'Inflation Targeting in Practice', *IMF Working Papers* 97/35, International Monetary Fund

Dixit, Avinash K. and Robert S. Pyndick, 1994, *Investment under Uncertainty*, Princenton: Princenton University Press

Domowitz, I., G. Hubbard and B. Petersen, 1986, 'Business Cycles and the Relationship between Concentration and Profits Margins', *Rand Journal of Economics*, 17, pp 1-17

Dornbusch, R., 1987, 'Exchange Rates and Prices', *American Economic Review*, 77, pp 93-106

Eleftheroiu, Maria, 2003, 'On the Robustness of the Taylor Rule in the EMU', *European University Institute*, Department of Economics, Working Paper 17

Elkayam, David, 2003, 'The Long Road from Adjustable Peg to Flexible Exchange Rate Regimes: The Case of Israel', *Monetary Studies*, Bank of Israel, Discussion Paper

Enders, W., 1995, *Applied Econometric Time Series*, John Wiley & Sons

Engle, R. F., 1982, 'Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of the United Kingdom Inflation', *Econometrica*, 50(4), pp 987-1007

Filardo, A., 1998, 'New Evidence on the Output Cost of fighting Inflation', *Economic Review*, Federal Reserve Bank of Kansas City, 3rd quarter

Fraga, Arminio, Ilan Goldfajn and André Minilla, 2003, 'Inflation Targeting in Emerging Market Economies', Paper presented at the *NBER Macroeconomics Annual Conference*

Fry, Maxwell, D. Julius, L. Mahadeva, S. Roger and G. Sterne, 2002, 'Key Issues in the Choice of Monetary Policy Framework', in *Monetary Policy Frameworks in a Global Context*, ed. by Lavan Mahadeva and Gabriel Sterne, London: Routledge

Gali, Jordi, 1992, 'How well does the IS-LM Model Fit Postwar U.S. Data?', *Quarterly Journal of Economics* 107, pp. 709-38

Gelos, Gaston and Alejandro Werner, 2002, 'Financial Liberalization, Credit Constraints and Collateral: Investment in the Mexican Manufacturing Sector', *Journal of Development Economics*, 67, pp 1-67

Ghei, Nita and Lana Pritchett, 1999, 'The three Pessimisms: Real Exchange Rates and Trade Flows in Developing Countries' in *Exchange Rate Misalignment and Measurement for Developing Countries,* ed. by Lawrence Hinkle and Peter Montiel, New York, Oxford University Press, pp 467-96

Gil-Diaz F. and A. Carstens, 1996, 'One Year of Solicitude: Some Pilgrim Tales about Mexico's 1994-1995 Crisis', *American Economic Review,* Papers and Proceedings, May, 86(2), pp 164-169

Goldberg, Linda, 1993, 'Exchange Rates and Investment in United States Industry', *Review of Economics and Statistics,* 75(4), pp 575-89

Goldberg, L. and C. Kolstad, 1995, 'Foreign Direct Investment, Exchange Rate Variability and Demand Uncertainty', *International Economic Review,* 36, pp 855-73

Goodfriend, M., 1991, 'Interest rates and the conduct of Monetary Policy', *Carnegie-Rochester Conference Series on Public Policy,* pp 7-30

Gordon, R. and S. R. King, 1982, 'The Output Cost of Disinflation in Traditional and Vector Autoregressive Models', *Brooking Papers on Economic Activity,* 1, pp. 205-242

Gourinchas, P., O. Landerretche and R. Valdes, 2001, 'Lending Booms: Latin America and the World', *NBER Working Paper* 8249, April

Greene, W., 2003, *Econometric Analysis,* Fifth Edition, New York: Prentice Hall

Groeneveld, J., K. Koedijk and C. Kool, 1998, 'Inflation Dynamics and Monetary Strategies: Evidence from Six Industrialized Countries', *Open Economies Review* 9, pp. 21-38

Güemez, G., 1996, 'The Strategy and the Evolution of the Economic Adjustment in Mexico', *Banco de Mexico,* Speech to the Board Trade Alliance

Haldane, A. ed., 1995, *Targeting Inflation,* Bank of England, London

Hansen, B. and K. West, 2002, 'Generalized Method of Moments and Macroeconomics', *Journal of Business and Economics Statistics,* 20(4), pp 460-469

Harchaoui, T., F. Tarkhani and T. Yuan, 2005, 'The Effects of the Exchange Rate on Investment: Evidence from Canadian Manufacturing Industries', *Bank of Canada,* Working Paper 2005-22

Hartman, Richard, 1972, 'The effects of Price and Cost Uncertainty on Investment', *Journal of Economic Theory,* 5, pp 258-66

Hendry, David, 1997, *Dynamic Econometrics,* Oxford University Press, New York

Humphrey, T., 1985, 'The Evolution and Policy Implications of Philips Curve Analysis', *Economic Review*, Federal Reserve Bank of Richmond, pp. 3-22

Hutchinson and Walsh, 1998, 'The output-Inflation Tradeoff and Central Bank Reform: Evidence from New Zealand', *The Economic Journal*, 108

Kamin, S. and J. Rogers, 1996, 'Monetary Policy in the End-Game to Exchange-Rate Based Stabilisations: The Case of Mexico', *International Finance Discussion Papers*, 540, Board of Governors of the Federal Reserve System

Kaminsky, G. and C. Reinhart, 1996, 'The twin crises: The causes of banking and balance of payments problems', *International Finance Discussion Papers*, 544, Board of Governors of the Federal Reserve System

Kaminsky, G., S. Lizondo and C. Reinhart, 1997, 'Leading Indicators of Currency Crises', *IMF Working Papers*, 97/79, International Monetary Fund

Krugman, P.R., 1979, 'A Model of Balance of Payments crisis' *Journal of Money, Credit and Banking,* 11(August), pp 311-324

Kuttner, Kenneth and Adam Posen, 1999, 'Does Talk Matter After All? Inflation Targeting and Central Bank Behaviour', *Federal Reserve Bank of New York*, Staff Report 88, October

Kydland, F. and E, Prescott, 1977, 'Rules Rather than Discretion: The Inconsistency of Optimal Plans', *Journal of Political Economy*, 85(3), pp 473-492

Laubach T. and A. Posen, 1997, 'Some Comparative Evidence on the Effectiveness of Inflation Targeting', *Federal Reserve Bank of New York*, Research Paper 9714, April

Lederman, D., A. M. Menendez, G. Perry and J. Stiglitz, 2003, 'Mexican Investment after the Tequila Crisis: Basic Economics, "Confidence" Effects or Market imperfections?', *Journal of International Money and Finance*, 22, pp 131-51

Lee, J., 1999, 'Inflation Targeting in Practice: Further Evidence', *Contemporary Economic Policy*, 17(3), July, pp. 332-347

Leiderman, Leonardo and Gil Bufman, 2000, "Inflation Targeting Under a Crawling Band Exchange Rate Regime: Lessons from Israel", in *Inflation Targeting in Practice: Strategic and Operational Issues and Application to Emerging Market Economies*, ed. by Mario I. Blejer, Alain Ize, Alfredo M. Leone, and Sergio Werlang, Washington: International Monetary Fund

Leonida, L., A. Ozkan and F. G. Ozkan, 2003, 'Investment and Exchange rates: Evidence from a Panel of UK Firms', *mimeo*

Mahadeva, L. and Sterne, G., eds., 2000, *Monetary Policy Frameworks in a Global Context*, London: Routledge

Mankiw, Gregory, 2001, 'The Inexorable and Mysterious Trade-off between Inflation and Unemployment', *The Economic Journal*, 111, May

Martinez L. and A. Werner, 2002, 'The Exchange Rate Regime and the Currency Composition of Corporate Debt: The Mexican Experience', Research Document, *Banco de Mexico,* mimeo

Masson, Paul R., Miguel A. Savastano and Sunil Sharma, 1998, 'Can Inflation Targeting be a Framework for Monetary Policy in Developing countries?', *Finance and Development*, March

Mayes, D. and B. Chapple, 1995, 'The Cost and Benefits of Disinflation: a Critique of the Sacrifice Ratio', *Reserve Bank of New Zealand,* Bulletin, 58(1), pp. 9-21

McCallum, B., 1996, 'Inflation Targeting in Canada, New Zealand, Sweden, the United Kingdom, and in General', *NBER Working Paper* 5579

Medina, J. and R. Valdes, 2002, 'Optimal Monetary Policy Rules when the Current Account Matters', *Central Bank of Chile*, Working Paper 77

Mehra, Y., 1999, 'A Forward-Looking Monetary Policy Reaction Function', *Economic Quarterly*, 85, Federal Reserve Bank of Richmond, pp 33-53

Mendoza, Miguel A., 1998, 'Inflacion y Crecimiento Econ6mico en México', *Monetaria*, XXI-21, abril-junio

Messmacher, M., 2002, 'Stabilization Policies in Mexico: 1982-2000', *Banco de Mexico*, mimeo

Mishkin, Frederick, 1997, 'Strategies from Controlling Inflation', in *Monetary Policy and Inflation Targeting: Proceedings of a Conference*, Economic Group, Reserve Bank of Australia, pp.7-38

Mishkin, F., 1998, 'International Experiences with Different Monetary Regimes', Conference on Monetary Rules, *Institute for International Economic Studies*, Stockholm University

Mishkin, F., 2000, 'Inflation Targeting in Emerging Market Countries', *American Economic Review Papers and Proceedings*, 9(2), pp 105-109, May

Mishkin, F. and A. Posen, 1997, 'Inflation Targeting: Lessons from Four Countries', Federal Reserve Bank of New York, *Economic Policy Review*, 3, pp. 9-110

Mishkin, F. and Miguel A. Savastano, 2000, 'Monetary Policy Strategies for Latin America', *NBER Working paper* 7617, March

Mishkin, F. and K. Schmidt-Hebbel, 2002, 'A Decade of Inflation Targeting in the World: What do we known and What do we need to know?, in *Inflation Targeting: Design, Performance,* ed. by Loaza, N. and R. Soto, Challenges, Santiago, Chile, Central Bank of Chile, pp. 171-219

Mohanty, M. S. and Marc Klau, 2004, Monetary Policy Rules in Emerging Market Economies: Issues and Evidence, *BIS* Working Paper 149, March

Morandé, F. and K. Schmidt-Hebbel, 2000, 'Monetary Policy and Inflation Targeting in Chile', in *Inflation Targeting in Practice: Strategic and Operational Issues and Application to Emerging Economies,* ed. by Mario Blejer *et al.*, IMF, pp 60-69

Muñoz Torres, R., 2005, 'Sacrifice Ratios and Inflation Targeting in Emerging Economies: A Comparative Analysis', in *Dynamic Models and Their Applications in Emerging Markets,* ed. by Sima Motamen-Samadian, Palgrave

Nadal-De Simone, F., 2001, 'Inflation Targeting in Practice: A Lucky Lot? *Contemporary Economic Policy*, 19(3), pp. 239-253, July

Nucci, Francesco and Alberto F. Pozzolo, 2001, 'Investment and the Exchange Rate: An Analysis with Firm-level Data', *European Economic Review*, 45, pp 259-83

Obstfeld, M. and K. Rogoff, 1996, *Foundations of International Macroeconomics,* Cambridge, Mass, MIT Press

Patrap, Sangeeta and Carlos Urrutia, 2004, 'Firm Dynamics, Investment, and Debt Portfolio: Balance Sheet Effects on the Mexican Crisis of 1994', *Journal of Development Economics*, 75, pp 535-63

Phillips, A. W., 1958, 'The Relation Between Unemployment and the Rate of Change of Money Wages in the United Kingdom 1861-1957', *Economica*, pp. 283-99

Razzak, W. A., 2002, 'Monetary Policy and Forecasting Inflation with and without the Output Gap', *Reserve Bank of New Zealand*, Discussion Paper Series, March

Reyes, Javier, 2004, 'Inflation Targeting or Fear of Floating in Disguise: The case of Mexico', *International Journal of Finance and Economics*, 9(1), pp. 49-69

Rudd, J. and K. Whelan, 2005, 'Modelling Inflation Dynamics: ACritical Survey of Recent Research', *mimeo*, September

Rudebusch, Glenn, D., 2005, 'Assessing the Lucas Critique in Monetary Policy Models', *Journal of Money, Credit, and Banking*, 37(2), pp 245-272

Sanchez, Oscar, 2001, 'Investment by Manufacturing Firms and the Transmission of Monetary Policy in Mexico', *Stanford University,* Working Paper 111

Sánchez, O., J. Seade y A. Werner, 1999, 'Los Costos Asociados al Proceso Desinflacionario', *Banco de México*, Documento de investigación 9903

Schaechter, A., Mark R. Stone and Mark Zelmer, 2000, 'Adopting Inflation Targeting: Practical Issues for Emerging Market Countries', *IMF Occasional Paper* 202, Washington DC

Schmidt-Hebbel K. and A. Werner, 2002, 'Inflation Targeting in Brazil, Chile and México: Performance, Credibility and the Exchange Rate', *Central Bank of Chile*, Working Paper 171, July

Schwartz, R, M. J., 2002, 'Assessing the Impact of Globalization: The Case of Mexico', *Banco de Mexico*, G-20 Case Study

Serven, Luis, 2002, 'Real Exchange Rate Uncertainty and Private Investment in Developing Countries', *World Bank*, Policy Research Working Paper 2823

Shapiro, Matthew D. and Mark W. Watson, 1998, 'Sources of Business Cycle Fluctuations', in *NBER Macroeconomics Annual*, eds. Oliver J. Blanchard and

SHCP, 1999, 'Challenges and Opportunities at the Turn of the Century', *Ministry of Finance and Public Credit* (SHCP), Economic Policy Documents and Reports, Mexico

Svensson, Lars E. O., 2000, 'Open-Economy Inflation Targeting', *Journal of International Economics,* 50, pp 155-183

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

Taylor, John B., 1999, 'A historical analysis of Monetary Policy Rules', in *Monetary Policy Rules,* ed. by Taylor, J., Chicago: The University of Chicago Press

Taylor, John B., 2001, 'The Role of the Exchange Rate in Monetary Policy Rules', *American Economic Review Papers and Proceedings*, 91, pp 263-67

Torres, Alberto, 2002, 'Monetary Policy and Interest rates: Evidence from Mexico', *Bank of Mexico*, mimeo

Weitzman, Nagar, 2002, 'Monetary Policy in Israel in an Era of Inflation Targets', *Bank of Israel*, Research Paper