INFLATION TARGETING IN EMERGING COUNTRIES:

THE EXCHANGE RATE ISSUES

A Dissertation

by

JAVIER ARTURO REYES ALTAMIRANO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment to the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2003

Major Subject: Economics

INFLATION TARGETING IN EMERGING COUNTRIES:

THE EXCHANGE RATE ISSUES

A Dissertation

by

JAVIER ARTURO REYES ALTAMIRANO

Submitted to Texas A&M University
in partial fulfillment to the requirements for the degree of

DOCTOR OF PHILOSOPHY

Approved as to style and content by:

Leonardo Auernheimer (Chair of Committee)	Thomas R. Saving (Member)
Dennis W. Jansen (Member)	Brian Balyeat (Member)
Leonardo Auernheimer (Head of Department)	

August 2003

Major Subject: Economics

ABSTRACT

Inflation Targeting in Emerging Countries:
The Exchange Rate Issues. (August 2003)
Javier Arturo Reyes Altamirano,
B.A., Instituto Tecnologico y de Estudios Superiores de Monterrey,
Campus Estado de México
Chair of Advisory Committee: Dr. Leonardo Auernheimer

The current discussion of Inflation Targeting (IT) in emerging economies deals with the effects that nominal exchange rate movements have on the overall inflation rate. The literature has focused in the analysis of the advantages and disadvantages that IT has with respect to other monetary policy regimes and the relevancy of the nominal exchange rate pass-through effect into inflation. So far none of them have dealt with the differences arising from the policy instruments used to fight off inflationary pressure under an IT regime. The literature on IT for emerging economies can be separated in two categories. In the first category the monetary authority uses interest rate policy as the instrument variable to implement and control the inflation target. The second category illustrates when the monetary authorities use international reserves as the instrument to influence the nominal exchange rate in such a way that the depreciation rate is consistent with the overall inflation target. This dissertation presents a model in which both policy instruments are available to the monetary authority. This model is used to address two questions: i) Is IT better than a monetary rule regime? and ii) Is it better to intervene directly in the foreign exchange market rather than use interest rate policy to control exchange rate pressure on inflation, or are they equivalent? The results show that there are important differences between these choices and the answers to these questions are shock dependent. These differences

arise because the intervention needed under IT is accompanied by important output costs or benefits depending on the direction of the shock being analyzed.

Regarding the pass-through effect, some studies have shown that the pass-through effect from currency depreciation into inflation has been decreasing and therefore is becoming less of an issue for these countries. The literature has offered different explanations for these declines but so far they have not been directly linked to the adoption of IT. This dissertation shows that lower pass-through levels can be a natural result of fear of floating observed in emerging countries that adopted IT and therefore exchange rate effects on inflation are still relevant.

To Maritza and my Parents

ACKNOWLEDGEMENTS

First of all I would like to thank my professors back at ITESM, they are the ones who introduced me to Economics and are partly responsible for my acceptance to Texas A&M. Especially, I would like to thank Professors Marcela Villegas, Benjamin Garcia and Gerardo Dubcovsky. During the first three years of the Ph.D. program in Texas A&M, I was heavily influenced by my professors including Heather Anderson, Richard Anderson, Badi Baltagi, James Griffin, Timothy Gronberg, William Neilson, Norman Swanson, and Curtis Taylor. I am sure that much of the knowledge they passed on to me is reflected on this dissertation.

I would like to express my eternal gratitude to Professor Leonardo Auernheimer who has been more than my advisor, inside the classroom he has been my mentor and guide for my economic thinking, while outside he has been a friend to me and my family. I also thank the other members of my committee: Professors Brian Balyeat, Dennis W. Jansen and Thomas R. Saving, who helped me in one way or another throughout the completion of this dissertation. Paula Hernandez-Verme is not on my committee, but she went out of her way to find time to discuss my research, and for this, I am thankful.

Over the past five years I have been in countless discussions with my fellow graduate students, and I thank them all, especially Chris Ball, Pablo Gonzalez, Sittisak Leelahannon, Karla Rossette, Victor Saenz and Harold Zavarce. My gratitude also goes to Professor Hae-shin Hwang and the Department of Economics for giving me the opportunity to come to Texas A&M. Finally, I thank Maritza for her unconditional support over the past ten years and my parents and brothers for their continuing support after twenty-eight years.

TABLE OF CONTENTS

CHAPTER Page

LIST OF TABLES

LIST OF FIGURES

FIGURE | Page

CHAPTER I

INTRODUCTION

After the currency crises that took place in the mid and late nineties, several emerging economies moved away from fixed exchange rate regimes towards more flexible arrangements. Several of these countries, like Brazil, the Czech Republic and Thailand introduced Inflation Targeting (IT) as their monetary policy regime[1]. Before these events the IT literature was focused on the developed countries that implemented this regime in the early nineties[2]. Due to the need to understand how IT would be implemented and how it would work in emerging economies several studies have recently surfaced in the literature in an attempt to address these concerns.

IT requires that the monetary authorities announce a numerical target for the inflation rate (point or range). They must also have a strong and credible commitment to price stability as the prime objective of the central bank accompanied with central bank independence and more transparent and clear communication with the public and the markets detailing the instruments that will be used to achieve and maintain the inflation target.

Masson, Savastano and Sharma (1997) laid the foundations of the analysis of IT in emerging economies by looking at how well these economies matched the desired characteristics. Their conclusions were that these requirements were largely unmet among emerging economies, either because of the heavy dependence of government revenue on seigniorage or because there was no firm commitment to having a low inflation rate as the overriding objective of the central bank. They also mentioned that IT in developed countries was adopted under conditions that are rarely found in emerging markets. These conditions are low initial inflation rates, considerable exchange rate flexibility and substantial central bank independence. More recently

---

This dissertation follows the style of the *American Economic Review*.

[1] Mishkin and Schmidt-Hebbel (2001).

[2] Bernanke, B.S., Laubach, T., Mishkin, F.S. and Posen, A.S. (1999).

Mishkin and Savastano (2001), and Agenor (2000) concluded that some medium and high income emerging economies may be able to implement IT. Not surprisingly these are emerging markets that after some years have achieved relatively low inflation rates, noticeable central bank independence and can refrain from implicit exchange rate targeting.

Currently, Brazil, Chile, the Czech Republic, Hungry, Korea, Mexico, Peru, Poland, and Thailand are all using IT as their monetary policy regime. Given the strong pace of adoption over the past five years, the literature has moved from analyzing implementation issues to analyzing technical issues of how IT should be practiced in emerging markets and how recommendable it is for these countries to have it and for others to adopt it. The discussion seems to be around the issues of fiscal dominance and the exchange rate effects on inflation.

The discussion around fiscal dominance, characterized by high levels of government deficits and strong dependence of the government revenue on seigniorage, came to a logical conclusion very quickly. The effects and inconsistencies of fiscal dominance for IT are the same as for any other regime. Governments pursuing persistent and significant fiscal imbalances under IT will eventually cause the collapse of the program: fiscal imbalances will have to be monetized or sudden and large depreciations will be used to erode public debt followed by high levels of inflation.

Kumhof, Li and Yan (2001) illustrate the fiscal dominance issues when they analyze the vulnerability of IT regimes to speculative attacks. If the government pursues an inconsistent monetary-fiscal policy mix the commitment to the inflation target forces the central bank to intervene in the foreign exchange rate market allowing a balance of payment crisis under an IT regime. The intervention by the central bank is directly in the foreign exchange market through the use of international reserves. They conclude that there are two differences between having IT instead of an exchange rate target. First the speculative attack under an IT regimes take place over a short period of time rather than instantaneously, as is the case under an exchange rate target. Second, the loss of reserves attributable to the attack under IT is smaller and increasing in the share of tradable goods in total consumption.

Regarding the exchange rate effects on inflation Eichengreen (2002) and Mishkin and Savastano (2001) emphasize the differences that should be considered when analyzing IT in emerging economies. The analysis should make the distinction between open-economy and developing country aspects. He addresses the question of how the IT framework should be extended to take into account the shocks that emerging economies are prone to. Specifically noting the fact that the analysis of IT in emerging economies should consider their historically high pass-through effect from exchange rate movements into inflation, the difficulty of forecasting inflation in a volatile environment and liability dollarization issues[3,4]. The forecasting difficulties and the high levels of debt denominated in a foreign currency affect directly the credibility of the IT regime just as they do in any other monetary regime. On the other hand the nominal exchange rate pass-through effect into inflation is particularly relevant for IT. In these countries different shocks cause exchange rate movements that translate into inflationary pressure and threaten to destabilize the economy. Under these circumstances a central bank implementing IT will be unwilling to let the exchange rate move and will intervene directly or indirectly in the foreign exchange market.

These possible interventions bring about another matter of contention in the IT literature related to the nominal exchange rate. This has emerged from the literature of "dirty floating or "fear of floating". Relevant studies in this literature include Calvo and Reinhart (2000), Reinhart (2000) and Lahiri and Vegh (2001). The conclusions of this literature are that for differing reasons most of the countries that claim to have a flexible exchange rate actually intervene directly or indirectly in the foreign exchange rate market trying to avoid high exchange rate volatility, the pure fear of floating argument, or to avoid output fluctuations. Many of the countries that claim to have an

[3] Goldfajn and Ribeiro da Costa Werland (2000) analyze empirically the historical pass-through effect for a panel of countries and show that this effect is considerably higher in emerging economies with respect to that observed in developed countries.

[4] Dollarization issues are those related to high levels of debt denominated in foreign currencies.

IT regime as their monetary policy framework have been included in the list of fear of floating countries.

The exchange rate issues for IT, basically fear of floating and the pass-through effect, have been identified and acknowledged in the recent literature and the discusson seems to be moving from a description mode to a mode of addressing the questions of how to deal with the issues, what the consequences are under IT and, what the advantages or disadvantages of IT are with respect to other monetary regimes. Some studies that lead the way into this new literature for IT include Kumhof (2001), Gali and Monacelli (2002), and Parrado and Velasco (2001).

Kumhof (2001) takes on the task of analyzing the differences between IT, a flexible exchange rate under monetary rules, and exchange rate targets. He concludes that it is very unclear whether IT is a superior policy in the face of different exogenous shocks, including changes in the real international interest rate, international inflation, inverse velocity and tradable income. He argues that the attractiveness of IT may lie in the fact that this regime gives the policymaker discretion.

With a different approach Parrado and Velasco use a simple dynamic neo-Keynesian model of a small open economy to examine the effects of different exchange rate regimes and inflation target indicators in the context of monetary policy rules. They use a welfare based approach to analyze the differences between having a policy rule that reacts to output gaps and exchange rate misalignments, and not only to inflation gaps between the target and the current inflation rate. They also extend their analysis to the fact that central banks could target domestic inflation only instead of the CPI. They conclude that the effects of inflation targeting on output depend crucially on the exchange rate regime and on the inflation index being targeted. They argue that the social loss under different shocks is much higher under managed exchange rates than under flexible exchange rates and also that targeting domestic goods inflation appears to outperform CPI targeting.

The study by Gali and Monacelli (2002) focuses on the analysis between three different monetary policy regimes: domestic inflation targeting, CPI targeting and an exchange rate peg. The response of the monetary authorities to domestic and foreign productivity shocks under each regime, specified in terms of an interest rate rule, has different effects on the real and nominal exchange rate resulting in different volatility levels of the exchange rate as well as different output and inflation gaps. The authors use welfare analysis to rank the regimes, noting that domestic inflation targeting dominates the other two in terms of welfare.

These studies have shown the differences between IT and other monetary policy regimes for different shocks that affect the exchange rate, but so far none of them have dealt with the differences arising from the policy instruments used to fight off inflationary pressure under an IT regime. Basically, the literature on policy instruments under IT can be separated in two categories. In the first category, the monetary authority uses a Taylor-type interest rate rule as the policy instrument to implement and control the inflation target; the interest rate reacts to output and inflation gaps and in the case of open economies they include, sometimes, a nominal or a real exchange rate gap[5]. The second category corresponds to those cases where the monetary authorities use international reserves as the instrument to influence the nominal exchange rate in such a way that the depreciation rate matches the necessary rate to comply with the overall inflation target. The next step is to merge both approaches into one comprehensive model, such that both policy instruments are available to the monetary authority. In reality central banks have access to both instruments and the economic consequences of using one or the other may result in relevant welfare differences for the economy in question.

Concerning the pass-through effect from exchange rate movements into inflation and its relevancy for IT in emerging economies, the literature has studied the correlation between the inflation rate and the depreciation rate, as well as estimated the share of depreciation that translates into inflation over a given period of time[6]. Most of the studies have found that the pass-through effect has recently been decreasing in

[5] Svensson, L.E.O. (2000) and Eichengreen (2001) illustrate these Taylor-type interest rate rules.
[6] In this sense, the pass-through effect analysis takes into consideration the short run and the long run by looking at different periods of time.

these countries and offer multiple explanations for these declines. Furthermore, some authors even argue that given the lower pass-through effects observed recently, domestic currency depreciation effects on inflation may no longer be an issue for emerging economies that adopted IT.

The interpretations of and for the declining pass-through effect include those by Mishkin and Savastano (2001), Leiderman and Bar-or (2000), and Schmidt – Hebbel and Werner (2002). Using different methodologies and arguments they all conclude that the pass-through effect depends on the credibility of the IT regime and therefore it is likely to decline over time as the IT commitment becomes clearer. Taylor (2000), Baqueiro, Diaz de Leon, and Torres (2002), and Choudhri and Hakura (2001) relate the exchange rate pass-through to the inflation environment. They argue and show empirically that when the inflation rate is low, individual's expectations are more likely to be in line with the authority's target and therefore will be less influenced by short term exchange rate movements[7]. Garcia and Restrepo (2001) show that for the past decade the decrease in the pass-through effect for Chile was related to negative output gaps that compensated the inflationary effects of the currency depreciation. Finally Campa and Goldberg (2002) in their study of 25 OECD countries argue that the most important determinants of the changes in the pass-through over time are microeconomic and are related to the industry composition of a country's import bundle.

So far none of these explanations or arguments link the decrease of the pass-through effect directly to the adoption of IT even though the reasoning used in some of these studies explicitly argues that central banks implementing IT may intervene in the foreign exchange rate market (fear of floating) in order to smooth or control the effects of sudden exchange rate movements on the inflation rate. If these interventions do take

[7] The data set used by Baqueiro, Diaz de Leon, and Torres (2002), and Choudhri and Hakura (2001) includes data for several emerging economies that adopted IT during the past few years. The authors divide the dataset into two sub-samples, one for the high inflation periods and the other for the low inflation periods. They show that the pass-through effect is lower for the low inflation sample but they do not elaborate on the fact that this sub-sample corresponds to the time period where most of these countries adopted IT.

place, the monetary authorities counteract sudden exchange rate movements and therefore the direct relation between inflation and currency depreciation breaks down. It is possible that the results of these interventions are lower correlation coefficients between inflation and domestic currency depreciation and lower pass-through effects.

In accordance with the current discussion of IT in emerging economies the objectives of this dissertation are to analyze the differences that emerge from using different monetary policy instruments to comply with the inflation target, and to investigate the relationship between the declining correlation between inflation and depreciation, lower pass-through effects, and the adoption of IT. The empirical analysis presented in Chapter II uses data for Brazil, Chile, and Mexico, three countries that adopted IT during the nineties, to show how the pass-through effect and the correlation between inflation and depreciation have been declining. This chapter also shows that these declines coincide with the time period in which these countries adopted IT, and, finally, presents evidence of fear of floating practices around the same time period. Central banks that exhibit fear of floating intervene directly or indirectly in the foreign exchange rate market. The instruments used for these interventions have different consequences for the real economy and the study of these differences is the motivation for the analysis presented in Chapters III and IV. Chapter III presents a comprehensive model in which the monetary authority can use international reserves or interest rate policy to fight off inflationary pressure emerging from sudden exchange rate movements that are the result of exogenous shocks.

The literature has also been comparing IT with alternative monetary regimes that emerging economies could adopt. Usually the alternative to IT is a monetary rule (Friedman Rule) where the central bank fixes the rate of growth or the path for the nominal money stock. The comprehensive model of Chapter III is used in Chapter IV to model IT and the monetary rule regime and compare the results obtained for different shocks, including changes in the world interest rate or money demand shocks. In this sense the analysis of Chapter III is along the lines of Kumhof (2001) but, most importantly, it uses a model that allows the government to use either international reserves or interest rate policy as policy instruments to implement IT, while allowing for comparisons with the rate of money growth rule. As a final point, Chapter IV shows that the declining correlation between inflation and depreciation as well as the lower pass-through effects observed recently can be related to the adoption of IT in emerging economies.

CHAPTER II

EMPIRICAL ANALYSIS OF THE EXCHANGE RATE PASS-THROUGH EFFECT INTO INFLATION AND FEAR OF FLOATING IN BRAZIL, CHILE, AND MEXICO

A. Introduction

The objective of this chapter is to present empirical evidence regarding the pass-through effect and Fear of Floating practices in emerging economies that adopted Inflation Targeting (IT). The countries included in this study are Brazil, Chile, and Mexico. Each respectively adopted IT in 1998, 1991, and 1997-1998. Even though these economies share various similarities given their inherit nature of being emerging economies, the ways and timing in which they each adopted IT is different. These similarities and differences offer the premises for the analysis of the pass-through effect which should consider both historical and temporary perspectives[8]. The cases of Chile and Mexico offer two different scenarios to analyze the pass-through effect for gradual adoption of inflation targeting while Brazil's data will be used to analyze this effect when IT is adopted with a big–bang approach.

This chapter seeks first to briefly review the implementation and evolution of IT in Brazil, Chile, and Mexico. The second section presents the analysis of the pass-through effect from exchange rate depreciation into inflation. After identifying the pass-through effect and its recent evolution, the last section presents an empirical study of fear of floating practices for Brazil, Chile, and Mexico. The results obtained are then presented and compared with those of previous studies.

[8] "Historical perspective" refers to the analysis of the data using long periods of time while temporary refers to short periods of time.

B. Brief Review of Inflation Targeting Adoption and Evolution[9]

1. Inflation Targeting Adoption

Brazil followed a "big bang" strategy for the adoption of IT. After the balance of payment crisis of 1998 and the high depreciation of the currency that followed, Banco Central do Brasil, Brazil's central bank, committed itself to controlling the pass-through effect of exchange rate depreciation into inflation by imposing a restrictive monetary policy that was based on the framework of IT and dirty floating practices. After inflation expectations were restrained, the board of the central bank moved quickly towards the adoption of a full IT regime. During the early months of 1999 the institutional framework, basically central bank independence, was put in place, and by July of the same year the monetary authority was able to announce inflation targets for 1999, 2000, and 2001.These targets were eight, six and four percent respectively with a tolerance band of two percent. Thus, this approach is considered a "big bang" approach because the inflation target was set to a one-digit level from the start and the target for 2001 was comparable to those of developed economies using IT[10]. This approach contrasts with those in Chile and Mexico where the target moved slowly towards those of developed economies.

Banco Central de Chile, Chile's central bank, initiated a gradual approach towards IT in September 1990 when it announced the inflation target for 1991, as a range target within a fifteen to twenty percent range, and continued doing so until 1999. During this year it announced the target for 2000 and also declared that from 2001 onwards the inflation target would be a range target within the limits of two and four percent per year. The IT gradual adoption was preceded by important institutional changes that gave the central bank both goal and instrument independence. With the gradual approach, the central bank also maintained an exchange rate target that started

[9] See Mishkin (2000), Mishkin and Savastano (2000), and Corbo and Schmidt-Hebbel (2001) for more information and details about IT in emerging economies.

[10] Sweden, Canada, Australia target inflation at levels of three percent. For more on Inflation Targeting for developed countries refer to Bernanke, et al (2001).

in 1984 and lasted until 1999. By 1999 Chile had the necessary requirements in place for IT, including an independent central bank, a credible commitment to low and stable inflation rates as the main objective of the monetary authority, and no commitments to controlling the exchange rate, or, in other words, a full-fledged inflation targeting regime.

In the case of Mexico, the continuing advance to the full adoption of IT started at the end of 1997 after Banco de Mexico, Mexico's central bank, started moving away from the monetary targeting regime that had been implemented after the currency crisis and financial crisis that took place in 1994 – 1995, better known as the Tequila Crisis. During 1998 and 1999 the monetary authority in the annual monetary reports presented an extensive analysis of the monetary policy actions implemented during 1997 and 1998. From these reports it is evident that monetary policy was being more responsive to inflation instead of responding to misalignments of the monetary target[11]. Finally in 1999, Banco de Mexico announced the inflation targets for 1999 through 2002 and made a commitment to achieve a three percent inflation rate for 2002 onwards. During the late 1990s, the central bank's institutional framework was modified in order to break the political cycle of the monetary authority given fiscal dominance issues. The new framework strengthened the independence of the central bank since the governor is chosen in the third year of the current presidential administration, which lasts for 6 years. The governor cannot be replaced until the third year of the next administration. The fiscal dominance issue was addressed by having the central bank set the inflation target for the next three to five years in conjunction with the ministry of finance so that any fiscal adjustments within this time frame have to take into account the inflation target.

[11] Exposición sobre la Política Monetaria para 1998 y 1999 (Monetary Policy Reports for 1998 and 1999).

2. Experience with Inflation Targeting

It is important to realize that Brazil, Chile, and Mexico have had different experiences with IT. If the realized inflation rates and the inflation targets are compared for the three countries, it can be observed that each has experienced misalignments between the two. Figure 1 shows the inflation targets (point or range) and the observed inflation rates for Brazil, Chile, and Mexico. Chile adopted a full-fledged IT in 1999, but the central bank missed the target for the first two years of the regime, when there was a point target rather than a range target. However, upon implementation of a range target the inflation rate has been within target range. Mexico missed the target in 1998, a year before the official adoption of IT, showed some recovery in 1999, the year of IT adoption, and has been roughly on target from 2000 through 2002. Brazil, with its "big bang" approach, was able to maintain the realized inflation rate within the IT range for 1999 and 2000, but since then the realized inflation rate has been above the upper limit by almost two percent in 2001 and seven percent in 2002.

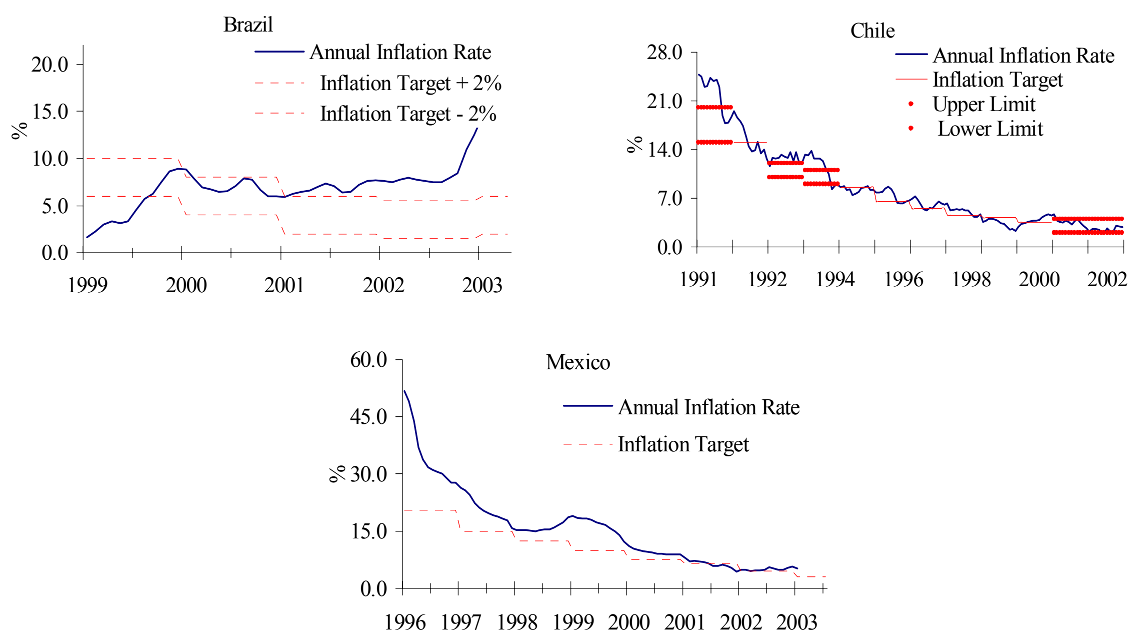

Fig. 1. Realized Annual Inflation Rates and Inflation Targets for Brazil, Chile, and Mexico.

Each of these countries has taken into consideration the fact that the regime must be as transparent as possible. In order to maintain this transparency, the monetary authorities prepare monetary reports, inflation reports, and other types of documents on a monthly, quarterly, or biannual basis. These reports explain the measures that have been undertaken to maintain the realized inflation consistent with the target, and in case the target is not met, either by undershooting or overshooting it, the central bank must make public a document, sometimes called an open letter, explaining the exact reasons for the breach and the policies undertaken to counteract the deviation. For these purposes, each central bank maintains a database where the public can access the documents[12]. In both 2001 and 2002, the governor of the central bank of Brazil sent two open letters explaining the reasons why the target was not met. The board of governors of the central bank of Mexico presents a quarterly report for inflation, while the central bank of Chile publishes on a biannual basis a monetary policy report where they comment on the actions taken to counteract the misalignments of the realized inflation and the target.

Therefore it is possible to conclude that Brazil, Chile, and Mexico have the necessary institutional requirements to implement IT but the annual inflation rates have not been strictly in line with the target rates. The monetary authorities of these countries have elaborated the reasons for these misalignments, including the inflation of controlled prices or commodity prices, wages, and the exchange rate. Wages and controlled prices are considered more predictable than the exchange rate and commodity prices. Commodity prices, like oil prices, are reflected mainly on controlled prices. But the exchange rate, which under IT is "flexible", is affected by both exogenous and endogenous shocks that are not easily foreseen or predicted[13]. Once these shocks take place, monetary policy tools can be used to counteract or reduce their effects on the exchange rate.

---

[12] These databases can be accessed online at www.bcb.gov.br for Brazil, www.bcentral.cl for Chile and www.banxico.org.mx for Mexico.

[13] The extent to which the nominal exchange rate is flexible under IT will be addressed in chapters III and IV of this dissertation. Calvo (2000) argues that the nominal exchange rate is not fully flexible under IT and under certain circumstances it resembles more a nominal exchange rate target.

For emerging countries that implement IT, if the exchange rate plays a relevant role in the determination of the price level then it is important to know the magnitude of the possible pass-through effect in order to determine how responsive monetary policy should be to unexpected shocks. The next section uses simple correlation and regression analyses for inflation and currency depreciation as a first step to analyzing the pass-through effect. Afterwards other econometric techniques are introduced to identify the magnitude of the effects of exchange rate movements on inflation for Brazil, Chile, and Mexico.

C. Empirical Analysis of the Pass-Through Effect[14]

This section presents the results of four different approaches utilized to provide empirical evidence of the pass-through from currency depreciation into inflation. Even though it is not the correct way to asses the magnitude of the pass-through effect, as it will be explained later on, a simple correlation analysis between inflation and currency depreciation is used as an initial approach. Following Garcia and Restrepo (2001) and Schmidt-Hebbel and Werner(2002) two correlation statistics have been computed[15]. The dataset is comprised of monthly observations of the annual inflation and depreciation rates for Brazil, Chile, and Mexico. The first statistic uses an increasing window with a fixed starting point that initially calculates the correlation coefficient for the first four years, and then one observation is added at a time thereafter. The second statistic uses a fully rolling window where the correlation coefficient is calculated for the first four years and then both the starting and ending dates move keeping the sample size constant. The datasets for Brazil, Chile, and Mexico include data from January 1993 to December 2002, January 1991 to December 2002, and January 1986 to December 2002, respectively.

[14] The exact description and the sources of the data are included in Appendix 1.

[15] Garcia and Restrepo (2001) studied the correlation between these two variables for the case of Chile by computing two rolling correlation statistics on monthly data for annual inflation and depreciation for the time period of January 1986 to December 2000.

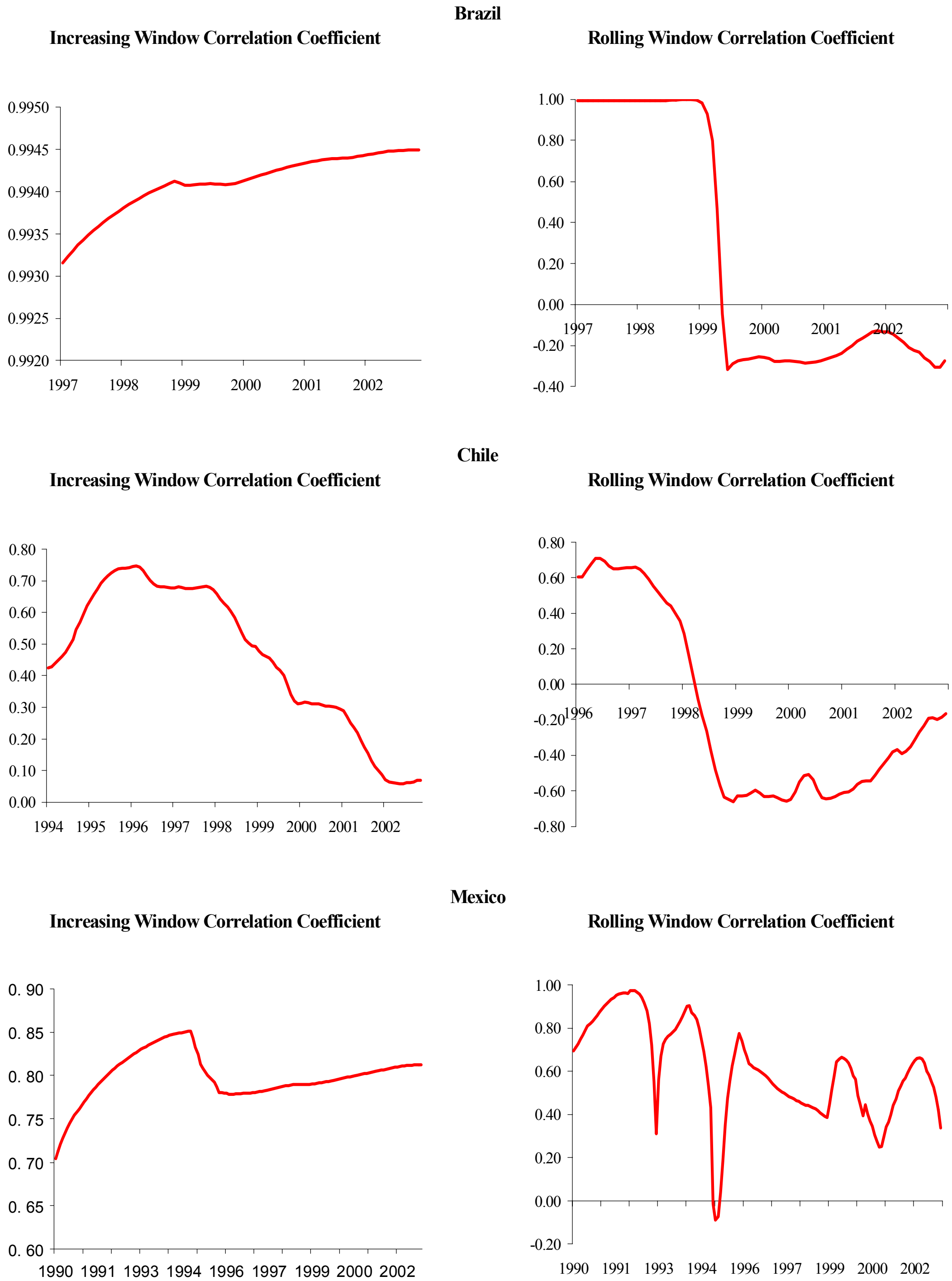

Fig. 2. Correlation Analysis between the Annual Inflation and Depreciation Rates for Brazil (1993:01 – 2002:12), Chile (1991:01 – 2002:12), and Mexico (1986:01 – 2002:12) with a Four Years Initial Window.

The results presented in Figure 2 show that the correlation between inflation and currency depreciation is very different for the three countries. This relation has been and still is highly positive in the case of Mexico, but for Chile it has been decreasing consistently when calculated with the increasing window and also with the rolling windows methodology where it even became negative for the last five years considered. In the case of Brazil, the increasing window results show that the correlation between inflation and depreciation rates has been increasing over time, but this correlation became negative for the rolling window in 1999. It is important to note that the increasing window for Brazil takes into account some of the years of the hyperinflation that the country suffered during the early 1990's. If the hyperinflation data is removed, January 1993 to April 1995, the correlation coefficient for the increasing window is negative for the sub-sample considered.

The correlation between the inflation rate and currency depreciation for Chile and Brazil became negative in 1999, the year in which the IT regime was fully adopted by both countries. The lower or even negative correlation coefficient is consistent with the results presented in the third chapter of this dissertation, where lower correlation coefficients are linked to interventions of the central bank that affect the nominal exchange rate. Intuitively the central bank will offset inflationary pressure from exchange rate movements by intervening directly or indirectly in the foreign exchange market. This intervention will result in lower rates of depreciation with respect to the inflation rate. Even in extreme cases, the intervention needed to comply with the inflation target will cause an appreciation of the currency in order to maintain the inflation rate adequately with the target.

The reason why the correlation coefficients obtained should not be used to make definite statements about the magnitude of the pass-through effect of depreciation on inflation is because they just measure the degree to which two variables are linearly associated. Lower correlation coefficients may be the result of temporary nominal exchange rate overshooting, which may not necessarily result in lower pass-through effects in the long run[16]. From now on I will not relate directly the results of lower correlation coefficients with lower pass-through effects, but Chapter IV shows that lower or even negative correlation between inflation and depreciation can be related to the adoption of IT in emerging economies.

In order to measure the magnitude, following Garcia and Restrepo (2001) and Goldfajn and Ribeiro da Costa Werlang (2000), two different regression analyses were used. The first one regresses the annual inflation rate on a trend and currency depreciation, while the second uses currency depreciation, real exchange rate deviations, output gap, and past values of inflation as right hand side variables. Again, for both regressions, the increasing and rolling windows approaches were used. In contrast to the correlation coefficients presented above, the estimated coefficients for the accumulated depreciation obtained with these regressions can be used to make statements about the magnitude of the pass-through effect. They are estimations for the share of accumulated currency depreciation that translates into inflation over different periods of time.

Explicitly the first regression used the following equation:

$$\Pi_t = \beta_1 \hat{e}_t + \beta_2 T_t + u \qquad (1)$$

where T_t and $\hat{e}_t$ respectively represent a time trend and currency depreciation. Estimated coefficients for the depreciation rate for increasing and rolling windows regressions are presented in Figure 3. The samples used for these regressions are the same as those used in the correlation analysis, but the initial windows are set to a range of five years.

[16] The simplest example of this is the model of exchange rate overshooting introduced by Dornbusch (1976).

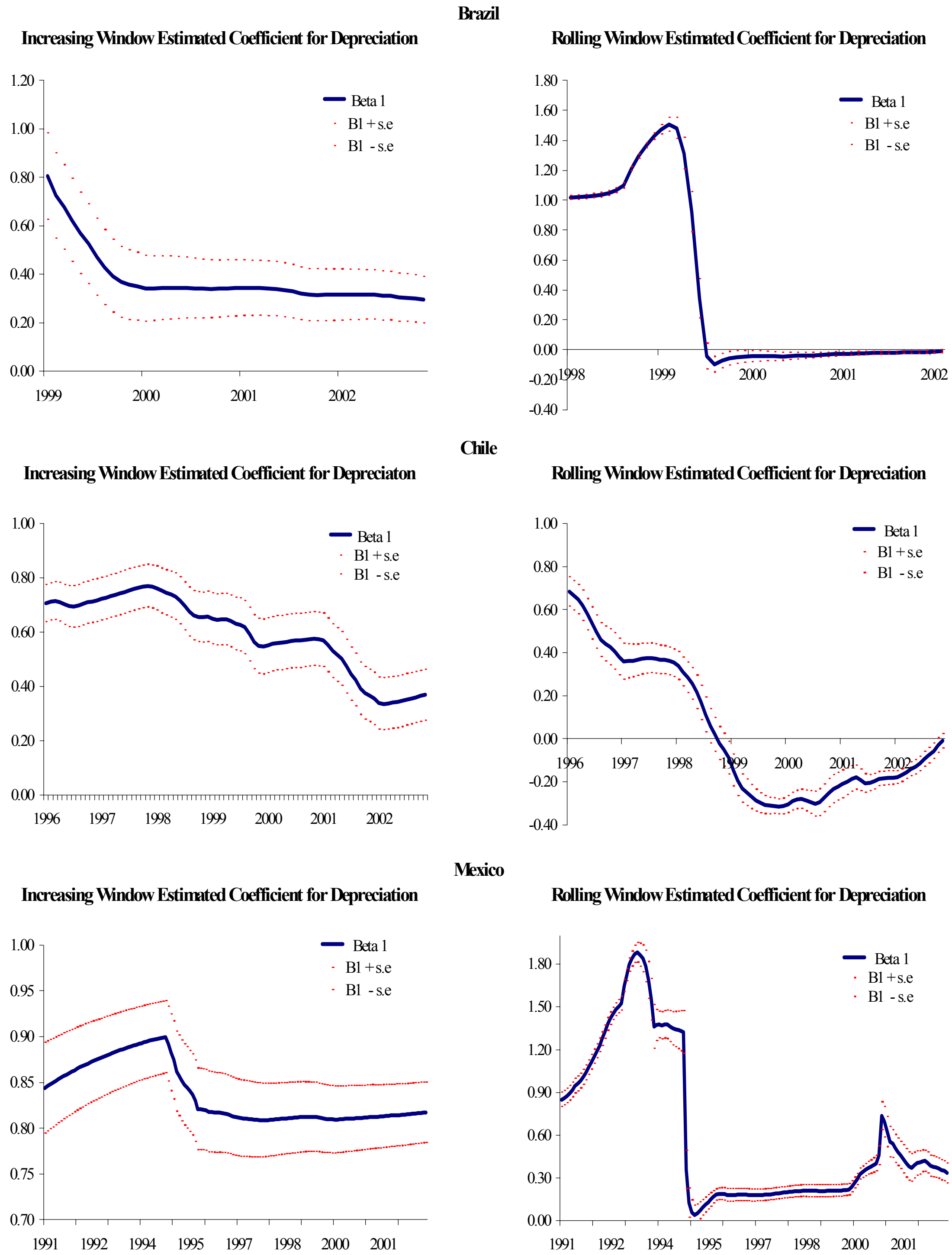

Fig. 3. Estimated Coefficients for the Depreciation Rate in Equation (1) for Brazil (1993:01 – 2002:12), Chile (1991:01 – 2002:12), and Mexico (1986:01 – 2002:12) with a Five Years Initial Window.

The second regression used the following equation:

$$\Pi_{[t,t+j]} = \beta_0 + \beta_1 \hat{e}_{[t-1,t+j-1]} + \beta_2 DIPI_{t-1} + \beta_3 DRER_{t-1} + \beta_5 \Pi_{[t-1,t+j-1]} \qquad (2)$$

where $\Pi_{[t,t+j]}$ and $\hat{e}_{[t,t+j]}$ represent the accumulated inflation and depreciation rates over the period of t to $t + j$, respectively. *DIPI* is a measure of output gap, while *DRER* is the real exchange rate deviation. The real exchange rate is defined as the price of traded goods over the price of non-traded goods[17]. Both output gap and real exchange rate deviation are calculated as deviations from their Hodrick-Prescott trends[18]. The dataset uses the same samples as previous calculations and industrial production indices are used as proxies for output[19]. This regression attempts to capture inflationary pressure that arises from sources other than the depreciation of the currency.

Intuitively, a positive output gap produces inflationary pressure because increasing costs are passed on to consumers[20]. Regarding the real exchange rate, the intuition is related to the price stickiness of non-traded goods. When the real exchange rate is above its trend, there is inflationary pressure from the "catching-up" effect of the non-traded goods price level[21]. The sticky price assumption of non-traded goods is used in the theory model presented in chapter three.

The coefficients for equation (2) were estimated for five different accumulated inflation and depreciation rates, specifically one, three, six, nine, and twelve months, using the rolling and the increasing windows methodology. For example one of the

---

[17] For the case of Chile and Mexico the real exchange rate series were obtained directly from the website of their central banks. The real exchange rate from Brazil, was calculated from the price indices for traded and non-traded goods reported from the website of the central bank of Brazil.

[18] Hodrick-Prescott trends were calculated with a smoothing parameter of 14400 as is standard for monthly observations.

[19] January 1993 to December 2002, January 1991 to December 2002, and January 1986 to December 2002, for Brazil, Chile, and Mexico respectively. The initial window is again set at five years.

[20] Goldfajn and Ribeiro da Costa Werlang (2000) also note that it is easier for firms to pass-through increases in costs to consumers when sales are increasing.

[21] Goldfajn and Valdes (1999) have shown that under this framework, if the currency depreciation is just enough to correct an overvaluation of the currency, then it would not translate into inflationary pressure. But currency depreciation that is not based on required adjustments of relative prices (real exchange rate) would induce inflation or would reverse itself (through nominal appreciation). Borensztein and De Gregorio (1999) have shown that usually the end result of large depreciations not based on correction of relative prices do indeed translate into inflationary pressure.

regression for the three months accumulated case would be the following: the accumulated inflation for the period April - June was regressed on the depreciation accumulated over the period of March to May, the industrial production index deviation present in March, real exchange rate deviation in March and the initial inflation, that is the accumulated inflation for the months of January to March. The logic behind the last three terms in this regression is that of reflecting the effects of the initial conditions on future inflation. The results for the estimated coefficients presented in Tables A.1.1 through A.1.6, included in Appendix 1, are presented as averages of the estimated coefficients for each year of the time period considered. For example, the increasing window estimated coefficient for depreciation for Chile in Table A.1.3 should be read as follows: the average estimated coefficients for currency depreciation for the increasing window regressions that include the months of January through December of 1996 are respectively 0.02, 0.18, 0.26, 0.23 and 0.25 for the one, three, six, nine, and twelve month accumulated rates regressions, while for the increasing window regressions that include the months of January through December of 2002 the coefficients for currency depreciation are (0.003), 0.01, 0.05, 0.05 and 0.05 for the one, three, six, nine, and twelve month accumulated regressions. The tables also present the estimated coefficients for the other explanatory variables included, also in averages. In general the coefficients have the expected signs, positive for the output gap, real exchange rate deviation, accumulated depreciation, and initial inflation, while their statistical significance changes throughout the regressions. This section is dedicated to the analysis of the pass-through effect from currency depreciation into inflation, so emphasis is placed on extensively presenting the results obtained for the estimated coefficient for currency depreciation for equation (2). The resulting coefficients for the different accumulated periods show how strong is the pass-through effect in the short and long run. A high estimated coefficient for the depreciation rate for the three months accumulated inflation rate case would signal a high short run pass-through. Figure 4 presents graphically the results for these coefficients for Brazil, Chile, and Mexico for different years. These graphs clearly illustrate a decreasing pass-through effect for the three countries, especially for Brazil and Chile over the past five to ten years[22].

The results presented in figures 3 and 4 show that the pass-through effect for the countries considered here has been decreasing. The historical effect (increasing window methodology) of currency depreciation on the inflation rate has been decreasing for the three economies considered in this study. The temporary effect (rolling window methodology) shows that for the cases of Brazil and Chile the estimated coefficient for currency depreciation fell dramatically after both of these countries adopted a full-fledged inflation targeting regime in 1999. However, for the Mexican economy this coefficient has not shown drastic changes during the time period where the economy has been under an IT regime. It changed dramatically in 1995, when the central bank abandoned the fixed exchange rate, something that is intuitively expected, but for the duration of the current IT regime this coefficient has only been decreasing slowly.

Using the results for the estimated coefficients of equation (2), currently from a historical perspective (increasing windows) a ten percent twelve month accumulated depreciation translates into almost four percentage points of inflation for Brazil, less than one percentage point for Chile and almost nine percentage points for Mexico[23,24]. From a temporary perspective (rolling windows) a ten percent twelve month accumulated depreciation translates into less than one percentage point of inflation for Brazil, less than one percentage point of deflation for Chile and almost three percentage points of inflation for Mexico[25].

---

[22] Once again, the results for the increasing window of Brazil include the data from the hyperinflation period that the economy went through in the early nineties. However if the methodology is used for the sub-sample of April 1995 through December 2002 the results are different. The estimated coefficients for the sub-sample case for Brazil are presented in Table A.1.7 of Appendix 1.

[23] For Brazil's sub-sample of April 1995 to December 2002.

[24] Note that all coefficients are statistically significant at 95 percent confidence level.

[25] Only the coefficients for Chile and Mexico are statistically significant.

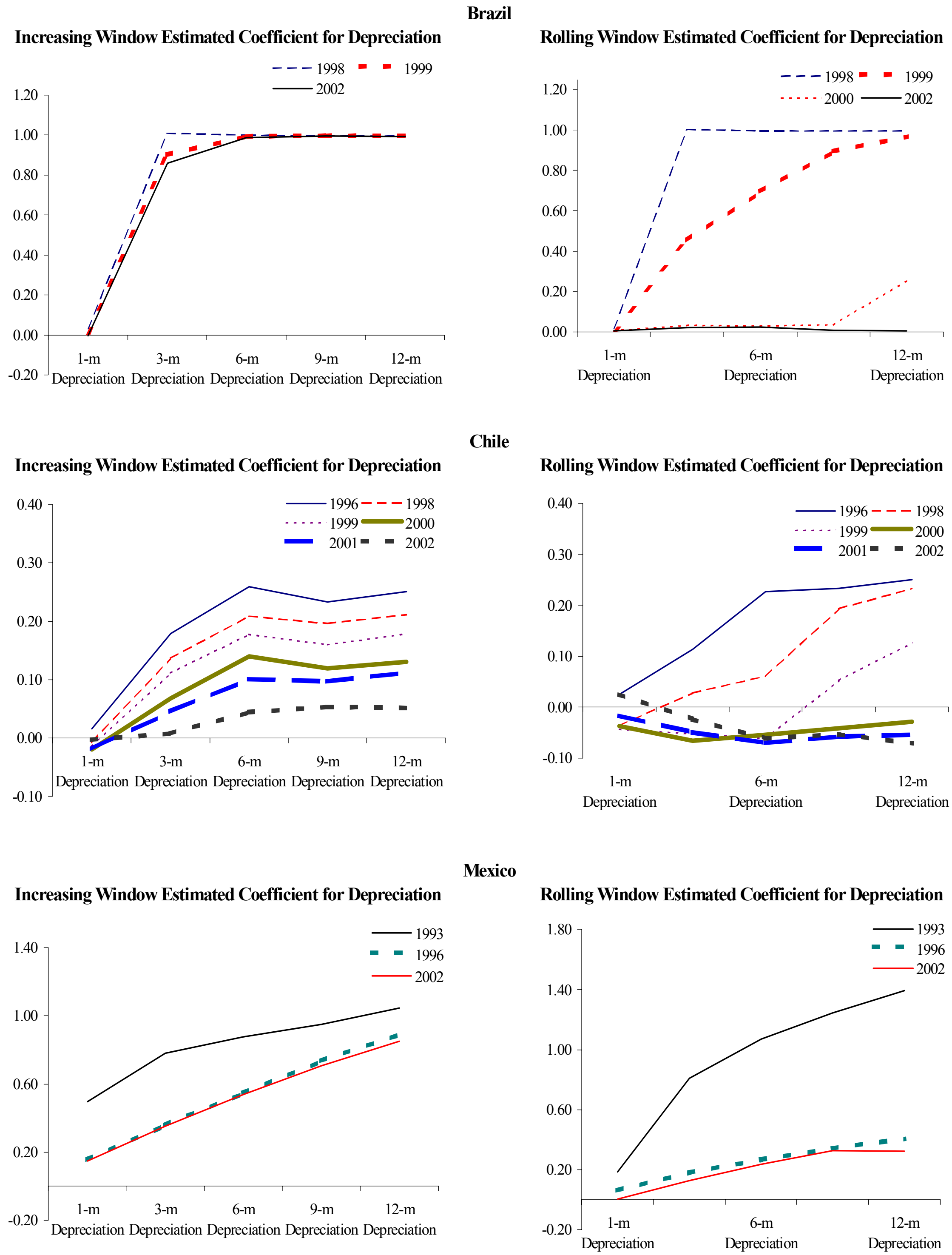

Fig. 4. Estimated Coefficients for the Depreciation Rate in Equation (2) for Brazil (1993:01 – 2002:12), Chile (1991:01 – 2002:12) and Mexico (1986:01 – 2002:12) with a Five Years Initial Window.

In order to extend the empirical findings of this study, following Carstens and Werner (1999), the inflationary processes for Brazil, Chile, and Mexico are also studied using vector error correction models (VECM) that trace the roots of inflationary pressure to currency depreciation, changes in the costs of labor, changes in controlled prices, and money creation by the central bank. Carstens and Werner (1999) were interested in showing how inflationary pressures had been arising from shocks other than monetary ones. They argued that the monetary policy of Banco de Mexico had been merely accommodating exogenous shocks to the exchange rate, wages, and controlled prices. Here their methodology is employed to show how much of the price level (CPI) variation is explained by shocks to the exchange rate, wages, and controlled prices.

The data used for the VECM analyses consists of monthly observations for CPI, exchange rate, wages, M1, and inflation of controlled prices (when available) for Brazil, Chile, and Mexico[26]. Standard augmented Dickey-Fuller and Johansen cointegration tests were used to justify the use of VECM instead of standard vector autoregression estimations (VAR) and to define the cointegrating equations needed for each case[27]. The time periods studied are January 1997 to December 2002 for Brazil and Chile and January 1997 to December 2001 for Mexico[28]. The cointegration tests used for each country determined that for Chile and Mexico the VECM should include one cointegrating equation, with intercept and no trend, and linear trend in data. For the case of Brazil the VECM should include two cointegrating equations, with intercept and trend, and linear trend in data. The number of lags was determined using Akaike and Schwarz information criteria. The VECM for Chile and Brazil included three lags, while only two were included for Mexico. Finally, the ordering of the variables for the identification of the shocks was as follows: exchange rate, controlled/administered

[26] The inflation on controlled prices or administered prices was available for Mexico and Brazil but not for Chile.

[27] For every variable used, for each country, the Dickey Fuller tests (D-F) failed to reject the null hypothesis of a unit root for the data in levels. While the D-F tests for the first differenced variables rejected the null hypothesis.

[28] Data on wages was only available up until 2001:12 for Mexico.

prices, wages, M1, and CPI. This ordering follows the intuitive argument of Carstens and Werner (1999). They argue that shocks to exchange rate, public prices (controlled or administered prices), and wages should positively affect the price level and M1. The impulse response functions, shown in Figures A.1.1 through A.1.3 in Appendix 1, show that for the estimated VECMs these effects are generally observed with this ordering[29].

The results obtained from the VECMs for Brazil, Chile, and Mexico can be examined as empirical evidence of the pass-through effect from exchange rate movements into inflation. Figure 5 presents two graphs. The one on the right showing the impulse response functions of CPI for a one standard deviation innovation in the exchange rate for the three countries. The one on the left shows the percentage of the variation of CPI that is explained by the exchange rate shock.

Figure 5 shows that the price level in Mexico is more responsive, relative to the other two countries, to innovations of the exchange rate. After twelve months, approximately thirty percent of the variance of the CPI in Mexico is explained by the exchange rate, while for Brazil and Chile respectively only fifteen and less than five percent of the CPI variance is explained by the exchange rate[30]. These numbers suggest that the pass-through effect is still relevant in Brazil and Mexico, while in Chile its relevancy is very low.

The four methodologies presented here (autocorrelation, the two simple regressions and vector error correction models) support, with different metrics, the same result. The pass-through effect and the correlation between inflation and domestic currency depreciation have both been decreasing for the three countries included in the study. This is more pronounced for Brazil and Chile, two countries that adopted full fledged inflation targeting regimes in 1999. Tables I and II summarize the results obtained here along with those obtained by previous studies.. The next logical step is to identify the reasons for these declines.

---

[29] It should be noted that the results are fairly robust to changes in the ordering.

[30] It is important to mention that the ordering used for the identification of the VECM for each country does not affect these results, in either magnitude or order.

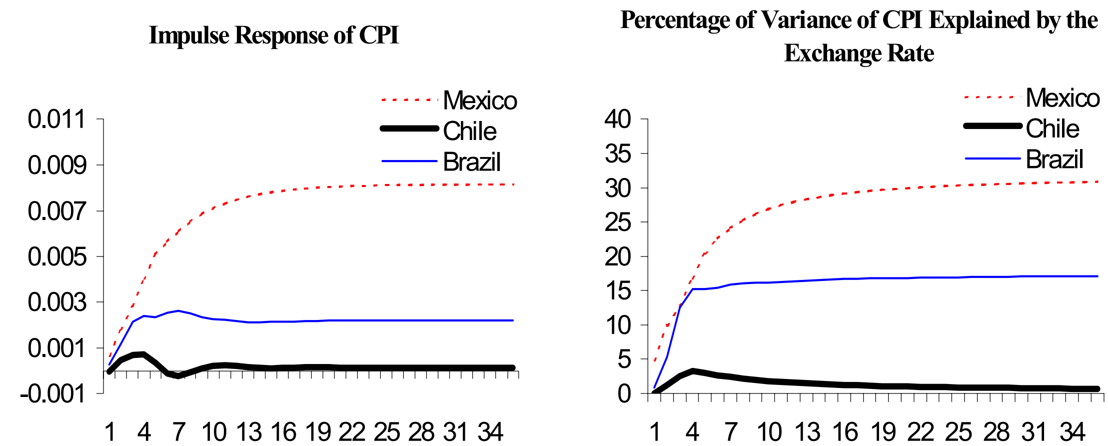

Fig. 5. Impulse Response Function of CPI and Percentage of Variance of CPI Explained by the Nominal Exchange Rate (After a One Standard Deviation Innovation in the Nominal Exchange Rate).

Table I. Correlation Analysis between Annual Inflation and Depreciation Rates

	Increasing Widows (long-term)				Rolling Winaows (short-term)			
				Chile				
Garcia and Restrepo (2001)	*1986 - 1994*	*1986 - 1997*	*1986 - 2000*	*1990 - 2002*	*1990 - 1994*	*1994 - 1998*	*1996 - 2000*	*1998 - 2002*
	0.40 - 0.60	0.60 - 0.80	0.40 - 0.60	na	0.40 - 0.60	(0.60) - (0.80)	(0.40) - (0.60)	na
Schmidt-Hebbel and Werner (2002)					*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
					0.37	(0.72)	(0.39)	na
Reyes (2003)	*1990 - 1994*	*1990 - 1997*	*1990 - 2000*	*1990 - 2002*	*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
	0.59	0.68	0.30	0.07	n.d.	(0.66)	(0.40)	(0.20)
				Brazil				
Schmidt-Hebbel and Werner (2002)					*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
					0.95	1	(0.16)	na
Reyes (2003)	*1993 - 1994*	*1993 - 1997*	*1993 - 2000*	*1993 - 2002*	*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
	na	0.99*	0.99*	0.99*	na	0.99	(0.26)	(0.07)
				Mexico				
Schmidt-Hebbel and Werner (2002)					*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
					0.28	0.66	0.67	na
Reyes (2003)	*1991 - 1994*	*1991 - 1997*	*1991 - 2000*	*1991 - 2002*	*1991 - 1994*	*1995 - 1998*	*1999 - 2001*	*1998 - 2002*
	0.84	0.78	0.80	0.81	0.43	0.52	0.58	0.49

Notes: Numbers in parenthesis represent negative numbers.
(*) Refers to the calculations from Brazil with the sub-sample that does not include the hyperinflation years

Table II. Estimated Nominal Exchange Rate Pass-through into Inflation

Garcia and Restrepo (2001)					
Based on Estimated Price Equation	Depreciation	Pass-through			
Chile	100%	33% after 8 qtrs.			
Schmidt-Hebbel and Werner (2002)					
Based on Rolling Windows Correlation Coefficients		Currently (1999-2001)			
Brazil		low pass through			
Chile		very low pass through			
Mexico		relatively high pass through			
Goldfajn and Ribeiro da Costa Werlang (2000)					
Based on Panel Data Regression Results	Depreciation	Pass-through			
For Emerging Economies (including Brazil, Chile and Mexico)	10%	3.9% after 6 months			
	10%	9.1% after 12 months			
Reyes (2003)					
Based on Rolling Windows Correlation Coefficients		(1998-2002)			
Brazil		low pass through			
Chile		very low pass through			
Mexico		relatively high pass through			
		2002	2000	1998	1996
Based on Rolling Windows Estimated Coefficients for Equation (1)	Depreciation	Pass-through	Pass-through	Pass-through	Pass-through
Brazil	10%	less than (1.0%) in 12 months	3.0% in 12 months	-	-
Chile	10%	less than (1.0%) in 12 months	(2.0%) in 12 months	2.5% in 12 months	4.0% in 12 months
Mexico	10%	3.3% in 12 months	5.0% in 12 months	2.0% in 12 months	1.7% in 12 months
		2002	2000	1998	1996
Based on Increasing Windows Estimated Coefficients for Equation (1)	Depreciation	Pass-through	Pass-through	Pass-through	Pass-through
Brazil	10%	10% in 12 months	10% in 12 months	10% in 12 months	-
Brazil*	10%	3.0% in 12 months	3.4% in 12 months	8.0% in 12 months	-
Chile	10%	3.6% in 12 months	5.7% in 12 months	6.5% in 12 months	7.1% in 12 months
Mexico	10%	8.0% in 12 months	8.0% in 12 months	8.0% in 12 months	8.0% in 12 months
		2002	2000	1999	1998
Based on Rolling Windows Estimated Coefficients for Equaiton (2)	Depreciation	Pass-through	Pass-through	Pass-through	Pass-through
Brazil (6 months accum.)	10%	less than 1.0%	less than 1.0%	6.80%	9.50%
Brazil (12 months accum.)	10%	less than 1.0%	2.50%	9.50%	9.70%
Chile (6 months accum.)	10%	less than (1.0%)	less than (1.0%)	less than (1.0%)	less than 1.0%
Chile (12 months accum.)	10%	less than (1.0%)	less than (1.0%)	1.30%	2.30%
Mexico (6 months accum.)	10%	2.40%	2.00%	2.30%	2.30%
Mexico (12 months accum.)	10%	3.25%	4.60%	3.50%	3.60%
		2002	2000	1999	1998
Based on Increasing Windows Estimated Coefficients for Equation (2)	Depreciation	Pass-through	Pass-through	Pass-through	Pass-through
Brazil (6 months accum.)	10%	9.50%	9.50%	9.50%	9.50%
Brazil (12 months accum.)	10%	9.70%	9.70%	9.70%	9.70%
Brazil* (6 months accum.)	10%	less than 1.0%	less than 1.0%	less than 1.0%	-
Brazil* (12 months accum.)	10%	3.50%	4.00%	5.40%	-
Chile (6 months accum.)	10%	less than 1.0%	1.40%	1.80%	2.00%
Chile (12 months accum.)	10%	less than 1.0%	1.30%	1.80%	2.10%
Mexico (6 months accum.)	10%	5.40%	5.40%	5.40%	5.30%
Mexico (12 months accum.)	10%	8.50%	8.60%	8.60%	8.70%

Notes: Numbers in parenthesis represent negative numbers.
(*) Refers to the calculations from Brazil with the sub-sample that does not include the hyperinflation years.

Garcia and Restrepo (2001) relate lower pass-through levels to negative output gaps (output below potential). Their argument is based on the intuitive result that negative output gaps tend to offset the inflationary pressure from depreciation by reducing margins[31]. Using data for Chile, Garcia and Restrepo (2001) initially assumed a negative output gap of two percent that fades over three years and showed that the pass-through effect from exchange rate depreciation is cut almost in half. Without the output gap they calculated that a one hundred percent depreciation translates into thirty-three percentage points of inflation within eight quarters, while in the presence of the negative output gap this number is reduced to almost thirteen percent.

Lower pass-through levels have also been related to the credibility of the IT regime. Strong credibility is associated with inflation expectations that are not closely linked to sudden exchange rate movements because individuals believe that the central bank will act effectively in order to counteract any inflationary pressure. The relevant issues here are the ways in which the counteraction is implemented. If exchange rate movements will translate into inflation pressure, then the policy enacted should be one that affects directly or indirectly the exchange rate. If there is no reason to believe that the exchange rate movement will affect inflation then there is no need for changes in monetary policy. Schmidt-Hebbel and Werner (2002) argue that emerging economies, relative to developed ones, are prone to higher pass-through from currency depreciation to inflation given their low central bank credibility, high degree of openness, history of high inflation, and relevant levels of liability dollarization[32]. These characteristics increase the likelihood and costs of financial crises due primarily to self-fulfilling attacks on the assets of these countries and large currency depreciations that cause banking failures, bankruptcies, and domestic recessions. Given the possibility of these adverse effects and the commitment to IT monetary policy in emerging economies may be more responsive to exchange rate movements.

[31] Mishkin (2001) argues that this is what usually happens when the currency depreciation is the result of negative terms of trade shock with negative effects on output.

[32] Liability dollarization refers to the important mismatches between foreign currency assets and liabilities of corporate, banking and public sectors.

The results of the different analyses presented in this section for Brazil, Chile, and Mexico show that these countries have historically high pass-through effects and high correlation coefficients between inflation and depreciation. Using the Schmidt-Hebbel and Werner (2002) argument, recent declines in both statistics may be related to actions undertaken by the monetary authorities in order to counteract the effects of sudden exchange rate movements. Given the relevant role played by currency depreciation in the determination of the CPI, policies enacted may be offsetting the initial exchange rate shocks and thus controlling the depreciation rate at a level that is consistent with the inflation target. The impulse response functions for the VEC analysis included in Appendix 1 show that the nominal exchange rate decreases consistently for Brazil and initially for Chile after there is a shock to the price level, while for Mexico it initially rises and then falls. This is consistent with the lower correlation observed between inflation and depreciation over the last years in these countries. In order to link this result to monetary policy responsiveness there should be evidence of direct or indirect intervention in the foreign exchange rate market, or in other words, evidence for fear of floating in Brazil, Chile, and Mexico.

D. Empirical Analysis of Fear Floating[33]

Central banks can intervene directly in the foreign exchange rate market (FOREX) using international reserves to buy/sell foreign currency and therefore control effectively the price of foreign currency in terms of domestic currency. There can also be an indirect intervention in the FOREX through the manipulation of the interest rate, known as an interest rate defense of the currency[34]. In theory, a country implementing IT should have a free floating exchange rate. Therefore, direct or indirect interventions in the FOREX would be considered fear of floating practices.

---

[33] The exact description and the sources of the data are included in Appendix 1.
[34] Flood and Jeane (2000) and Drazen(1999).

Using monthly observations for currency depreciation, interest rate, and international reserves for Brazil, Chile, and Mexico it is possible to analyze the responsiveness of interest rates and international reserves to exchange rate movements. The datasets used are for the time period of January 1997 to December 2002 in which Chile and Mexico were moving towards IT and Brazil adopted it with the “big bang” approach.

This analysis is carried out by using vector auto regression (VAR) analysis[35]. The endogenous variables are monthly observations for currency depreciation, percentage change of international reserves, and the nominal interest rate[36]. Two lags were included for the three countries.[37] The results are presented here using variance decomposition graphs of the VARs, but the impulse response functions, shown in Figures A.1.4 through A.1.6, are included in Appendix 1. Figure 6 shows the percentage of the variance of the interest rate that is explained by the depreciation rate after twelve months. This percentage is around nineteen percent for Brazil and Chile and sixty five percent in the case of Mexico. Also in Figure 6, the percentage of the variance of international reserves explained by innovations of the currency depreciation after 12 months is around five percent for Chile and Mexico, and thirteen percent for Brazil. These numbers suggest, to a certain extent, that international reserves and interest rates are responding to exchange rate movements. Mexico and Chile seem to be using more the interest rate, while Brazil utilizes both. By way of comparison, the graph also presents the results of this analysis carried out on data from Canada for the same time period. With respect to Canada, the Latin American interest rates react more to currency depreciation shocks, while international reserves are only more responsive for Brazil.

---

[35] Unit root tests rejected the null hypothesis of a unit root for the variables included in the VARS.

[36] The interest rates used are Tasa de Fondeo for Mexico, Monetary Policy rate for Chile and SELIC rate for Brazil. Different reports of the central banks of these countries mention that these are the interest rates considered as the representative interest rate for the stance of monetary policy.

[37] Number of lags determined using Akaike and Schwarz information criteria.

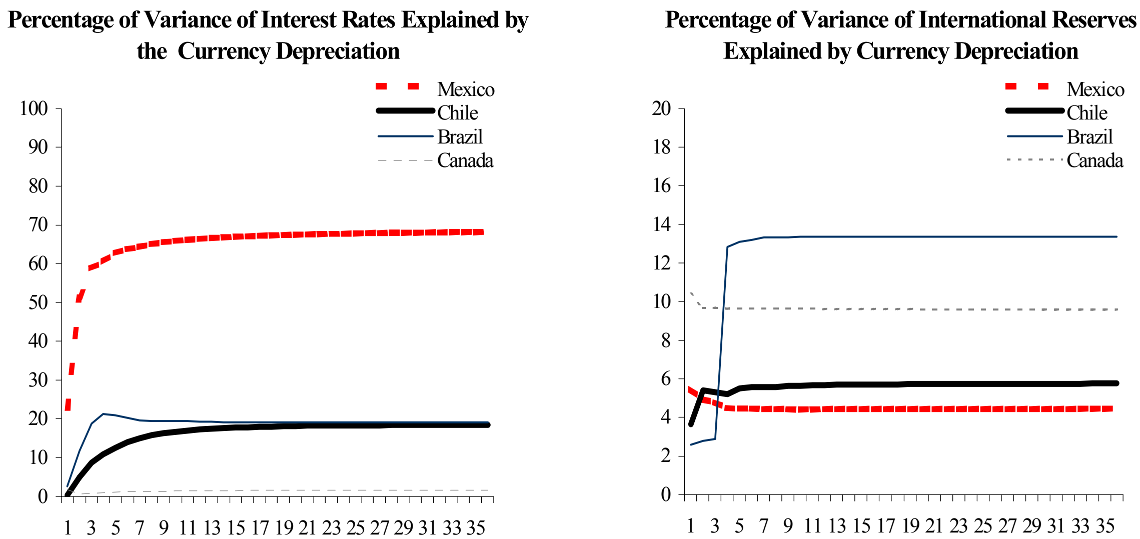

Fig. 6. Percentage of Interest Rate and International Reserves Variance Explained by Domestic Currency Depreciation (After a One Standard Deviation Innovation in Currency Depreciation).

Previous studies of fear of floating have compared the variability of interest rates and international reserves for emerging and industrialized economies that claim to have a free floating exchange rate[38]. Table III presents the results of the variability analysis that follows the methodology introduced by Calvo and Reinhart (2000). The premise behind the analysis is based on the theory of fixed and floating exchange rates. Under a fixed or managed nominal exchange rate regime, the variability of the exchange rate should be low, while the variability of international reserves and/or interest rates, the instruments used to control or manage the regime, should be high. For the floating exchange rate regime the opposite results should hold. Calvo and Reinhart (2000) present their results by reporting for each country the probability of observing monthly percent changes (basis points changes) within a certain range for the depreciation rate and the international reserves (for the nominal interest rate).

Table III presents the analysis for Brazil, Chile, and Mexico, using data from July 1994 to December 2002, January 1996 to December 2002, and January 1989 to December 2002, respectively. The samples are divided into two sub-samples. The first

[38] Reinhart (2000), Reinhart and Calvo (2000) and Schmidt-Hebbel and Werner (2002)

one corresponds to the time periods for which these countries implemented managed floating exchange rates, while the second corresponds to the IT regime (flexible exchange rate)[39].

Table III. Variability Analysis of the Nominal Exchange Rate, International Reserves and the Nominal Interest Rate

	Probability that the Monthly Percent Change in Depreciation Falls Within		International Reserves Falls Within		Probability that the Monthly Change of the Nominal Interest Rate Falls Within		Probability that the Monthly Change of the Nominal Interest Rate is Higher than	
	+/- 1.0%	+/- 2.5%	+/- 1.0%	+/- 2.5%	25 basis pts.	50 basis pts.	400 basis pts	500 basis pts.
Brazil (managed float) 94:07 - 98:12	81.1	92.4	22.6	49.1	5.6	11.3	39.6	35.8
Brazil (IT) 99:01 - 02:12	8.3	39.5	20.1	43.8	45.9	66.7	12.5	10.4
Chile (managed float) 96:01 - 98:12	70.1	91.2	44.1	64.7	79.4	82.3	0.0	0.0
Chile (IT) 99:01 - 02:12	23.4	63.8	40.4	80.8	69.5	82.9	0.0	0.0
Mexico (managed float) 89:01 - 94:11	63.4	95.8	8.5	28.2	25.4	33.8	9.9	5.7
Mexico (IT) 98:01 - 02:12	26.2	63.9	26.2	65.6	11.5	22.9	8.5	4.9

Notes: The managed float classification follows that of Calvo and Reinhart (2000).

The results in Table III are interpreted as follows. A lower probability of falling within the range of +/- one percent or +/- five percent for the nominal exchange rate or international reserves indicates higher variability. For the nominal interest rate, a lower probability of falling within the 25 or 50 basis points indicates higher variability, while a higher probability of falling outside the 400 – 500 basis point range indicates higher variability.

Table III shows that the variability of the nominal exchange rate is indeed higher under IT with respect to the managed floating samples for the three countries considered here. For the case of Brazil, the variability of international reserves is very similar across regimes, but is slightly higher for the IT regime whereas the interest rate

[39] Managed floating exchange rates include crawling pegs, bands and exchange rate targets.

variability decreased substantially. The data from Chile shows that international reserves are slightly less variable under IT whereas the interest rate is slightly more variable. Finally, regarding Mexico, the variability of international reserves decreased under IT, while the nominal interest rate variability increased. Therefore fear of floating could be identified in Chile and Mexico by the higher variability of the interest rates under IT, while for Brazil these practices are tied to the higher variability of international reserves.

For a comparison of these results with those observed in developed countries implementing IT examine Table A.1.8 in Appendix 1. The variability of reserves in Brazil is still slightly higher and the variability of the nominal interest rate is higher for Mexico. The results for Chile are similar to those of developed countries implementing IT.

Schmidt-Hebbel and Werner (2002) is another study that elaborated on fear of floating issues. The authors argue that fear of floating practices in emerging economies are temporary. That is, these countries respond to exchange rate movements under certain circumstances and for limited periods of time. They estimated a Taylor rule where the real interest is a function of the inflation gap, output gap, currency depreciation, and the foreign interest rate. They used the rolling windows methodology and showed that for Brazil, the estimated coefficient for currency depreciation increased substantially in 2000-2001, while for Chile and Mexico it increased for the time period of 1998 – 1999 in response to market pressures that emerged during and after the Asian, Russian, and Brazilian crises of 1997 – 1998.

Regarding documented interventions in the FOREX, which can be characterized as fear of floating, it should be noted that Brazil openly intervened in the FOREX directly in 2001 by selling six billion US dollars during the year[40]. The central bank of Chile publicly announced that in order to reduce nominal exchange rate volatility it would sell 1.5 billion US dollars in the FOREX in the middle of 2001 and would issue three billion US dollars in dollar-denominated peso Bank debt to provide a

[40] Monetery Report of 2001, Banco Central do Brasil.

hedge against future depreciation[41]. Mexico's central bank had in place a formal scheme to accumulate reserves during 1996 – 2001, and it also introduced a contingent dollar sale mechanism from January 1997 to June 2001, that was enacted when the peso depreciated heavily during one day[42]. The total sales through this scheme were for 2 billion US dollars[43].

E. Conclusion

The results presented here and those of previous studies show that emerging economies like Brazil, Chile, and Mexico have had high pass-through effects from exchange rate movements into inflation and the inflation and depreciation rates have also been highly correlated. Recently these effects have been subsiding, and these declines coincide with the time periods in which these countries adopted IT as their monetary policy regime. At the same time, in comparison to developed inflation targeting countries, Brazil, Chile, and Mexico have shown high levels of direct (international reserves) an indirect (interest rate defense) intervention in the foreign exchange rate market. In other words, there is evidence of fear of floating practices. The next step is to determine whether the lower correlation observed between inflation and depreciation and the declining pass-through effects can be the result of fear of floating observed under IT. As was mentioned previously, Schmidt-Hebbel and Werner (2002) argue that monetary policy may be more responsive to exchange rate movements given the central bank's commitment to IT and the costs associated with sudden depreciations. Chapter III presents a theoretical model that is used in Chapter IV to analyze the possible relation between IT and the declines observed in the pass-through effect and the correlation between inflation and depreciation. The model also shows that direct and indirect interventions in the foreign exchange rate market, under

---

[41] Monetary Report of 2001, Banco Central de Chile.

[42] Werner (1997) and Werner and Milo (1998) argue that in theory and in practice this mechanism had no noticeable effects on the volatility and trend of the exchange rate.

[43] Most of these sales took place in 1998. For more on this contingent scheme see. Werner (1997).

certain circumstances, are justified by the commitment to IT. These interventions translate into lower correlation between inflation and domestic currency depreciation because they break the linear relation between the two variables. The premise behind these results is related to the real exchange rate and the relevant role that prices of traded goods play in the determination of the overall price level in the economy.

The theoretical model analyzes also the effects of fear of floating practices in the economy. Secifically trying to see if there are any differences resulting from using the interest rate as the policy tool to control the exchange rate pressure on inflation instead of international reserves, or are these tools equivalent. Results show that each of these policy tools has different effects on the return of foreign assets, the domestic interest rate, as well as in production and consumption decisions. These effects result in welfare differences that can be ranked in order to make conclusions about which policy is preferred. The analysis also compares the results obtained for the IT regime with respect to those obtained for a monetary rule regime (Friedman's rule). The reason for this is to compare IT with the alternative regime being suggested to these countries in the economic literature[44].

[44] Kumhof (2001).

CHAPTER III

THE COMPREHENSIVE MODEL FOR INFLATION TARGETING AND A MONETARY RULE

A. Introduction

This chapter elaborates on the presentation of the comprehensive model that will be used in chapter IV to analyze exchange rate pressure under IT and compare the results with those obtained in a framework where the central bank fixes the rate of money growth for the nominal money stock (Friedman rule type). Chapter IV also uses this model to relate lower pass-through effects to fear of floating practices that under certain circumstances are justified by the central bank's commitment to the inflation target. As mentioned in the previous chapter the main feature of the model presented here is that it allows the government to use either international reserves or interest rate policy as policy instruments to implement IT, as well as allowing for a comparison with the rate of money growth rule

B. The Model

The model is a continuous time representative agent model for a small open economy, based on Lahiri and Vegh (2001) and Auernheimer and George (2000)[45]. There are two types of goods, traded and non-traded, produced by the private sector. Individuals live forever and maximize utility derived from the consumption of both

[45] I modify Lahiri and Vegh's model in order to include one traded good and one non-traded good, instead of two traded goods. The model is also extended to include the inflation targeting constraint. Inflation Targeting is not discussed in the Lahiri and Vegh (2001) paper, they used the model to analyze dirty floating in the context of nominal wage rigidities. From Auernheimer and George (2000) the current model uses their specification for the sluggish non-traded good price and their assumptions for the production of the non-traded good.

types of goods. The economy can borrow or lend freely in world capital markets. The world price of the traded good is taken as given and the law of one price for this good is assumed to hold at all times.

1. Consumers

The representative individual consumes traded and non-traded goods, holds domestic deposits, H_t, and foreign bonds. Deposits are held in domestic commercial banks and yield the deposits interest rate, i_t^d, while foreign bonds yield the world interest rate, r_t. The individual's lifetime utility function is given by:

$$U \equiv \int_0^\infty \left(\frac{1}{1-1/\sigma} \left[\left(c_t^T\right)^\rho \left(c_t^H\right)^{1-\rho} \right]^{1-1/\sigma} \right) e^{-\beta t} dt \quad (3)$$

where c_t^T and c_t^H denote traded and non-traded goods consumption, respectively, while σ and β represent the inter-temporal elasticity of substitution and the rate of time preference. The rate of time preference is assumed to be equal to the world interest rate[46]. Individuals do not hold cash. Instead, they perform transactions with deposits and face transaction costs, TC_t.

Let P_t^T, P_t^H, P_t^{T*} and E_t denote the domestic price level for the traded good, domestic price level for the non-traded good, foreign price level of the traded good and the nominal exchange rate, respectively. The nominal exchange rate is defined as the price of foreign currency in terms of domestic currency and the rate of currency depreciation is denoted by $\hat{E}_t = \dot{E}_t / E_t$. The real exchange rate is defined as $\varepsilon \equiv P_t^T / P_t^H$, and the law of one price for the traded good determines that $E_t P_t^{T*} = P_t^T$. If P_t^T is normalized to one, without loss of generality, the individual's flow budget constraint in terms of the traded good is:

[46]This avoids the problems of ever increasing or decreasing consumption paths.

$$i_t^{\,d} h_t \frac{P_t}{E_t} + \frac{x_t^H}{\varepsilon_t} + \Omega_t^T + \Omega_t^B + \tau_t + r_t a_t^I = \dot{a}_t^I + c_t^T + \frac{c_t^H}{\varepsilon_t} + \dot{h}_t \frac{P_t}{E_t} + \Pi_t h_t \frac{P_t}{E_t} + TC_t(\alpha, h_t) \quad (4)$$

where a_t^I represents foreign bond holdings that yield the world interest rate, Ω_t^T and Ω_t^B are dividends received from commercial banks and firms producing the traded good, τ_t stands for lump sum transfers received from the government, Π_t is the overall inflation rate for the consumption based domestic price index presented below, and x_t^H denotes production of the non-traded good[47].

The last term in equation (4), TC_t, denotes the transaction costs incurred by individuals. Transaction costs are lower as individuals increase their holdings of real deposits. α is a positive constant and $h_t = H_t / P_t$ denotes real deposits in terms of the composite consumption good that yield the interest rate on deposits, i_t^d. H_t denotes the nominal stock of deposits in domestic currency and P_t is the consumption based domestic price index[48] determined by the minimum expenditure required to purchase one unit of the composite good, $(c_t^T)^\rho (c_t^H)^{1-\rho}$:

$$P_t = \frac{E_t^\rho (1-\rho)^{(\rho-1)}}{(P_t^H)^{\rho-1} \rho^\rho} \qquad (5)$$

The problem for the representative individual consists of maximizing (3) subject to (4) by choosing optimal values for consumption of traded and non-traded goods, deposits and foreign asset holdings while taking as given i_t^d, r_t, the level of τ_t, as well as the path for Ω_t^T and Ω_t^B.

Assuming the following explicit form for the transaction costs technology:

$$TC_t(\alpha, h_t) = h_t^2 - \alpha h_t + \kappa \quad , \quad h_t \in [0, \frac{\alpha}{2}] \qquad (6)$$

---

[47] For simplicity the production of the non-traded good is not modeled explicitly, the assumptions about the production are explained in detail later in this chapter.

[48] The Price Index, P_t, is the solution to the minimization of the expenditure function $P_t = P_t^T c_t^T + P_t^H c_t^H$ subject to $\left(c_t^T\right)^\rho \left(c_t^H\right)^{1-\rho} = 1$.

where α and κ are positive constants, the first order conditions for the utility maximization problem imply:

$$\frac{\rho}{1-\rho}\frac{c_t^H}{c_t^T} = \varepsilon_t \qquad (7)$$

$$h_t = \frac{\alpha}{2} - \frac{I_t^d}{2}\frac{P_t}{E_t} \qquad (8)$$

where I_t^d denotes the real deposits spread, $i_t^m - i_t^d = r_t + \hat{E}_t - i_t^d$, which represents the opportunity cost of holding real deposits[49].

Equation (7) is the usual condition that equates the marginal rate of substitution between consumption of traded and non-traded goods to their relative price. Equation (8) shows that real demand deposits are increasing in α and decreasing in the opportunity cost of holding them, I_t^d.

2. Overall Inflation Rate and Price Sluggishness of the Non-Traded Good (x^H)

The consumption price index derived earlier, equation (5), can be rewritten as follows:

$$P_t = E_t^{\rho}(P_t^H)^{1-\rho}\rho^{-\rho}(1-\rho)^{-(1-\rho)} \qquad (9)$$

Taking logs and differentiating with respect to time the overall inflation rate, Π_t, can be expressed as:

$$\Pi_t = \rho\hat{E}_t + (1-\rho)\pi_t^H \qquad (10)$$

I assume that the non-traded good price responds sluggishly, specifically as a function of the depreciation rate of domestic currency, $\hat{E}_t$, and the difference between the current and the steady state equilibrium of the real exchange rate:

$$\pi_t^H = \hat{E}_t + \gamma(\varepsilon_t - \varepsilon^*) \qquad (11)$$

[49]The transaction cost function, equation (4), considers only positive transaction costs, as it is standard in the literature.

where ε^* represents the steady state equilibrium level for the real exchange rate[50]. Equation (11) implies that the real exchange rate will adjust according to[51]:

$$\hat{\varepsilon}_t = \gamma(\varepsilon^* - \varepsilon_t) \qquad (12)$$

Using equations (10) and (11), the overall inflation rate is:

$$\Pi_t = \hat{E}_t + \gamma(1-\rho)(\varepsilon_t - \varepsilon^*) \qquad (13)$$

Equation (13) implies that exchange rate movements translate into inflationary pressure due to the sluggish adjustment of the non-traded good price level. These exchange rate movements can be in response to exogenous shocks like changes in the world interest rate, r_t, or money demand shocks that cause a reallocation of assets. Inflationary pressure arises from the catching up effect of the non-traded good price level. These effects continue until the real exchange rate is back to its steady state equilibrium, ε^*.

3. Production of the Non-Traded Good

Instead of explicitly modeling firms producing the non-traded good, x_t^H, I have assumed that there is a constant exogenous level for the long run production level net of government purchases, x^{H*}, equal to the consumption level of this good that corresponds to the steady state equilibrium level for the real exchange rate, ε^*. In the short run, production will completely adjust to the level of consumption. The long run real exchange rate can be derived from equation (7) after taking into account the market clearing condition,

$$\varepsilon_t^* = \frac{\rho}{1-\rho}\frac{x^{H*}}{c_t^T} \qquad (14)$$

[50]The inflation rate of the non-traded good is a function of the expected depreciation rate, $\hat{E}_t^a$, but I am assuming perfect foresight, so $\hat{E}_t^a = \hat{E}_t$. The sluggish response of the non-traded good mirrors the resulting price stickiness that would be obtained with the forward-looking sticky price model of non-traded goods by Calvo(1983) and the modified version of this framework presented in Kumhof (2000).

[51] Recall that $\varepsilon_t = P_t^T / P_t^H$ and that that the law of one price for the traded good determines that $E_t = P_t^T$, therefore $\hat{\varepsilon}_t = \hat{E}_t - \pi_t^H$.

Equation (14) implies that for given levels of consumption of the traded good and the real exchange rate, at every point in time, production of the non-traded good will be determined by the level of consumption of that good. In other words, the non-traded good market will always clear, $x_t^H = c_t^H$. Eventually production will adjust the long run level as the real exchange rate moves towards its steady state equilibrium.

4. Production of the Traded Good (x^T)

Firms producing the traded good have a production technology that uses an imported input, K_t, as its sole input. Firms have the following production function:

$$x_t^T = [K_t]^{\theta} \quad 0 < \theta < 1 \qquad (15)$$

They also face a credit-in-advance constraint to pay for the imported input, in other words they use bank loans denominated in domestic currency to pay for their working capital:[52,53]

$$n_t \geq \psi K_t \ , \quad \psi > 0 \qquad (16)$$

where $n_t = N_t / E_t$ denotes loans, in terms of the traded good, from commercial banks and the equality holds whenever there is a positive cost for loans, i.e. $i_t^L - i_t^m = I_t^L > 0$. Firms producing the traded good hold foreign bonds, a_t^T, that yield the world interest rate, r_t. These firms have real financial wealth defined by the difference between their foreign bond holdings and the loans that they acquire from commercial banks, $q_t^T = a_t^T - n_t$.

[52] This assumption, as in Lahiri and Vegh (2001), introduces a credit channel into the model by introducing a demand for bank loans.

[53] These loans are revolving loans, meaning that firms do not accumulate debt. The firms first get the loan with which they acquire the input needed for the production of the current period, then they sell the good and repay the loan immediately.

From (15) and (16) and imposing the standard transversality condition, the firm's profit maximizing problem reduces to :

$$\underset{K}{Max} \int_0^\infty \Omega_t^T dt = q_0^T + \int_0^\infty \left[K_t^\theta - K_t\left(1 + \psi I_t^L\right)\right] dt \qquad (17)$$

The first order condition for the profit maximization problem results in the following demand function for the imported input:

$$K_t = \left[\frac{\theta}{1+\psi I_t^L}\right]^{\frac{1}{1-\theta}} \qquad (18)$$

Equation (18) shows that the demand for the imported input is decreasing in the loans spread, I_t^L, and it determines implicitly the demand for commercial banks loans.

5. The Banking Sector

The representative bank extends loans, n_t to the firms producing the traded good, charging them the interest rate on loans, i_t^L, holds government bonds, $z_t = Z_t / E_t$, that pay interest rate, i_t^G, accepts deposits from consumers paying them an interest rate of i_t^d, and holds required reserves for these deposits, $M_t / P_t = m_t \geq \delta H_t / P_t = \delta h_t$. The banking sector is assumed to be perfectly competitive[54]. This implies that the banks balance sheet in terms of the traded good is equal to $m_t(P_t / E_t) + n_t + z_t = h_t(P_t / E_t)$, and the profit maximization problem for the representative bank is the following:

$$\underset{h,n,z}{Max}\,\Omega_t^B = I_t^d h_t \frac{P_t}{E_t} + I_t^L n_t + I_t^G z_t - i_t^m m \frac{P_t}{E_t} \qquad (19)$$

[54] The modeling of the banking sector follows Lahiri and Vegh (2000) and Lahiri and Vegh (2001)

where I_t^G is the government interest rate spread, $i_t^G - i_t^m$. Noting that δ is set exogenously by the monetary authority, commercial banks receive no interest payment on their reserve holdings other than the return on real money balances meaning that banks will not hold excess reserves. Then using the banks' balance sheet, the first order conditions for the maximization problem are:

$$(1-\delta)\left(i_t^L - i_t^m\right) + \left(i_t^m - i_t^d\right) = \delta\ i_t^m \qquad (20)$$

$$\left(i_t^L - i_t^m\right) = \left(i_t^G - i_t^m\right) \qquad (21)$$

Equation (20) is the standard result where banks equalize the marginal revenue and the marginal cost of an additional unit of deposits. The marginal revenue depends on the deposit spread and the loans spread that they get when they lend a fraction, 1-δ, of the additional unit of deposits. Using equation (21) it is easy to notice that the interest rate on loans must be equal to the interest rate obtained from government bonds. This is the condition for an interior solution. Intuitively this is the result of perfect substitution between government bonds and commercial loans from the viewpoint of commercial banks. From equation (20) the resulting expression shows that at every point in time the interest rate on deposits is determined by the interest rate paid by government bonds, $i_t^d = (1-\delta) i_t^G$, giving effective interest rate control to the government[55].

In order to ensure a determinate demand for deposits and loans, the following restriction for the interest rate is imposed in the model, $0 \le i_t^G - i_t^m \le \delta\ i_t^G$. Assuming non-negative loan and deposit spreads derives the condition. It is worthwhile to note that there is an implicit relationship between the demand for deposits in commercial

[55] This is based on the well-known setup introduced by Calvo and Vegh (1995), where the government issues interest-bearing money. In this case the government issues bonds, but the interest for government bonds affects directly the interest rate on the liquid asset of the economy (real deposits) through the banking system.

banks and money demand, which is determined by the reserve requirements that banks must hold.

6. Government

For this setup the government is comprised of the fiscal authority and the central bank. The first one issues government bonds, paying the government interest rate, i_t^G, consumes the non-traded good, G_t^H, and makes lump-sum transfers, τ_t, to the public. The Central Bank sets δ, issues domestic currency, M_t, and holds international reserves, R_t, that pay the world interest rate, r_t. The flow budget constraint for the government in terms of the traded good is:

$$r_t R_t + \dot{m}_t \frac{P_t}{E_t} + m_t \Pi_t \frac{P_t}{E_t} + \dot{z}_t + z_t \hat{E}_t = \dot{R}_t + \tau_t + \frac{G^H{}_t}{\varepsilon_t} + i_t^G z_t \qquad (22)$$

The central bank's balance sheet identity is given by:

$$E_t R_t + D_t = M_t \quad , \quad D_t = D_t^G - Z_t \qquad (23)$$

where D_t denotes the net nominal domestic credit that results from subtracting nominal government bonds, Z_t, from gross nominal domestic credit, D_t^G[56].

Moving away from fiscal implications, from (22), the lump sum transfers to the consumers consist of seigniorage revenue from issuing cash and bonds and the interest earned on international foreign holdings by the government. A final standard assumption is made by setting the rate of accumulation of international reserves equal to zero in steady state, $\dot{R}_t = 0$. This assumption doesn't mean that the government can't intervene in the foreign exchange market, but rather that it can only embark on discrete interventions by increasing or decreasing the level of international reserves

7. The Aggregate Budget Constraint

[56] Net nominal domestic credit, D_t, represents government debt with the central bank. Government bonds work in a way that is very similar to bank loans. They are revolving loans to the government.

The aggregate budget constraint is derived from summing up the budget constraints of consumers, firms, banks and the government. The resulting aggregate constraint is

$$\dot{W}_t = W_t r_t + \frac{x_t^H}{\varepsilon_t} + x_t^T - c_t^T - K_t - \frac{c_t^H}{\varepsilon_t} - [h_t^2 - \alpha h_t + \kappa] \qquad (24)$$

where W_t represents total level of net foreign assets, $R_t + a_t^I + a_t^T$. Recalling that the equilibrium condition in the market for the non-traded good holds at all times and noting that consumption of the traded good adjusts to the level that satisfies the condition $\dot{W}_t = 0$, then for a level of total net foreign assets given by past history, W_o, the equilibrium level of traded good consumption is determined by:

$$c_t^T = W_0 r_t + x_t^T - K_t - [h_t^2 - \alpha h_t + \kappa] \qquad (25)$$

C. Characterizing the Equilibrium

I am interested in comparing three different monetary policy regimes. The first is the standard monetary rule regime, where the central bank fixes the rate of growth of the nominal money stocks. The other two regimes are both IT regimes, but they differe in the policy instrument used to comply with the inflation target. Recall that here the instrument will be used to fight off inflation pressure coming from exchange rate movements which means that the instrument will affect directly or indirectly the level of the nominal exchange rate. The first IT regime uses direct intervention of the central bank in the foreign exchange market, using international reserves. The second one uses interest rate policy to indirectly affect the level of the nominal exchange rate.

For the monetary rule, given that banks have reserve requirements on the deposits they received, it can be stated that $M_t / P_t = m_t \geq \delta H_t / P_t = \delta h_t$ and the evolution of real money in the economy is given by

$$\delta \frac{\dot{h}_t}{h_t} = \frac{\dot{m}_t}{m_t} = (\mu_t - \Pi_t) \qquad (26)$$

where μ_t is the rate of money growth and Π_t is the overall inflation rate. Combining equations (13) and (26) and using (8) to substitute for $\hat{E}$ results in

$$\frac{\dot{h}_t}{h_t} = (\mu_t + r_t - i_t^d - \alpha \frac{E_t}{P_t} + 2h_t \frac{E_t}{P_t} - (1-\rho)\gamma(\varepsilon_t - \varepsilon^*))\frac{1}{\delta} \qquad (27)$$

After linearizing equations (27) and (12) the system can be represented in a phase diagram. There is a unique non-trivial steady state, which is a saddle and therefore dynamic equilibria are determined with no fluctuations observed[57]. Figure (7), shows this diagram. When the central bank is implementing a monetary rule it fixes the rate of money growth, μ_t, and the diagram depicted in figure (7) can be used to analyze the equilibrium paths that the system follows as it returns to the steady state. Consumption for the traded good is determined by equation (25), given the levels for the real exchange rate, real demand deposits, and the level of net foreign assets determined by past history (W_0). This by equation (14), also determines non-traded good production and consumption.

[57] It is important to note that both variables in the phase diagram are control variables, but after introducing a shock to the system, there exist only one ε that puts the system on the saddle path.

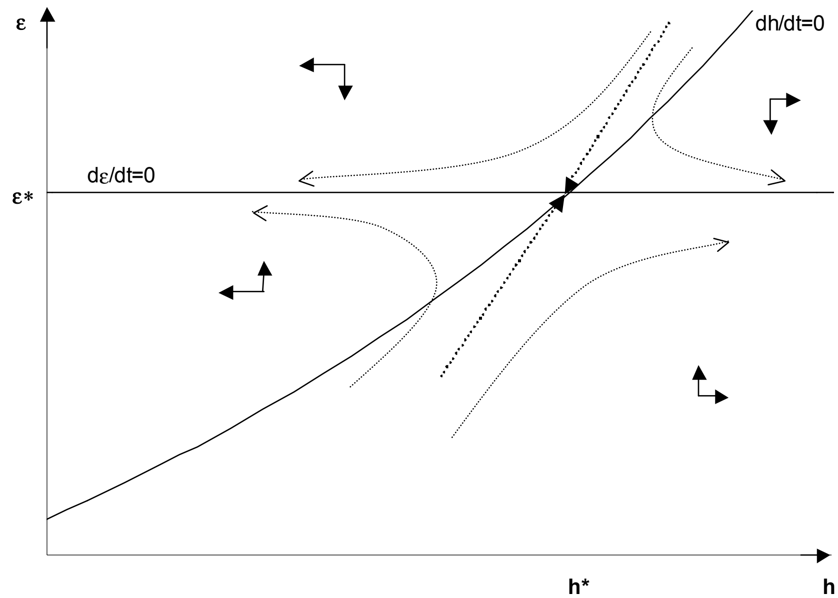

Fig. 7. Phase Diagram of the Comprehensive Model.

In the case where the monetary authority is implementing IT, the central bank sets the overall inflation target, Π. When the economy is not at steady state, the central bank will control the level of the nominal exchange rate by directly intervening in the foreign exchange market or by using an interest rate policy. The objective of the central bank is to keep the depreciation rate of domestic currency at a rate that is consistent with overall inflation. By doing so it looses control over the money supply which will be endogenously determined as is the case with a standard fixed exchange rate regime. Under this framework equation (8) establishes the relationship that holds at all times between the demand for real deposits and the real exchange rate. When the system returns to the steady state, the levels of consumption, production and real deposits held by individuals will be the same as in the case of the monetary rule if the inflation target and the target rate of growth set for the nominal money stock are the same. The use of the interest rate and international reserves to control the nominal exchange rate is classified as fear of floating. But these fear of floating practices are justified since they reflect the response of monetary policy to inflationary pressure arising from exchange rate movements.

D. Inflation Targeting Policy Instruments

When the central bank follows a monetary rule, the rate of depreciation, $\hat{E}_t$, is endogenously determined and the monetary authorities do not react to exogenous shocks that affect the economy. Under IT, the central bank has two different instruments to influence the nominal exchange rate in order to keep it at or move it to a level that is consistent with the inflation target. This can be seen by rewriting the central bank's balance sheet, equation (23), as follows:

$$E_t = \left(m_t - \frac{D_t}{P_t} \right) \frac{P_t}{R_t} \qquad (28)$$

Equation (28) shows that given a level of international reserves, R_t, the monetary authorities can use the interest rate, i_t^d, to modify the level of E_t, since changes in the interest rate influence directly m_t given the relationship that exists between real money holdings and real deposits. The central bank could also, given m_t, intervene directly in the foreign exchange market using international reserves, and hence change the level of E_t.

Given the differences between the monetary rule and IT, different types of shocks can be introduced to the system and the resulting adjustment processes for the system under each regime can be analyzed. This is just the comparison of one regime against the other. But the model also allows for another comparison depending on which instrument is used to implement the IT scheme.

CHAPTER IV

INFLATION TARGETING, MONETARY RULE AND PASS-THROUGH EFFECT ANALYSIS USING THE COMPREHENSIVE MODEL

A. Introduction

The first section of this chapter uses the comprehensive model to analyze the outcomes of two types of shocks, world interest rate and money demand shocks. It compares the results obtained under the monetary rule against those from the two IT regimes and discusses the differences that exist between IT with international reserves and IT with interest rate policy. The second section shows that direct and indirect interventions under IT result in lower correlation coefficients between currency depreciation and inflation as well as in lower pass-through effects from the nominal exchange rate movements into inflation.

B. World Interest Rate (r_t) Shock

Equation (27) shows that shocks to the world interest rate change the steady state equilibrium for the comprehensive model. Intuitively the world interest rate is directly related to the opportunity cost of holding real deposits, that is, a higher world interest rate increases this opportunity cost. Therefore these shocks will also affect the nominal exchange rate as individuals reallocate their assets in response to changes in r_t. These effects are the same for the three regimes considered here, IT with international reserves, IT with interest rate, and a monetary rule. Consequently the steady state is the same for all of these regimes.

1. Under a Monetary Rule Case

This section describes the adjustment process that the variables follow under a monetary rule after a once and for all increase in the world interest rate, r_t. Figure 8 illustrates the effects of the change in r_t. First of all the $\dot{h}_t / h_t = 0$ line shifts to the left, while the $\dot{\varepsilon}_t / \varepsilon_t = 0$ line is unaffected. The diagram shows the saddle path that corresponds to the new equilibrium for real deposits. The adjustment process takes place as follows. The demand for real deposits is determined by Equation (8). A change in the world interest rate will increase the opportunity cost of holding real deposits, I_t^d . There will be an immediate jump of the nominal exchange rate given the individuals undesired excess level of real deposits. This jump will be such that the unique real exchange rate that puts the system on the new saddle path is obtained. Thereafter the system will follow the saddle path moving toward the new steady state level for real deposits.

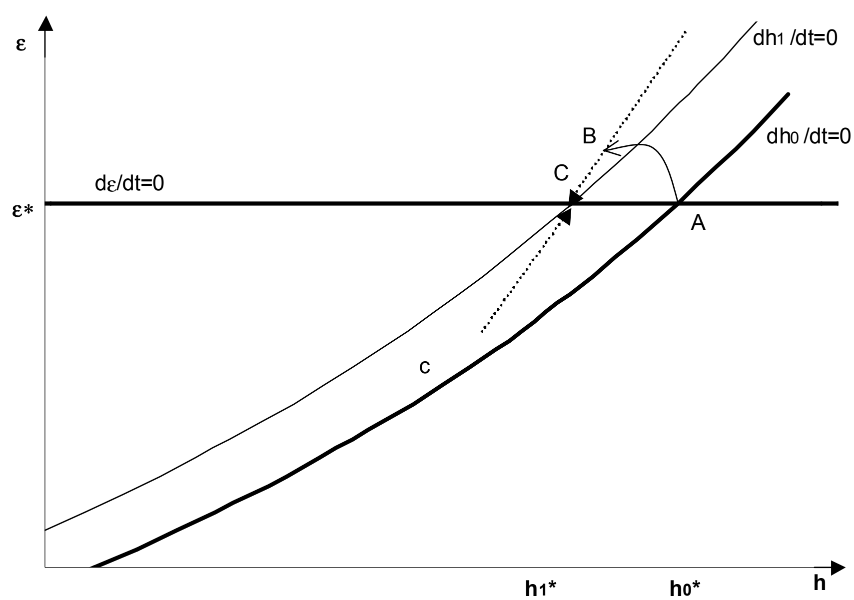

Fig. 8. Representation of an Increase in the World Interest Rate.

The adjustment paths for the different variables in the system are depicted in Figure 9 and the parameters used in the simulation are presented in Table A.2.I, included in the Appendix 2. The graphs corresponding to the consumption levels of the traded and non-traded goods show that these will be higher than their new steady state level for the duration of the adjustment period. This result follows from the higher interest returns that individuals receive for their holdings of foreign assets and because, for a period of time, production of the traded good exceeds its new steady state equilibrium level given that the opportunity cost of loans, I_t^L, drops initially and adjusts slowly towards its new steady state. Another source of the higher consumption levels is that even though transaction costs rise immediately after the change in r_t, they do not reach their steady state level, they will also be lower for a period of time. Finally the sluggish adjustment of the home good price will result in a higher overall inflation rate throughout the adjustment process. Once the real exchange rate returns to the steady state level, the overall inflation rate will be equal to the unchanged rate of monetary growth set by the central bank.

2. Under Inflation Targeting

Before discussing the IT regimes it is important to notice that the government does not need to intervene to avoid the initial jump of the nominal exchange rate. This is a once and for all jump and therefore it would not affect overall inflation rate if prices were perfectly flexible. The problem comes from the sluggishness of the non-traded good price. After the jump of the nominal exchange rate, the non-traded good inflation rate will be affected by the catching up effect that comes from the inequality between the steady state and current real exchange rate. Given this inflation pressure, the monetary authority will be forced to intervene in the foreign exchange market. The central bank will set a depreciation rate or a path for the nominal exchange rate that will be consistent with the overall inflation target.

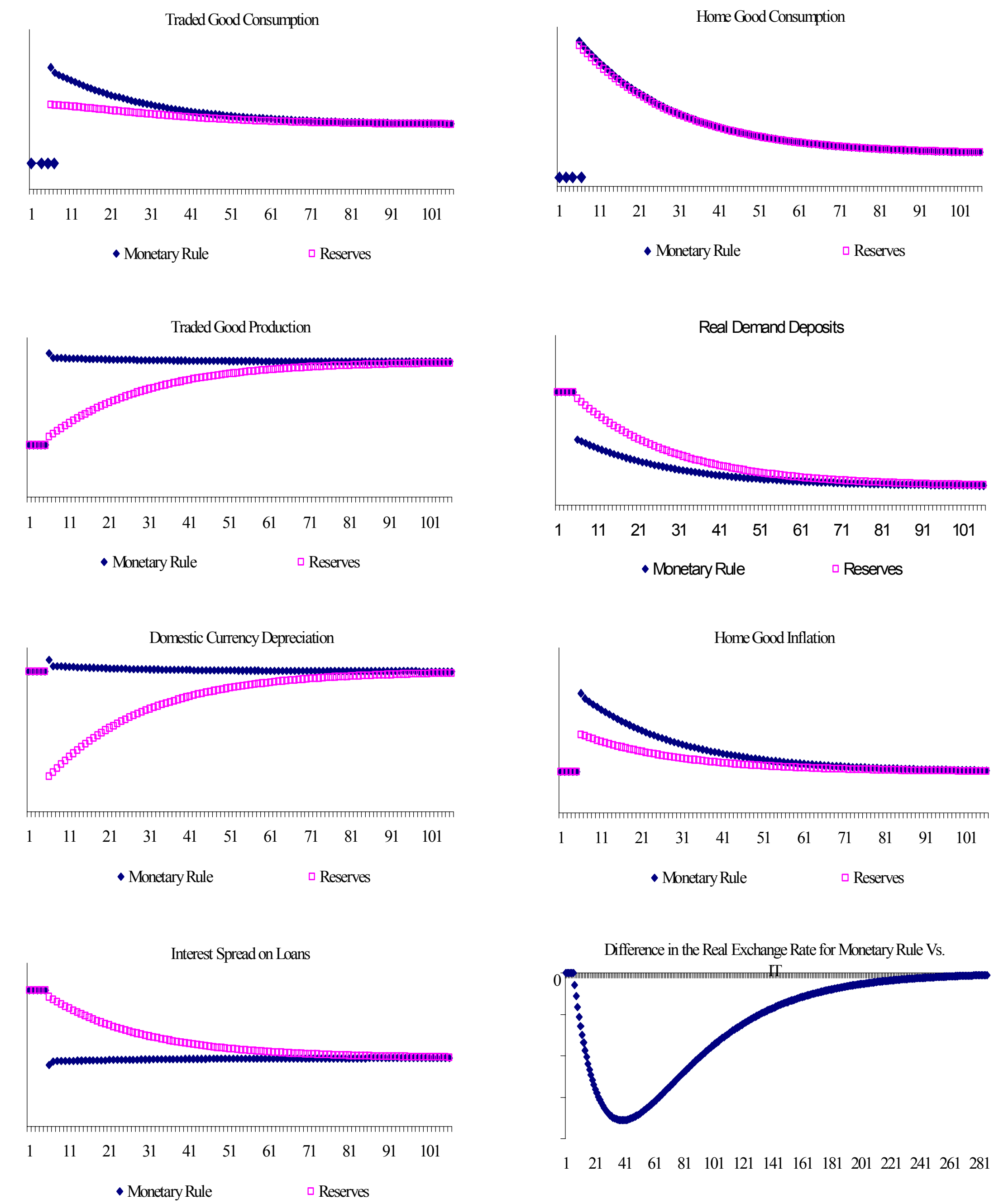

Fig. 9. An Increase in the World Interest Rate: Results for the Monetary Rule and the Inflation Targeting Regime with International Reserves.

In other words, the difference between the current and the steady state level of real exchange rate will force the central bank to set a lower depreciation rate, $\hat{E}_t$, for the domestic currency. The sum of this rate and non-traded good inflation must equal to the overall inflation target.

2.A. With International Reserves

First consider the case where the central bank uses international reserves to influence the nominal exchange rate and satisfy the overall inflation target after there has been an increase in the world interest rate. In this case, as was mentioned before, Equatioen (8) determines the relationship between real demand deposits and the real exchange rate that holds at all times. The central bank adjusts its level of international reserves according to the real money demand, determined by the relation of reserve requirements and real deposits, the real exchange rate level and the depreciation rate consistent with the overall inflation target.

The depreciation rate that is consistent with the inflation target will be lower than the depreciation rate that was observed when the central bank was implementing a monetary rule. Figure 9 shows this and the other paths for the variables in the system for IT with international reserves and for the monetary rule case. The lower depreciation rate, with respect to the one observed under a monetary rule, causes two different effects, a positive (benefit) and a negative one (cost). Together these ultimately result in lower levels of consumption for traded and non-traded goods, relative to those observed under the monetary regime. The negative one comes from the effect that the rate of depreciation has on the opportunity cost of loans. In contrast to the monetary rule case, the interest spread on loans still drops after the change in r_t but it stays above the new steady state level throughout the adjustment period. This causes a lower level of production of the traded good relative to that observed under the monetary rule case. The positive effect comes from the level of real deposits which will be higher throughout the adjustment period, relative to the monetary rule result, since the opportunity cost of holding them in this case is lower. Therefore transaction costs are lower under the IT regime with international reserves. These two effects enter equation (25) and determine that consumption for the traded good and therefore production and consumption of the non-traded good as well are lower under the inflation targeting regime that uses reserves as the instrument to control the exchange rate. This follows from the fact that the negative effect on production of the traded good (cost) dominates the positive effect from lower transaction costs (benefit).

2.B. With Interest Rate Policy

Now consider the case where the central bank uses interest rate policy to influence the nominal exchange rate and satisfy the overall inflation target. In this case the monetary authorities will try to induce a demand for real deposits that is consistent with the exchange rate path and the inflation target. To do so they will use the interest rate on domestic government bonds, i_t^g. Recall that these bonds are held by commercial banks and using equations (20) and (21) this policy directly affects the interest rate on real deposits. Again, there is a positive effect (benefit) reflected in lower transaction costs and a negative effect (cost) reflected in lower production levels for the traded good that will end up causing a lower consumption level of traded and home goods through out the adjustment process, relative to the one observed under the monetary rule. The transmission channels again are the lending spread and the opportunity cost of holding real demand deposits. The difference with respect to IT with international reserves is that these are now affected in two ways. The first is due to the lower depreciation rate, relative to the one observed under the monetary rule regime. And the second due to the effects that the changes in i_t^g will have on I_t^d and I_t^L. Figure 10, shows the paths that the variables of the system follow under an IT regime with interest rate policy, IT with direct intervention in the foreign exchange market (via international reserves) and under the monetary rule regime. Under IT, for both cases, the central bank is trying to force a lower rate of depreciation for the domestic currency, which under an IT regime that uses interest rate policy translates

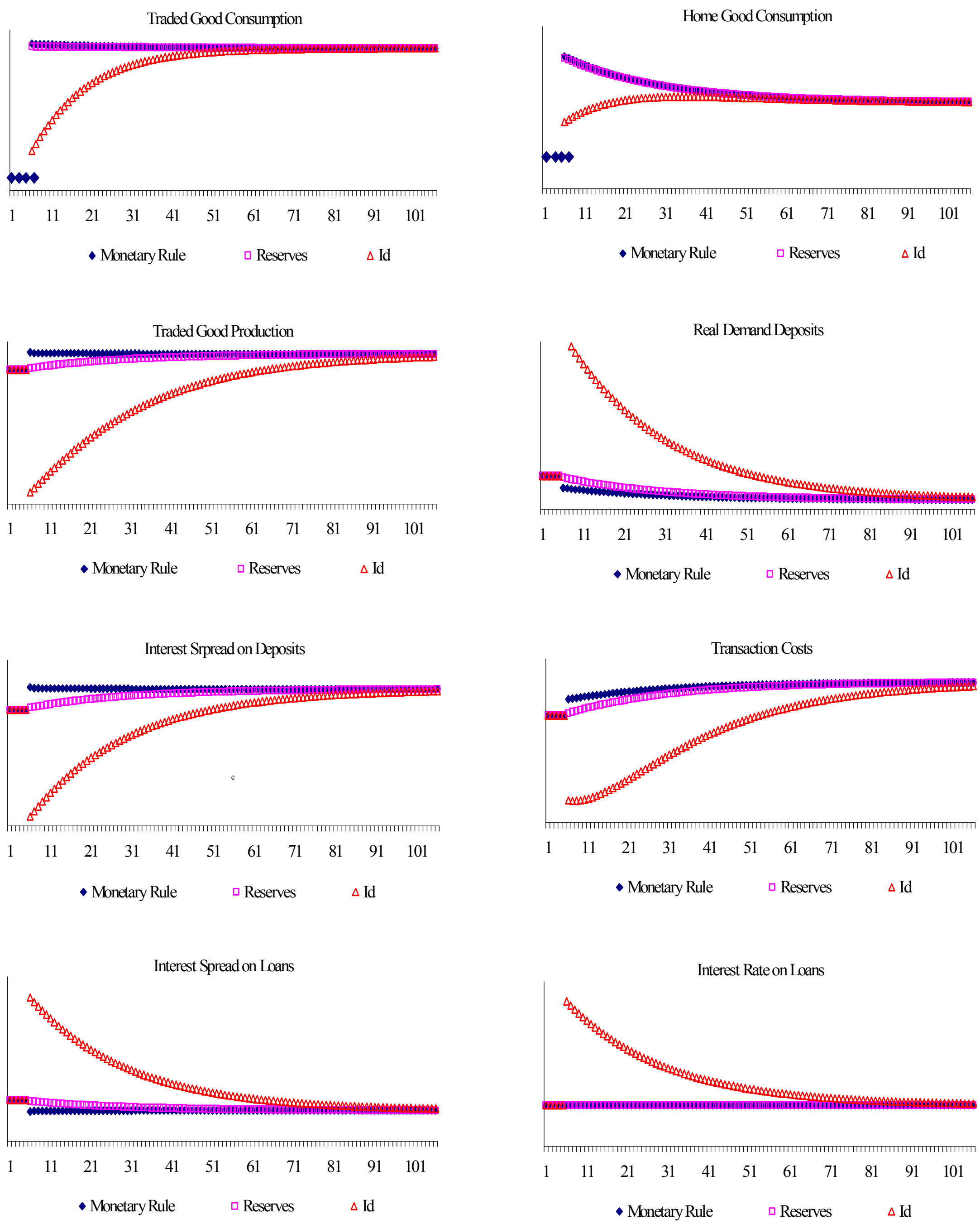

Fig. 10. An Increase in the World Interest Rate: Results for the Monetary Rule, the Inflation Targeting Regime with International Reserves, and the Inflation Targeting Regime with Interest Rate Policy.

into a higher i_t^g throughout the adjustment process and until the new steady state is reached.

The higher interest rate on government bonds will increase the interest rate spread on loans and will lower the opportunity cost on holding real demand deposits, relative to the IT case with international reserves. This situation will be reflected in lower levels of production for the traded good and higher real deposits holdings. These effects, just as in the IT with international reserves case, enter in the equation that determines the level of consumption for the traded good and therefore the level of production and consumption of the home good. The result is a lower level of consumption than under the IT regime with international reserves and the monetary rule regime. The result implies that the positive effect that the policy has on transaction costs, due to higher holdings of real deposits, is again overwhelmed by the negative effects that it has on the production of the home goods.

C. Money Demand Shock

In the comprehensive model presented in Chapter III there is a relationship between real money holdings and real deposits determined by the reserve requirements that commercial banks hold on deposits they received, $\delta \cdot h_t = m_t$. Following Equation (8) from chapter III, different values of α change the demand for real deposits. Then changes in the parameter α in the transaction cost function can be interpreted as money demand shocks in the model. An increase in α corresponds to positive demand shock, while a decrease corresponds to a negative shock. Intuitively positive shocks to α lower the marginal cost of holding real deposits but the marginal benefit, i_t^d, remains unaffected. Given this inequality, individuals will increase their real deposit holdings until the equalization is attained once more, situation that happens in the new steady state. Once again these effects are the same across the three regimes considered here.

1. Under a Monetary Rule

The shock analyzed here is that of an unexpected once and for all increase in α. Figure 11 shows the corresponding phase diagram that shows the effects of the change in α. In this case the $\dot{h}_t / h_t = 0$ line shifts to the right and the new steady state corresponds to a higher level of real deposits. The change in α causes a reallocation of assets by the individuals moving out of foreign assets into domestic assets. Higher holdings of real deposits will translate into lower transaction costs that will ultimately allow higher levels of consumption of both goods. Since the nominal exchange rate is flexible, there will be an immediate decrease in the price of foreign currency in terms of domestic currency such that the real exchange rate that puts the system on the saddle path is attained. Once on the saddle path, lower rates of currency depreciation, non-traded good inflation, and overall inflation prevail throughout the adjustment process.

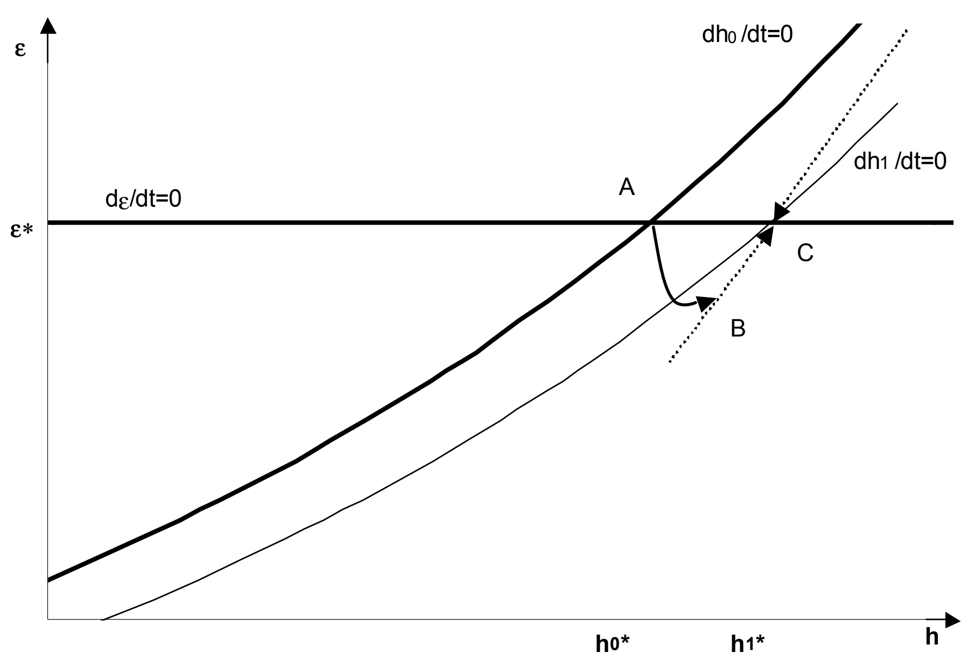

Fig. 11. Representation of a Positive Money Demand Shock.

Figure 12 shows the resulting paths followed by the different variables in the system. Production of the traded good, after an initial drop, returns to its steady state value as does the opportunity cost of commercial loans. Opportunity cost of commercial loans increases initially because of the lower rates of depreciation. The steady state corresponds to a higher level of real deposits holdings that result in lower transaction costs and higher levels of consumption.

2. Under Inflation Targeting

Following the argument presented in section 2.A above, the government does not need to intervene to avoid the initial decrease of the nominal exchange rate. This is a once an for all change that does not affect the overall inflation rate. After α decreases, the same situation that occurs under a monetary rule regarding the reallocation of assets is present for this case. There will be an initial decrease of the nominal exchange rate and an initial fall of the real exchange rate. Given the price sluggishness of the non-traded good the catching up effect is characterized by a lower inflation rate for this type of good throughout the transition. This situation forces the central bank to establish a path for the nominal exchange rate that results in higher rates of depreciation, with respect to the monetary rule, in order to comply with the inflation target. Just as in the case of the shock to the world interest rate, the steady state for the system under IT is the same as the steady state for the monetary rule.

2.A. With International Reserves

As in the case of a change in the world interest rate presented in section 1.A., Equation (6) determines the relationship between real deposits and the real exchange rate that holds at all times. Taking this relation into account, after the increase in α the central bank will adjust the level of international reserves according to the level needed to maintain the nominal exchange rate at a level consistent with the inflation target.

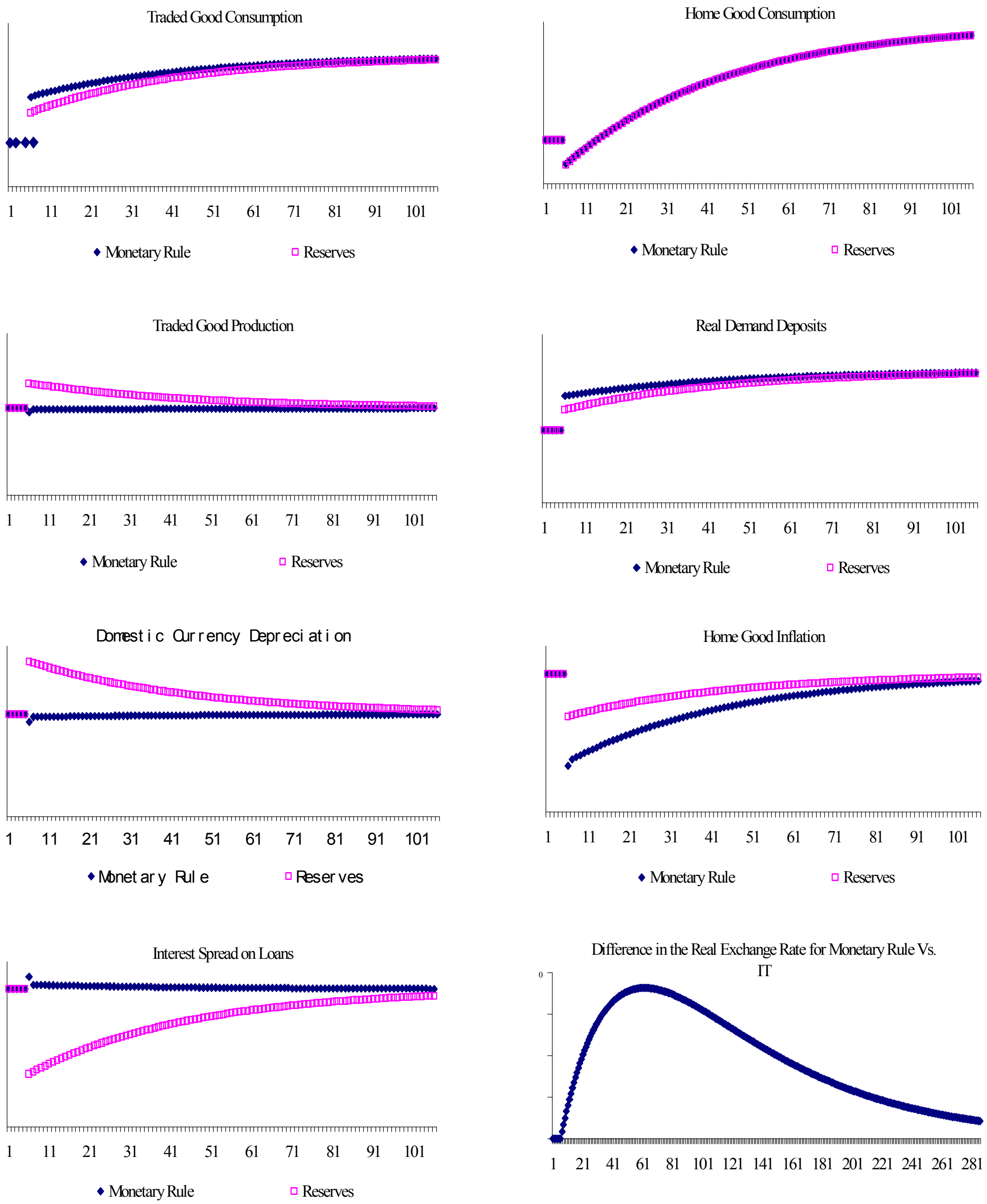

Fig. 12. A Positive Money Demand Shock: Results for the Monetary Rule and the Inflation Targeting Regime with International Reserves.

The result of these actions, with respect to those observed under a monetary rule, is a higher level of production of the traded good (since the opportunity cost of commercial loans is lower) and higher transaction costs (since the opportunity cost of holding real deposits is higher) throughout the transition.

Figure 12 shows the adjustment paths that the different variables of the system follow as they approach steady state. When the results of IT and the monetary rule regime are compared, the higher transaction costs observed under IT offset the higher production of the traded good. In other words the costs introduced by the IT commitment offset the benefits. This situation results in lower levels of consumption for IT with respect to the monetary rule.

2.B. With Interest Rate Policy

When the interest rate is used to influence the depreciation rate of domestic currency in order to comply with the inflation target, important differences arise between IT with interest rates, IT with international reserves and the monetary rule regime. After the initial drop of the nominal exchange rate, due to the increase in α, the monetary authority will decrease the interest rates on government bonds which in turn, by Equations (20) and (21), will affect the interest rate on real deposits. The reduction of the government bond interest rate is such that the level of real money holdings satisfies Equation (28), taking as given the level of international reserves and the determined path for the nominal exchange rate that is consistent with the inflation target.

When the central bank uses the interest rate as the policy tool to comply with the inflation target it introduces additional differences to the opportunity costs of commercial loans and holdings of real deposits, with respect to the two alternative regimes discussed before. Throughout the adjustment process the opportunity cost of holding real deposits is higher since in this case the interest rate on government bonds is lowered, while the opportunity cost on commercial loans decreases for the same reason.

Figure 13 presents the adjustment paths for the variables in the system. When the results of IT with interest rate policy are compared to those obtained for the cases of IT with international reserves and the monetary rule it is possible to observe that the differences caused by the different opportunity costs. Throughout the adjustment process, higher opportunity costs of holding real deposits will result in lower levels for these and therefore higher transaction costs. These transaction costs are higher than those observed for the monetary rule and even higher than the resulting ones from the IT with international reserves regime. The results for the traded good are exactly the opposite, throughout the transition the opportunity cost of commercial loans is lower and therefore production of the traded good is the highest level with respect to the other two regimes. The higher transaction costs and the higher production of the traded good can be interpreted as costs and benefits, respectively, of the IT regime. Once again the costs offset the benefits and the consumption levels for IT with international reserves are the lowest of the three regimes.

D. Summarizing the Results and Welfare Analysis

Looking at figures (9), (10), (12) and (13) is easy to visualize that the worst results for consumption and production are the ones that result from the case where the monetary authorities implement IT using the interest rate on government bonds as the instrument variable. The highest levels of production and consumption are achieved when the central bank follows a monetary rule. In order to formalize these conclusions, some elaboration on welfare comparisons for these regimes is needed.

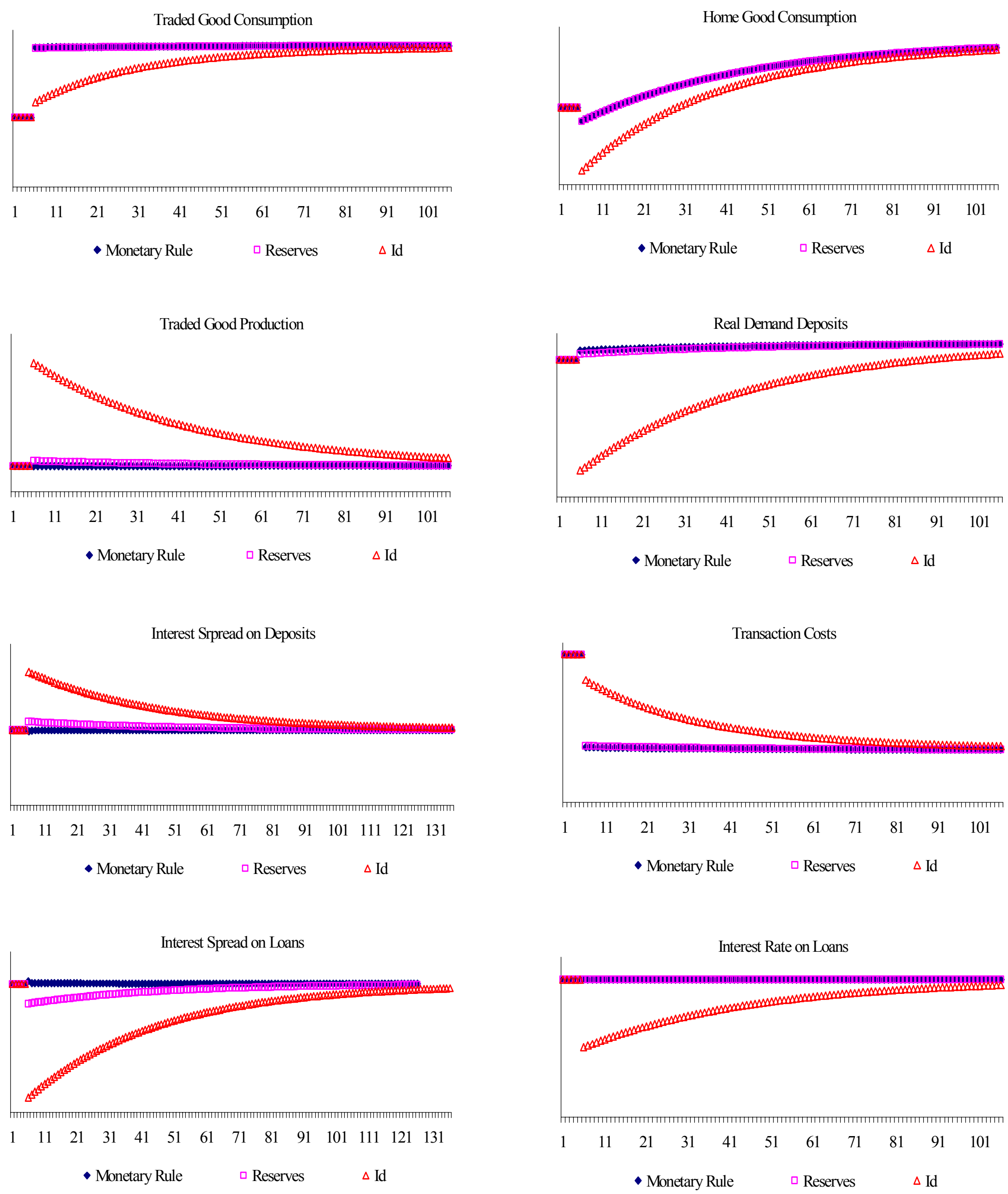

Fig. 13. A Positive Money Demand Shock: Results for the Monetary Rule, the Inflation Targeting Regime with International Reserves and the Inflation Targeting Regime with Interest Rate Policy.

First notice that the steady state equilibrium is the same for the three regimes. The difference in welfare comes from the adjustment period after the shock occurs, that is, after the change in the world interest rate or a money demand shock. To measure welfare I use the utility function for the individuals, which depends on consumption of traded and home goods. I calculate the sum of the present value for the utility levels from the period when the shock occurs onward. These welfare calculations for the case of an increase in the world interest rate show that

U Mon. Rule	>	U IT Reserves	>	U IT interest rate policy
(1.97)		(1.96)		(1.94)

while for the money demand shock, decrease in α, show that

U Mon. Rule	>	U IT Reserves	>	U IT interest rate policy
(1.47)		(1.45)		(1.42)

These results would lead to a misleading conclusion, recommending the dismissal of IT in favor of the monetary rule. But it is important to keep in mind that the results presented here are for an increase in the world interest rate and a positive money demand shock. The results would be the complete opposite if the current analysis were to be replicated for a fall in the world interest rate and a negative money demand shock.

These results indicate that the answers for both questions about which regime is better, IT or a monetary rule, and which IT regime is better, IT with reserves or IT with interest rates, depend on the direction of the shock that is being analyzed. But even though the answers are shock dependent, a recommendation can still be extracted from this analysis: if emerging economies decide to use IT as their monetary policy regime, the optimal policy for the central bank, based on welfare, is to use international reserves to maintain the inflation target when there is an increase in the world interest rate or a positive money demand shock, and interest rate policy should be used when the opposite shocks take place.

One more thing to notice is that after the world interest rate increases or there is a money demand shock the central bank that is implementing either IT regime, will be forced to influence directly or indirectly the nominal exchange rate in order to comply with the inflation target. This behavior is something that should be expected in emerging economies with IT regimes in place and should be differentiated from the standard fear of floating since it is justified by the IT mandate to comply with a specific inflation target.

E. Comment on the Parameters of the Model

The results discussed above are robust to different combinations of all the parameters. But there is one parameter that affects the conclusions. This parameter is θ, the parameter of the production function for the traded good. The magnitude of this parameter changes the conclusions at some extent. The simulations discussed use a high value for θ, which translates into high costs for the direct or indirect intervention under the IT regimes. These costs being reflected in lower production levels of the traded good due to the higher lending spreads (opportunity costs of commercial loans) that firms face when the monetary authority implements IT instead of a monetary rule when there is an increase in the world interest rate or a positive money demand shock. When θ is low enough, the benefits from lower transaction costs under IT, relative to the ones under the monetary rule regime, overwhelm the costs of the intervention and therefore consumption and welfare would be higher for the case where IT is used instead of the monetary rule, and interest rate policy would be the preferred instrument for IT. I have used a high value for θ for my simulations because for emerging economies it is realistic to assume that changes in the interest rate on loans have strong effects in production, while for developed countries these effects could be lower due to greater hedging possibilities available in these countries.

F. Correlation between Inflation and Domestic Currency Depreciation, Pass-Through Effect and Fear of Floating under Inflation Targeting

The previous section showed that under certain circumstances central banks implementing IT will intervene directly or indirectly in the foreign exchange rate market in order to comply with the inflation target. The empirical results of Chapter II showed that when Brazil, Chile and Mexico had some sort of managed floating exchange rate the correlation between inflation and depreciation rates was high and this correlation decreased as they moved towards the implementation of a full fledged IT regime. The comprehensive model setup for the overall inflation rate can be used to replicate the correlation analysis of Chapter II and show that the decrease in correlation after the adoption of IT can be related to the direct or indirect interventions in the foreign exchange rate market. In other words, lower correlation coefficients can be related to fear of floating observed under IT.

1. The Framework for the Analysis

The IT regime presented in Chapter III was for a strict inflation target, therefore the central bank was committed to achieving the point target for the inflation rate at every point in time. In that case the variance of the inflation rate is zero and it is not possible to perform a correlation analysis between the depreciation rate of domestic currency and the overall inflation rate. In order to circumvent this problem, a gradual inflation targeting scheme is introduced into the comprehensive model in order to allow small fluctuations of the overall inflation rate under IT[58]. In reality countries that announce point targets are not expected to meet them exactly but the realized rate should not be consistently above or below the target and a clear trend towards the point target should persist. The analysis shown here will use the same parameters as those

---

[58] The results presented in the previous section are unaffected when the analysis is carried out with the gradual IT rule as long as the gradual rule does not translate into major differences between the point target and the gradual target. For the parameters chosen and the shocks considered the difference between the point target and the gradual target should not be higher than +/-0.50 percentage points. If higher shocks, in magnitude, are introduced this difference can be increased.

used in the previous section, but the overall inflation rate is not forced to be exactly equal to the point target. I assume that the central bank will use the following ad-hoc adjustment rule and that individuals are aware of this rule. For the cases where inflationary pressure arises from a sudden increase of the nominal exchange rate in response to an increase in the world interest rate or a negative money demand shock, the overall inflation rate will be allowed to be above the target for a certain period of time. The difference between the realized inflation rate and the target will decrease as the system returns to the steady state. Initially the margin of error allowed is 0.50 percentage points and the range at every point in time there after is determined by 0.50 ($exp(1)/exp(t)$)[59].

In order to replicate the analysis of Chapter II a regime switch in the model should be considered. That is Brazil, Chile, and Mexico were under a managed fixed regime before adopting the gradual IT regime[60]. The comprehensive model was not used to analyze managed fixed exchange rate regimes. But the inflation setup can be used to analyze this scheme. Recall that the inflation rate of the non-traded good was determined by equation (11), here repeated as Equation (29),

$$\pi_t^H = \hat{E}_t^A + \gamma(\varepsilon_t - \varepsilon^*) \qquad (29)$$

where $\hat{E}_t^A$, the expected currency depreciation rate, was replaced by $\hat{E}_t$ because perfect foresight was assumed. One way to model the managed fixed regime is to assume now that the central bank announces that it will set the currency depreciation around a certain mean but that slight fluctuations will be observed[61]. Then the expected depreciation rate will be the mean depreciation but it will slightly differ, randomly, from the realized one. Then Equations (12) and (13) should be rewritten as follows:

---

[59] As t increases the difference between the allowed inflation rate and the point target decreases.

[60] The managed fixed regime refers to a nominal exchange rate regime in which the monetary authority announces that in average the depreciation rate will be around a certain level but slight fluctuations are observed.

[61] The reason why a strict fixed exchange rate regime is not used for the simulation is the same reason why the a gradual inflation targeting scheme was considered. Under a strict fixed exchange rate regime the rate of depreciation is constant, therefore it is not possible to analyze the correlation between inflation and depreciation.

$$\hat{\varepsilon}_t = (\hat{E}_t - \hat{E}_t^A) + \gamma(\varepsilon^* - \varepsilon_t) \qquad (30)$$

$$\Pi_t = \hat{E}_t^A + \rho(\hat{E}_t - \hat{E}_t^A) + \gamma(1-\rho)(\varepsilon_t - \varepsilon^*) \qquad (31).$$

Notice that these equations are the same as (12) and (13) when perfect foresight is assumed. The slight random differences that will exist between the realized and the expected depreciation rates will introduce, once again, fluctuations that will be captured by the correlation analysis. The nice result of modeling the managed fixed regime in this way is that the real exchange rate will tend to be around the steady state and then at a certain point in time a regime switch can be introduced. That is, at time *t* the central bank can announce that it will follow an IT regime with a floating exchange rate. Once this announcement is made the model goes back to the perfect foresight equations of Chapter III.

2. Nominal Exchange Rate Movements and the Correlation between Inflation and Domestic Currency Depreciation under Inflation Targeting

The regime switch considered here is one that resembles the case of Brazil but the intuitive result applies for the cases of Chile and Mexico. The central bank will abandon the managed fixed regime right after the world interest rate increases or the money demand shock takes place. This could be the result of not having the international reserves needed to satisfy the asset reallocation of the individuals or because the central bank is not willing to defend the currency with interest rate because of fiscal implications. Then they let the exchange rate adjust and adopt an IT regime.

The shock analyzed here is that of an unexpected once and for all increase in the world interest rate at time *t*, similar to the one analyzed in the previous section. Before time *t* the central bank was enforcing a managed fixed regime, as described above, with rates of currency depreciation with in the range of six percent +/-0.50 percentage points. At time *t* the shock takes place. The central bank lets the exchange rate adjust and adopts a gradual inflation target of six percent with a decreasing range of +/-0.50 percentage points[62]. The previous section showed that the central bank can use the interest rate or the international reserves as the monetary policy tool used to maintain the nominal exchange rate at the level that is consistent with the inflation target. Therefore the depreciation rate will be lower than the one that would have been obtained if a flexible exchange rate with a monetary rule had been in place.

Figure 14 presents the simulated paths for the overall inflation rate and the depreciation of the domestic currency. Before time *t* the system is under the managed fixed regime described above and after *t* is under the gradual IT regime. Table IV presents the rolling and increasing windows correlation coefficients calculated for the data in the graph. Notice that the values in the table match the results presented for Brazil, Chile, and Mexico in Chapter II. Before IT is adopted there is a highly positive linear relation between the two variables, while after the adoption the correlation decreases and even becomes negative.

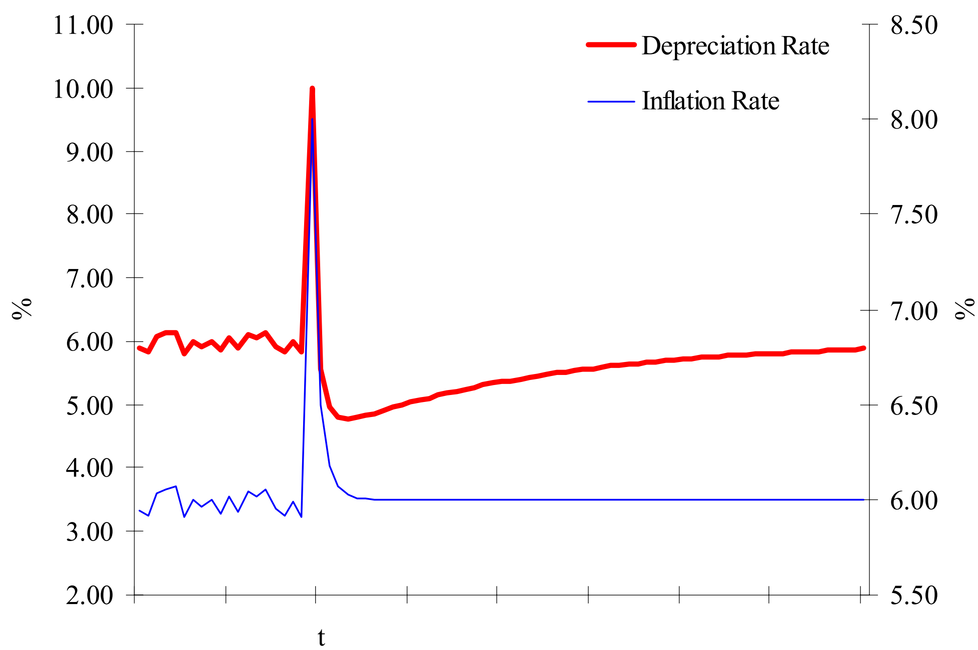

Fig. 14. Simulated Data for the Inflation and Depreciation Rates.

[62] As explained before the range of +/ - 0.50 decreases as time passes by $0.50(exp(1)/exp(t))$.

Table IV. Simulated Correlation between the Inflation and Depreciation Rates for a Regime Switch from Fixed Exchange Rate to an Inflation Targeting Regime

Period	Increasing Windows	Period	Rolling Windows
$t - 30, t$	0.9919	$t - 30, t$	0.9959
$t - 30, t + 15$	0.7608	$t - 15, t + 15$	0.8119
$t - 30, t + 30$	0.7392	$t, t + 30$	0.8142
$t - 30, t + 30$	0.7352	$t + 15, t + 45$	-0.5278
$t - 30, t + 60$	0.7348	$t + 30, t + 60$	-0.4515

3. Nominal Exchange Rate Pass-Through Effect into Inflation under Inflation Targeting

In order to assess if the lower pass-through effects observed recently in Brazil, Chile, and Mexico is related to the adoption of IT, it is possible to perform a comparison between the pass-through effect that would be observed after a sudden nominal exchange rate movement under a managed fixed regime and under IT. The pass-through effect can be measured by looking at the ratio of the overall price level and the nominal exchange rate under each regime. This ratio illustrates the share of the domestic currency depreciation that translates into inflation.

Appendix 3 shows a simple analytical framework that is used here to compute the ratio described above. This framework shares the same characteristics of the inflation framework described in chapter III, but for simplicity it is a discrete time framework. The two regimes considered are a managed fixed exchange rate and an strict IT regime. In the first case the central bank sets the rate of currency depreciation at three percent. While in the second the central bank sets the overall inflation target rate also at three percent. The key feature of the managed fixed regime is that after a shock hits the nominal exchange rate, the price level will be allowed to adjust as necessary as the system returns to equilibrium. For the IT regime, once the nominal exchange rate shock takes place, the monetary authority will set a path for the domestic currency depreciation that is consistent with the inflation target. This intervention in the foreign exchange rate market is needed to offset the non-traded good inflation rate in such a way that the combination of the depreciation rate and the non-traded good inflation rate results in the overall inflation target.

The nominal exchange rate shock under the managed fixed regime corresponds to a scenario in which the central bank devalues the currency by twenty percent and then fixes the rate of devaluation at three percent. For the IT regime, as it was presented in section B in this chapter, the sudden jump in the nominal exchange rate could be the result of an increase in the world interest rate while the central bank is pursuing an inflation target of three percent. For both cases the shock takes place at time τ. Figure 15 presents the simulated data for the nominal exchange rate, the non-traded good price level and the overall price level[63].

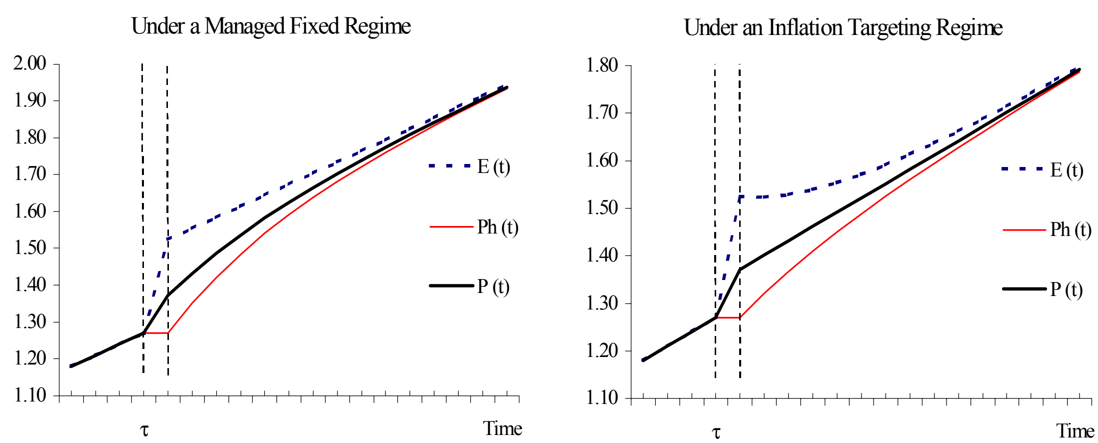

Fig. 15. Simulated Data for the Nominal Exchange Rate (E), Non-Traded Good Price Level (Ph), and Overall Price Level (P).

The vertical dotted lines in both graphs of Figure 15 represent time τ. At this point in time the nominal exchange rate jumps to the level determined by the shock, the overall price level also increases to a level determined by the share of the traded-good

[63] The corresponding values for the parameters of the simulation are 0.20 for the parameter that determines the degree of sluggishness of the non-traded good price, γ, 0.40 for the share of the traded good in the overall price index, ρ, and an initial shock to the nominal exchange rate of 20 percent. For the inflation target the central bank sets a target of three percent for the overall inflation rate, while in the case of the managed fixed regime the central banks sets a rate of devaluation of three percent.

price in the overall price index, and, finally, the non-traded good price remains at the original level since it responds sluggishly, in other words it can not increase immediately.

As mentioned above, the ratio that illustrates the magnitude of the pass-through effect under each regime is the ratio between the overall price level and the nominal exchange rate. Let r_1 denote the ratio between the overall price level and the nominal exchange rate for the managed fixed regime, and r_2 represent the ratio for the case of the IT regime. Then it is possible to assess if the pass-through effect is greater in one of the regimes by looking at $R = r_1 / r_2$. If the pass-through effect is higher under a managed regime, then R should be greater than one. Figure 16 shows the results for R.

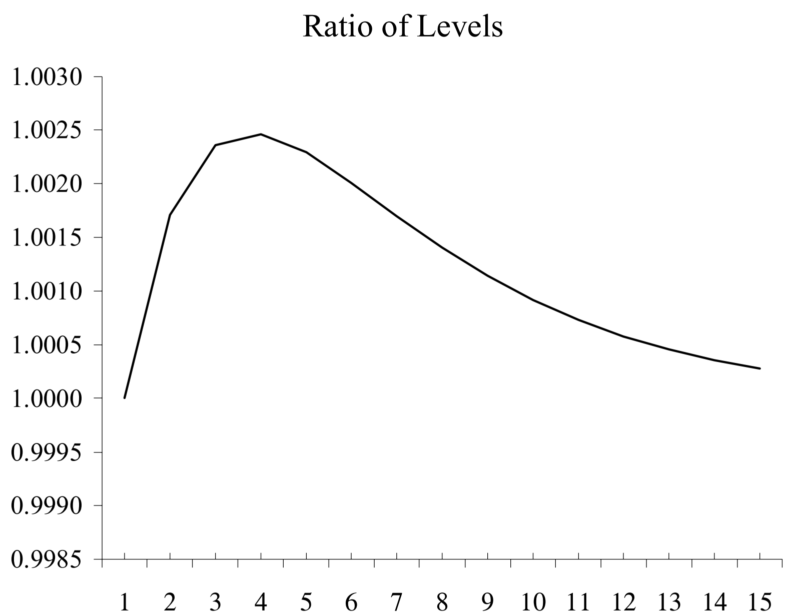

Fig. 16. Ratio between the Pass-Through Effect under a Managed Fixed and the Pass-through Effect under an Inflation Targeting Regime.

The results presented in Figure 16 indicate that a lower pass-through effect is observed under IT. Appendix 3 shows that this result always holds and explains that the magnitude of the difference between the pass-through effects of both regimes depends on the share of traded goods in the overall price level, the degree of the non-traded goods price sluggishness and the magnitude of the initial shock to the nominal exchange rate. The higher the share of the traded good in the overall price level, the lower is the difference in pass-through effect between the two regimes. The degree of the sluggishness of the non-traded good affects the speed at which both pass-through effects converge to one, the less sluggish non-traded good price is the faster the convergence occurs. Finally the greater the initial change in the nominal exchange rate the greater will be the pass-through effect under the managed fixed regime with respect to the IT regime.

The results of the simulations presented in sections 2 and 3 support the arguments that fear of floating practices in small open economies that adopted IT result in lower correlation between inflation and domestic currency depreciation and these practices can be related also to the lower exchange rate pass-through effects into inflation that have been observed recently. The direct or indirect interventions in the foreign exchange rate market result in lower rates of currency depreciation while the overall inflation is above the target. This situation translates into lower or even negative correlation coefficients in contrast to those observed for the period of time in which a managed float was in place.

CHAPTER V

CONCLUSIONS

In accordance with the current discussion of IT in emerging economies the objectives of this dissertation were to analyze the differences that emerge from using different monetary policy instruments to keep the overall inflation rate consistent with the inflation target and to investigate also the possible relationship between the adoption of IT in emerging economies, the declining correlation between inflation and depreciation, and the lower pass-through effects observed recently in these countries.

The relevance of these objectives comes from the fact that previous studies have looked at the advantages and disadvantages of adopting IT instead of the alternative monetary rule regime, but so far no one has looked at the consequences of implementing IT by controlling the overall inflation rate with different policy instruments. Regarding the pass-through effect, the literature has shown that this effect has recently been decreasing in emerging economies and therefore the effects of domestic currency depreciation on inflation may no longer be an issue for emerging economies that adopted IT. The explanations offered so far for these results have not established a clear link between these results and the adoption of IT even though the reasoning used by some previous studies explicitly argues that central banks implementing IT may intervene, directly or indirectly, in the foreign exchange rate market (fear of floating) in order to smooth or control the effects of sudden exchange rate movements on the overall inflation rate. If such interventions do take place, the monetary authorities counteract sudden exchange rate movements and therefore the direct relation between inflation and currency depreciation breaks down. It is not the case then that the pass-through effect is no longer an issue, in fact it is still an issue, but it may no longer be observable by directly analyzing inflation and exchange rate data.

The objectives pursued in this dissertation are clearly related. The fact that fear of floating observed in emerging economies brings about the question of what economic consequences emerge from using different instruments to intervene directly or indirectly in the foreign exchange rate market as central banks try to keep the overall inflation rate consistent with the target.

The empirical results obtained in Chapter II show that the correlation between inflation and depreciation of domestic currency, as well as the exchange rate pass-through effect into inflation, has been decreasing over the past few years for Brazil, Chile, and Mexico. The results show also that these declines coincide with the adoption of IT. For the same period of time evidence of fear of floating is found for these economies. The simulation presented in Chapter IV illustrates that it is possible to relate the declines in the correlation between inflation and depreciation, and the lower pass-through effect to the fear of floating observed in emerging economies that adopt IT. This simulation matches the empirical results for the lower correlation levels between inflation and currency depreciation observed in the data and the lower magnitude of the pass-through effect. These results offer an alternative explanation for the declining pass-through effect observed recently, one that relates these declines directly to the adoption of IT and suggest also that the lower pass-through levels observed recently in the data may not be sufficient evidence to argue that the effects of domestic currency depreciation on inflation may no longer be an issue for emerging economies that adopted IT. In fact the fear of floating evidence points in the opposite direction, these effects are so strong that if they are ignored it would not be possible to maintain the inflation rate consistent with the target.

The evidence for fear of floating emerges from the analysis of the variability of the nominal exchange rate, international reserves and the nominal interest rate. The results presented in Chapter II can be used to argue that fear of floating in Mexico is characterized by the heavy usage of the interest rate as the policy instrument used to indirectly affect the nominal exchange rate. Fear of floating in Brazil however is characterized by the heavy usage of international reserve to keep the depreciation rate consistent with the inflation target. In other words two emerging economies that adopted IT use two different policy instruments to comply with their inflation target.

This is basically the motivation for the comprehensive model described in Chapter III and the simulations presented in Chapter IV, where the questions about the differences that arise from using one instrument or the other to comply with the inflation target, and the advantages and disadvantages that IT has over the monetary rule are addressed using this comprehensive model.

The results obtained indicate that the answers for both questions –about which regime is better, IT or a monetary rule, and which IT regime is better, IT with reserves or IT with interest rates – depend on the direction of the shock that is being analyzed. Despite this, there is a recommendation that still can be extracted from this analysis: if emerging economies decide to use IT as their monetary policy regime the optimal policy for the central bank, based on welfare, is to use international reserves to maintain the inflation target when there is an increase in the world interest rate or a positive money demand shock, and interest rate policy should be used when the opposite shocks take place.

One more thing to notice is that after the world interest rate increases or there is a money demand shock, the central bank that is implementing an IT regime, no matter which instrument is used, will be forced to directly or indirectly influence the nominal exchange rate in order to comply with the inflation target. This behavior is something that should be expected in emerging economies with IT regimes in place and should be differentiated from the standard fear of floating since it is justified by the IT mandate to comply with a specific inflation target.

REFERENCES

Agénor, Pierre-Richard. "Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting." in Norman Loayza and Raimundo Soto, eds., *Inflation Targeting: Design, Performance, Challenges.* Santiago de Chile, Central Bank of Chile, 2002, pp. 79 – 169.

Auernheimer, Leonardo and George, Susan M. "Bad Dreams Under Alternative Anchors: Are the Consequences Different?" International Monetary Fund Working Paper WP/00/20, February 2000.

Banco de México. "Exposición Sobre la Política Monetaria para 1998." Banco de México, www.banxico.org.mx, 1998.

___________. "Exposición Sobre la Política Monetaria para 1999." Banco de México, www.banxico.org.mx, 1999.

Banco Central do Brasil. "Annual Report 2001." Banco Central do Brasil, www.bcb.gov.br, 2001.

Banco Central de Chile. "Informe de Política Monetaria 2001." Banco Central de Chile, www.bcentral.cl, 2001.

Baqueiro, Armando, Diaz de Leon, Alejandro, and Torres, Alberto. "Fear of Floating or Fear of Inflation? The Role of the Exchange Rate Pass-Through." Banco de México, Documentos de Investigación No.2003-02, January 2003.

Bernanke, Ben S., Laubach, Thomas, Mishkin, Frederick S., and Posen Adam S. "Inflation Targeting." Princeton, NJ: Princeton University Press, 1999.

Borensztein, Eduardo and De Gregorio, José. "Devaluation and Inflation after Currency Crises." Unpublished manuscript, Universidad de Chile, February 1999.

Calvo, Guillermo and Reinhart, Carmen. "Fear of Floating." National Bureau of Economic Research (Cambridge, MA) Working Paper 7993, 2000.

___________."Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economics*, September 1983, 12(3), pp.383-398.

___________."Capital Markets and the Exchange rate, with Special Reference to the Dollarization Debate in Latin America." Unpublished manuscript, University of Maryland, College Park, April, 2000.

__________, and Vegh, Carlos. "Fighting Inflation with High Interest Rates: The Small Open Economy Case Under Flexible Prices." *Journal of Money, Credit and Banking*, February 1995, 27(1), pp. 49-66.

Campa, Jose Manuel and Linda S. Goldberg. "Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?" National Bureau of Economic Research (Cambridge, MA) Working Paper 8934, 2002.

Carstens, Agustin and Werner, Alejandro. "Mexico's Monetary Policy Framework Under a Floating Exchange Rate Regime." Banco de México, Documentos de Investigacion, No. 9905, May 1999.

Choudhri, Ehsan and Hakura, Dalia. "Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?", International Monetary Fund Working Paper WP/01/194, 2001.

Christoffersen, Peter F. and Wescott, Robert F. "Is Poland Ready for Inflation Targeting?." International Monetary Fund Working Paper WP/99/41, 1999.

Corbo, Vittorio and Schmidt-Hebbel, Klaus. "Inflation Targeting in Latin America." Central Bank of Chile Working Papers, No. 105, September 2001.

Drazen, Allan. "Interest Rate Defense Against Speculative Attacks as a Signal: A Primer." Unpublished manuscript, University of Maryland, College Park, February 2001.

Eichengreen, Barry. "Can Emerging Markets Float? Should They Inflation Target?" Unpublished manuscript, University of California, Berkeley, February 2002.

__________, Masson, Paul, Savastano, Miguel, and Sharma, Sunil. "Transition Strategies and Nominal Anchors on the Road to Greater Exchange Rate Flexibility." Princeton Essays in International Finance, No.213, April 1999.

Flood, Robert P. and Jeanne, Olivier. "An Interest Rate Defense of a Fixed Exchange Rate." International Monetary Fund Working Paper WP/00/159, October 2000.

Gali, Jordi and Monacelli, Tommaso. "Monetary Policy and Exchange Rate Volatility in a Small Open Economy." National Bureau of Economic Research (Cambridge, MA) Working Paper 8905, 2002.

Garcia, Carlos J. and Restrepo, Jorge E. "Price Inflation and Exchange Rate Pass-Through in Chile." Central Bank of Chile Working Papers, No 128, November 2001.

Goldfajn, Illan and Ribeiro da Costa Werlang, Sergio. " The Pass-Through from Depreciation to Inflation: A Panel Study." Banco Central Do Brasil Working Papers Series, N.5, September 2000.

__________, and Valdes, Rodrigo. " The Aftermath of Appreciations." *Quarterly Journal of Economics*, February 1999, 114(1), pp. 229-262.

Kumhof, Michael. "Inflation Targeting Under Imperfect Credibility." Unpublished manuscript, Stanford University, Stanford, CA, April 2000.

__________." A Critical View of Inflation Targeting: Crises, Limited Sustainability, and Aggregate Shocks." Central Bank of Chile Working Papers, No. 127, November 2001.

__________, Li, Shujing, and Yan, Isabel. "Balance of Payment Crises under Inflation Targeting." Unpublished manuscript, Stanford University, Stanford, CA, May 2001.

Lahiri, Amartya and Vegh, Carlos. "Living with the Fear of Floating: An Optimal Policy Perspective." National Bureau of Economic Research (Cambridge, MA) Working Paper No.8391, 2001.

Leiderman, Leonardo and Hadas, Bar-Or. "Monetary Policy Rules and Transmission Mechanisms under Inflation Targeting in Israel." Unpublished working paper, Bank of Israel, 2000.

Masson, Paul R., Savastano, Miguel A., and Sharma Sunil. "The Scope for Inflation Targeting in Developing Countries." International Monetary Fund Working Paper WP/97/130, 1997.

Mishkin, Frederick S. "Inflation Targeting in Emerging Countries." *American Economic Review*, May 2000, 90(2), 105 – 109.

__________. "The Transmission Mechanism and the Role of Asset Prices in Monetary Policy." National Bureau of Economic Research (Cambridge, MA) Working Paper No. 8617, 2001.

__________, and Schmidt-Hebbel, Klaus. "One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?" National Bureau of Economic Research (Cambridge, MA) Working Paper No. 8397, 2001.

__________, and Savastano, Miguel A. "Monetary Policy Strategies for Latin America." *Journal of Development Economics*, December 2001, 66(2), 415 – 444.

Parrado, Eric and Velasco, Andres. "Alternative Monetary Rules in the Open-Economy: A Welfare-Based Approach." Central Bank of Chile Working Papers No. 129, November 2001.

Reinhart, Carmen. "The Mirage of Floating Exchange Rates." *American Economic Review*, May 2000, 90(2), 65-70.

Schmidt-Hebbel, Klaus and Werner, Alejandro. "Inflation Targeting in Brazil, Chile, and Mexico: Performance, Credibility, and the Exchange Rate." Central Bank of Chile Working Papers, No. 171, July 2002.

Svensson, Lars E. "Open Economy Inflation Targeting." *Journal of International Economics*, February 2000, 50(1), 155 - 183.

Taylor, John. "Low Inflation, Pass-Through and the Pricing Power of Firms." *European Economic Review*, June 2000, 44(7), pp.1389-1408.

Werner, Alejandro. "El Efecto sobre el Tipo de Cambio y las Tasas de Interés de las Intervenciones en el Mercado Cambiario y del Proceso de Esterilización." Banco de México, Documentos de Investigación, Diciembre,1997.

__________, and Milo, Alexis. "Acumulación de Reservas Internacionales a través de la Venta de Opciones: el Caso de México." Banco de México Documentos de Investigación, No. 9801, Abril 1998.

APPENDIX 1

Data Sources and Description

	Brazil	Chile	Mexico
CPI data	Broad National Consumer Price Index (IPCA) reported by the Central Bank (www.bcb.gov.br)	Consumer Price Index (CPI) reported by the Central Bank (www.bcentral.cl)	Consumer Price Index (CPI) reported by the Central Bank (www.banxico.org.mx)
Inflation Targets	Different Annual Monetary Policy Reports (www.bcb.gov.br)	Different Annual Monetary Policy Reports (www.bcentral.cl)	Different Annual Monetary Policy Reports (www.banxico.org.mx)
Nominal Exchange Rate	Average Nominal Exchange Rate reported by the Central Bank (www.bcb.gov.br)	Average Nominal Exchange Rate reported by the Central Bank (www.bcentral.cl)	Average Nominal Exchange Rate reported by the Central Bank (www.banxico.org.mx)
Real Exchange Rate	Real Exchange Rate calculated using the broad national consumer price index for non-tradable goods and tradable goods both reported by the	Real Exchange Rate reported by the Central Bank (www.bcentral.cl)	Real Exchange Rate reported by the Central Bank (www.banxico.org.mx)
Industrial Production Index	Industrial Production Index reported by the Central Bank (www.bcb.gov.br)	Industrial Production Index reported by the Central Bank (www.bcentral.cl)	Industrial Production Index reported by the Central Bank (www.banxico.org.mx)
Controlled Prices	Broad National Consumer Price Index (IPCA) - Supervised Prices reported by the Central Bank (www.bcb.gov.br)	NA	Administired Prices Index reported by the Central Bank (www.banxico.org.mx)
Wage	Average Earnings reported by the Central Bank (www.bcb.gov.br)	Real Labor Cost Index reported by the Central Bank (www.bcentral.cl)	Minimum Wage Index reported by the Central Bank (www.banxico.org.mx)
M1	M1 reported by the Central Bank (www.bcb.gov.br)	M1 index reported by the Central Bank (www.bcentral.cl)	M1 reported by the Central Bank (www.banxico.org.mx)
International Reserves	International Reserves - Total reported by the Central Bank (www.bcb.gov.br)	International Reserves - Reserve Assets (New Series) reported by the Central Bank (www.bcentral.cl)	International Reserves reported by the Central Bank (www.banxico.org.mx)
Nominal Interest Rate	Interest Rate - Selic reported by the Central Bank (www.bcb.gov.br)	Monetary Policy Nominal Interest Rate reported by the Central Bank (www.bcentral.cl)	Cetes 28 days reported by the Central Bank (www.banxico.org.mx)

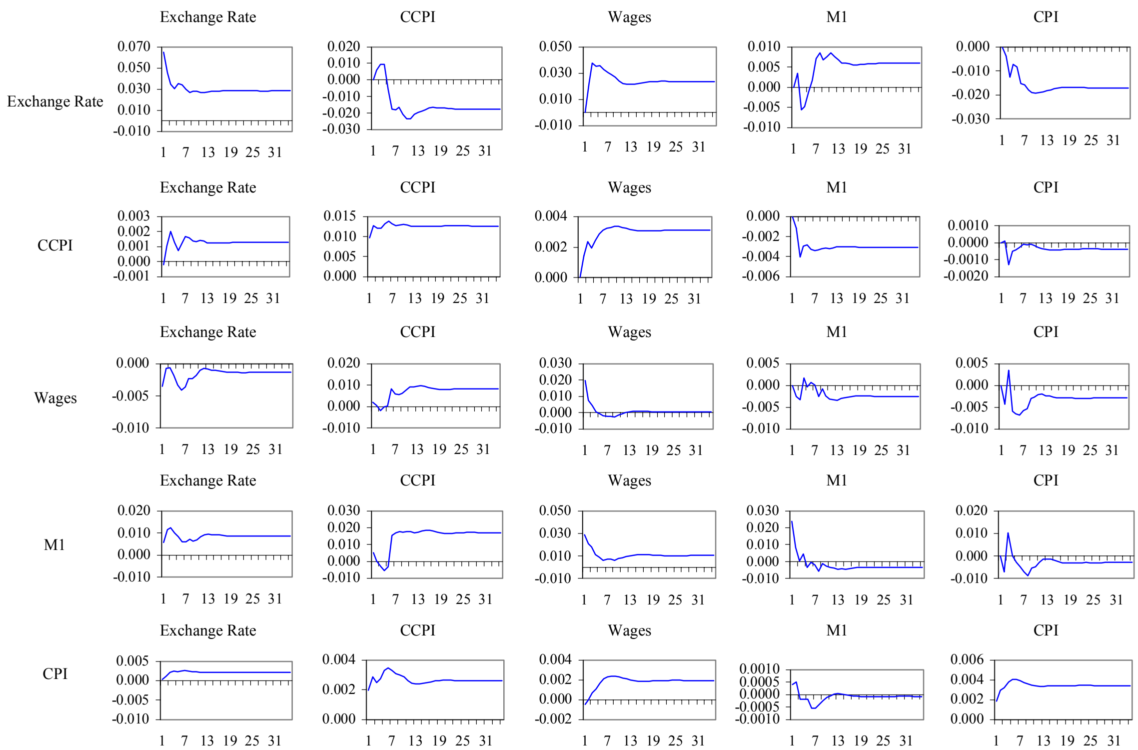

Fig. A.1.1 Impulse Response Functions for Vector Error Correction Model for Brazil

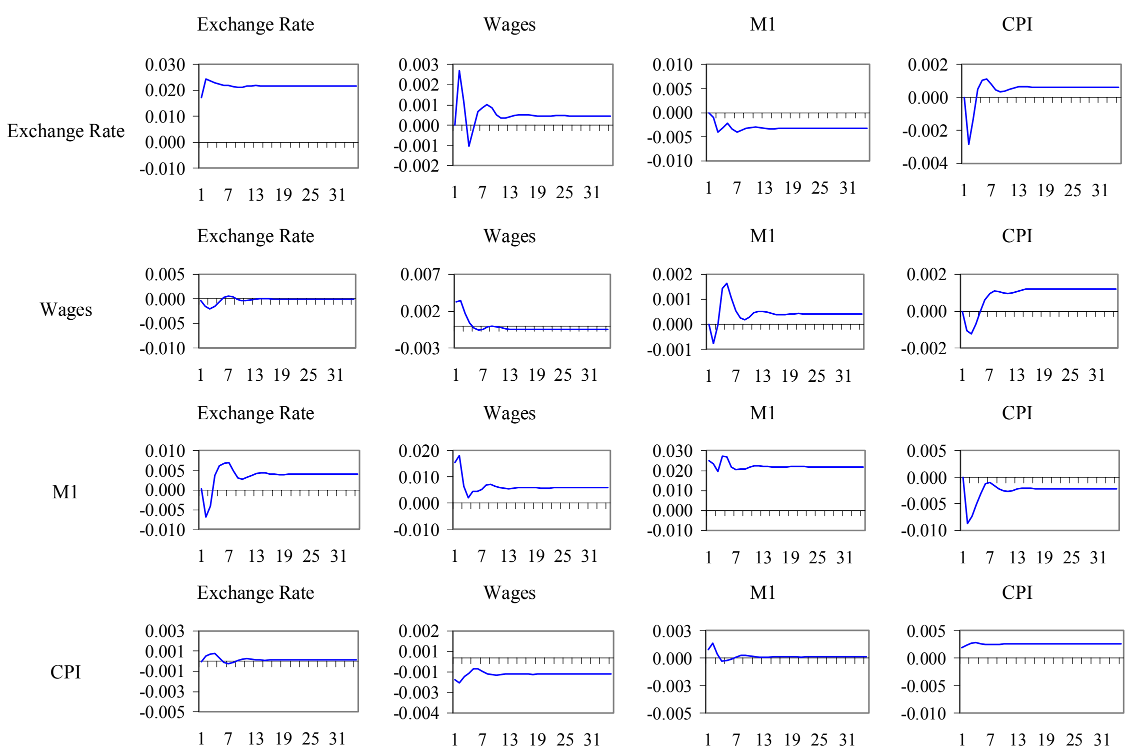

Fig. A.1.2 Impulse Response Functions for Vector Error Correction Model for Chile

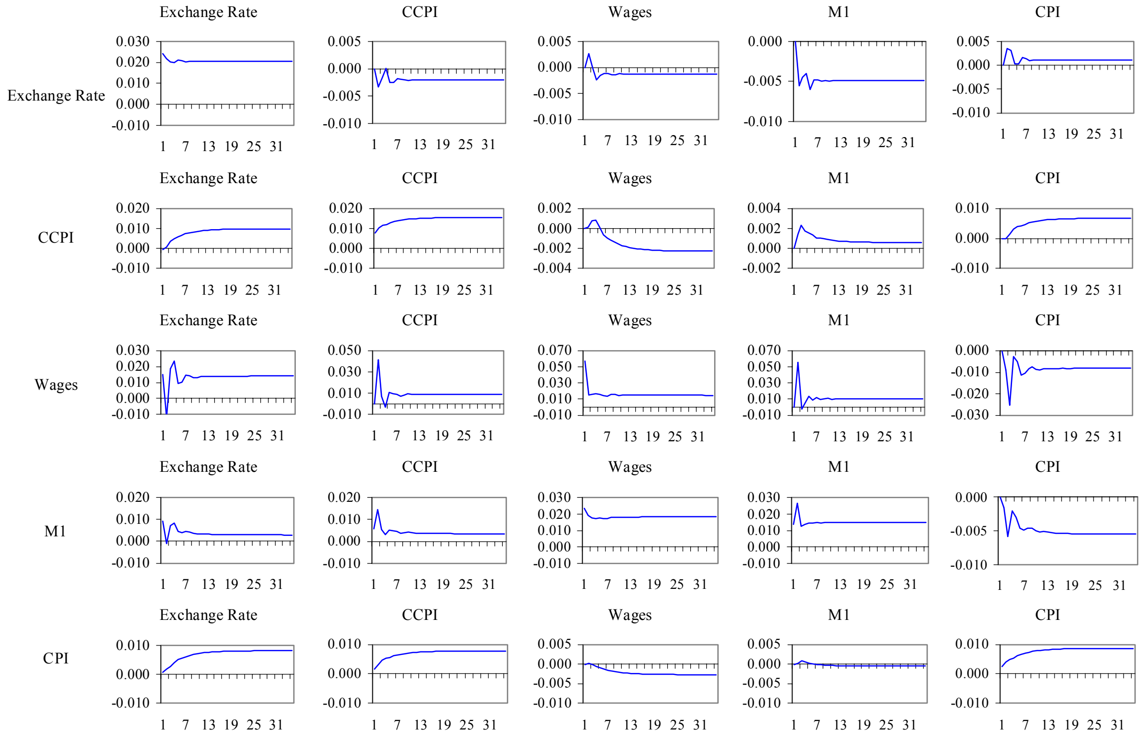

Fig. A.1.3 Impulse Response Functions for Vector Error Correction Model for Mexico

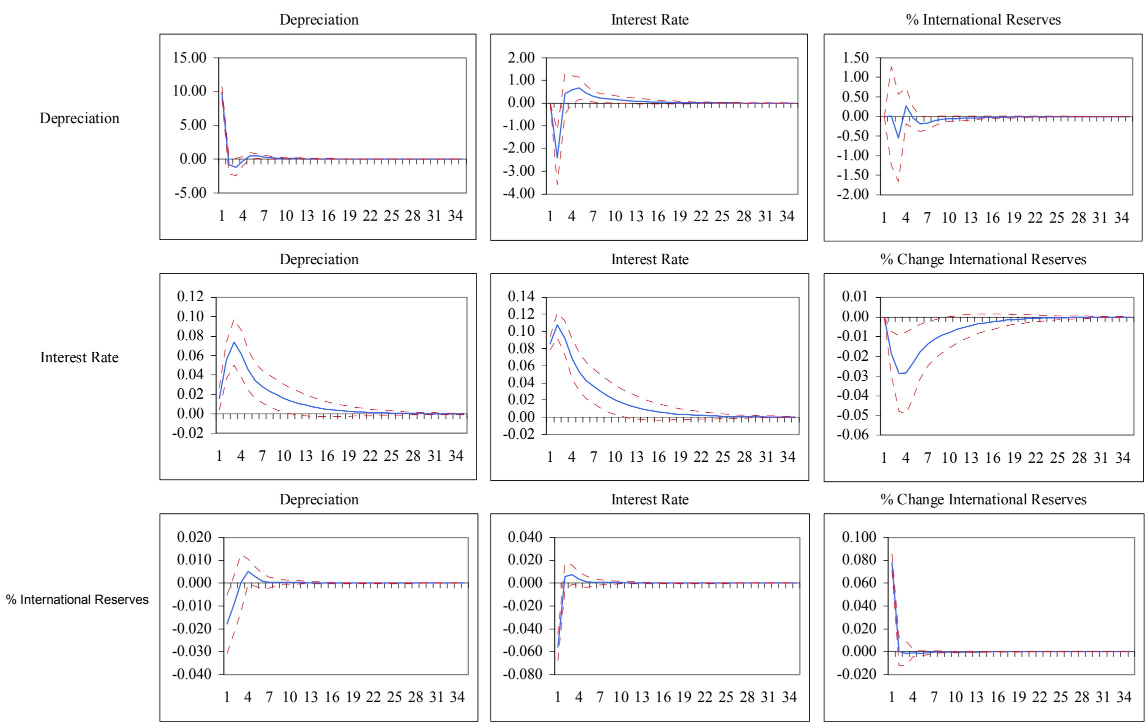

Fig. A.1.4 Impulse Response Functions for Vector Error Correction Model For Brazil

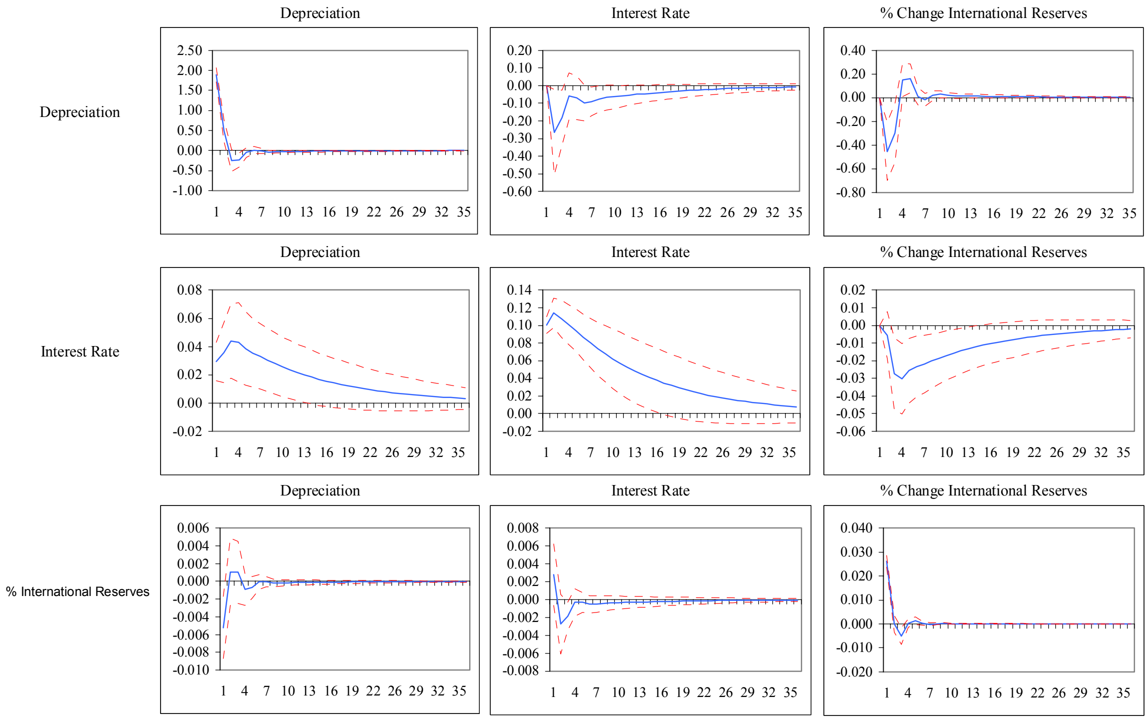

Fig. A.1.5 Impulse Response Functions for Vector Error Correction Model for Chile

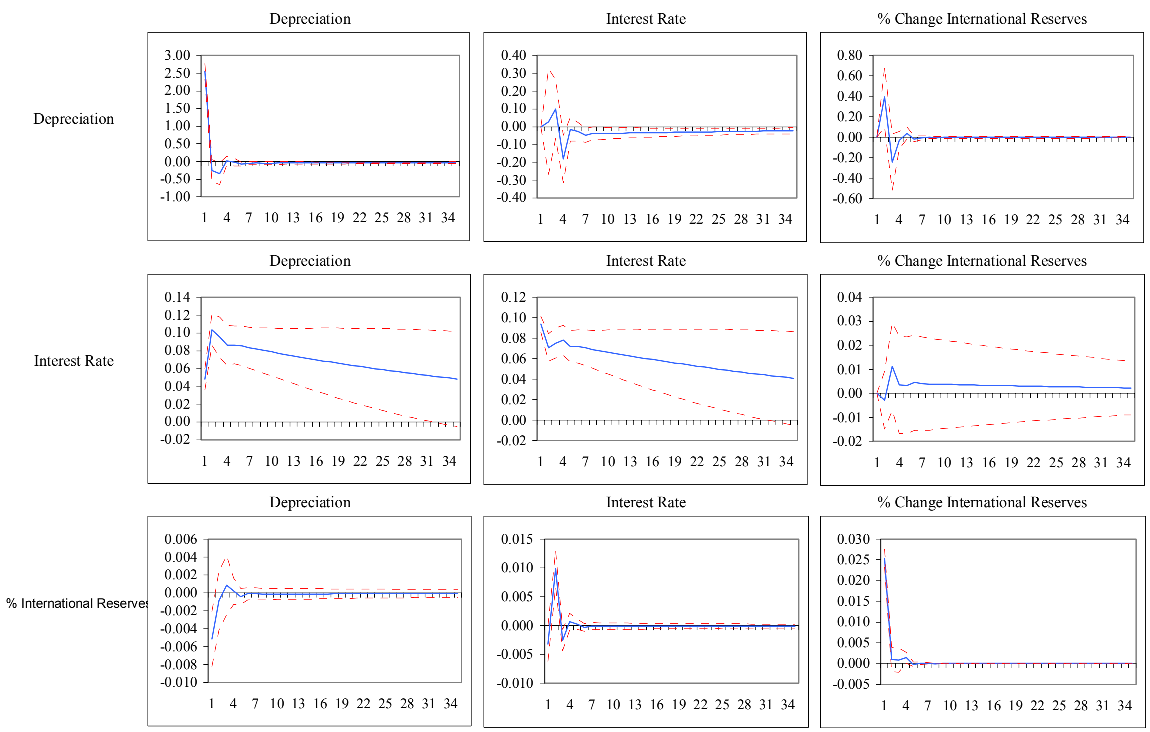

Fig. A.1.6 Impulse Response Functions for Vector Error Correction Model for Mexico

Table A.1.I Increasing Windows Estimated Coefficients for Equation (2) for Brazil

One month Accumulated Rates	1998	1999	2000	2001	2002
C	-0.75	-0.53	-0.19	-0.11	-0.11
S.E.	0.94	0.73	0.57	0.48	0.43
t-stat	-0.80	-0.72	-0.33	-0.23	-0.26
Depr.	0.03	0.01	-0.002	-0.003	-0.004
S.E.	0.14	0.07	0.06	0.05	0.05
t-stat	0.24	0.14	-0.03	-0.05	-0.09
IPI	0.01	0.00	-0.01	-0.01	-0.01
S.E.	0.09	0.07	0.06	0.06	0.05
t-stat	0.09	0.00	-0.15	-0.13	-0.18
Real E	-0.41	-0.37	-0.30	-0.28	-0.28
S.E.	0.22	0.18	0.15	0.13	0.12
t-stat	-1.88	-2.03	-2.02	-2.11	-2.24
Ini. Inf.	1.00	1.01	1.00	0.99	0.99
S.E.	0.13	0.08	0.07	0.06	0.06
t-stat	7.43	12.98	14.62	15.82	17.33

Three-months Accumulated Rates	1998	1999	2000	2001	2002
C	6.06	0.48	-0.09	-0.79	-1.10
S.E.	2.41	2.64	2.07	1.71	1.56
t-stat	2.50	0.22	-0.05	-0.47	-0.70
Depr.	1.01	0.90	0.88	0.88	0.86
S.E.	0.04	0.05	0.05	0.04	0.04
t-stat	25.70	18.60	18.60	19.72	19.93
IPI	-0.13	-0.10	-0.09	-0.08	-0.06
S.E.	0.21	0.24	0.22	0.20	0.19
t-stat	-0.63	-0.43	-0.40	-0.40	-0.34
Real E	1.59	0.59	0.46	0.34	0.29
S.E.	0.57	0.70	0.58	0.51	0.49
t-stat	2.77	0.88	0.79	0.66	0.58
Ini. Inf.	-0.14	0.03	0.06	0.08	0.09
S.E.	0.06	0.07	0.06	0.05	0.05
t-stat	-2.29	0.45	1.02	1.40	1.80

Six-months Accumulated Rates	1998	1999	2000	2001	2002
C	-6.7	-10.6	-5.90	-4.74	-5.49
S.E.	7.73	6.36	4.69	3.68	3.25
t-stat	-0.9	-1.68	-1.23	-1.30	-1.69
Depr.	1.00	0.99	0.99	0.99	0.99
S.E.	0.02	0.02	0.02	0.02	0.02
t-stat	44.3	43.36	44.87	47.60	49.75
IPI	1.60	1.07	0.80	0.68	0.73
S.E.	0.57	0.52	0.45	0.40	0.37
t-stat	2.78	2.06	1.76	1.67	1.95
Real E	-2.80	-3.13	-1.84	-1.43	-1.57
S.E.	1.81	1.68	1.33	1.10	1.03
t-stat	-1.55	-1.87	-1.36	-1.31	-1.53
Ini. Inf.	0.05	0.06	0.04	0.03	0.04
S.E.	0.04	0.04	0.03	0.03	0.03
t-stat	1.13	1.66	1.22	1.18	1.43

Nine Months Accumulated Rates	1998	1999	2000	2001	2002
C	-12.46	-19.8	-13.8	-8.30	-9.26
S.E.	23.17	16.5	11.7	8.57	7.30
t-stat	-0.54	-1.22	-1.16	-0.98	-1.27
Depr.	1.00	1.00	1.00	0.99	0.99
S.E.	0.02	0.02	0.02	0.02	0.01
t-stat	49.55	54.3	58.4	62.6	66.7
IPI	0.49	0.30	0.05	-0.03	0.05
S.E.	1.51	1.22	1.02	0.91	0.82
t-stat	0.33	0.25	0.05	-0.03	0.06
Real E	-5.33	-6.36	-4.48	-2.93	-3.20
S.E.	5.32	4.33	3.36	2.56	2.33
t-stat	-1.00	-1.47	-1.31	-1.15	-1.38
Ini. Inf.	0.04	0.05	0.04	0.02	0.03
S.E.	0.05	0.04	0.03	0.02	0.02
t-stat	0.85	1.38	1.24	1.07	1.29

Twelve-months Accumulated Rates	1998	1999	2000	2001	2002
C	-33.89	-37.14	-33.62	-16.68	-14.9
S.E.	60.63	41.45	29.58	20.43	16.8
t-stat	-0.55	-0.91	-1.12	-0.82	-0.88
Depr.	1.00	1.00	1.00	0.99	0.99
S.E.	0.02	0.02	0.02	0.02	0.01
t-stat	48.88	54.99	60.42	65.01	69.5
IPI	-4.78	-3.35	-3.05	-2.90	-2.73
S.E.	3.62	2.86	2.36	2.08	1.87
t-stat	-1.32	-1.17	-1.30	-1.39	-1.46
Real E	-11.44	-12.53	-11.12	-6.63	-6.21
S.E.	13.38	10.55	8.40	6.04	5.33
t-stat	-0.85	-1.19	-1.31	-1.10	-1.17
Ini. Inf.	0.04	0.05	0.04	0.03	0.02
S.E.	0.05	0.04	0.03	0.02	0.02
t-stat	0.82	1.18	1.34	1.14	1.21

Notes:

C: Constant.

Depr: Accumulated depreciation over the different time periods.

IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.

Ini. Inf.: Initial Inflation.

Table A.1.II Rolling Windows Estimated Coefficients for Equation (2) for Brazil

	1998	1999	2000	2001	2002
One month Accumulated Rates					
C	-0.69	-0.15	0.17	0.26	0.26
S.E.	0.97	0.44	0.08	0.07	0.08
t-stat	-0.70	0.86	2.22	3.50	3.45
Depr.	0.02	0.00	0.01	0.00	0.01
S.E.	0.14	0.04	0.01	0.01	0.01
t-stat	0.11	0.28	0.87	0.79	0.93
IPI	-0.02	-0.01	-0.01	-0.01	-0.01
S.E.	0.10	0.05	0.01	0.01	0.01
t-stat	-0.18	-0.26	-1.00	-1.59	-1.06
Real E	-0.39	-0.19	-0.02	0.00	0.00
S.E.	0.24	0.12	0.02	0.02	0.03
t-stat	-1.64	-1.17	-1.17	-0.25	0.15
Ini. Inf.	1.00	0.75	0.63	0.44	0.45
S.E.	0.14	0.08	0.10	0.12	0.12
t-stat	7.16	9.09	6.67	3.78	3.63
Three-months Accumulated Rates					
C	6.34	1.53	0.57	1.14	1.13
S.E.	2.42	1.61	0.26	0.24	0.26
t-stat	2.61	2.23	2.26	4.76	4.43
Depr.	1.00	0.45	0.03	0.02	0.02
S.E.	0.04	0.04	0.01	0.01	0.01
t-stat	25.3	9.36	2.84	2.27	2.58
IPI	-0.13	-0.16	-0.01	-0.02	-0.01
S.E.	0.21	0.16	0.02	0.02	0.02
t-stat	-0.59	-0.65	-0.34	-1.13	-0.45
Real E	1.76	0.40	-0.04	-0.02	0.01
S.E.	0.59	0.45	0.06	0.05	0.07
t-stat	2.99	0.38	-0.62	-0.51	0.23
Ini. Inf.	-0.15	0.04	0.52	0.11	0.14
S.E.	0.06	0.05	0.09	0.12	0.15
t-stat	-2.47	1.77	5.69	0.89	0.91
Six-months Accumulated Rates					
C	-6.41	-4.61	1.99	1.38	2.16
S.E.	7.74	4.31	0.52	0.41	0.55
t-stat	-0.81	-0.74	3.24	3.28	3.97
Depr.	1.00	0.69	0.03	0.03	0.02
S.E.	0.02	0.03	0.02	0.01	0.01
t-stat	43.7	25.45	2.12	2.84	2.18
IPI	1.67	0.45	-0.01	-0.03	-0.02
S.E.	0.58	0.36	0.04	0.02	0.02
t-stat	2.88	0.56	-0.60	-1.32	-0.66
Real E	-2.64	-1.31	0.01	0.08	0.12
S.E.	1.82	1.18	0.13	0.07	0.10
t-stat	-1.44	-1.33	0.45	1.04	1.17
Ini. Inf.	0.05	0.05	0.36	0.37	0.16
S.E.	0.04	0.03	0.04	0.10	0.16
t-stat	1.06	2.76	7.08	4.24	1.02

	1998	1999	2000	2001	2002
Nine Months Accumulated Rates					
C	-12.44	-9.84	3.22	2.22	3.76
S.E.	23.18	10.49	0.99	0.52	0.73
t-stat	-0.54	-1.60	4.85	4.28	5.12
Depr.	1.00	0.90	0.04	0.02	0.01
S.E.	0.02	0.02	0.03	0.01	0.01
t-stat	49.44	46.10	0.48	1.60	0.76
IPI	0.51	0.20	0.00	-0.02	-0.01
S.E.	1.51	0.79	0.08	0.03	0.03
t-stat	0.34	-0.22	0.10	-0.64	-0.34
Real E	-5.31	-2.28	-0.69	0.18	0.21
S.E.	5.32	2.78	0.27	0.10	0.11
t-stat	-1.00	-1.13	-2.23	1.72	1.88
Ini. Inf.	0.04	0.03	0.06	0.37	0.10
S.E.	0.05	0.02	0.01	0.07	0.13
t-stat	0.84	2.16	6.42	5.58	0.82
Twelve-months Accumulated Rates					
C	-33.89	-18.22	-3.32	4.52	5.55
S.E.	60.63	25.51	2.21	0.59	0.79
t-stat	-0.55	-1.44	1.99	7.84	7.02
Depr.	1.00	0.97	0.25	0.00	0.00
S.E.	0.02	0.02	0.03	0.01	0.01
t-stat	48.88	65.98	5.72	0.20	0.36
IPI	-4.78	-0.98	-0.04	-0.05	-0.03
S.E.	3.62	1.75	0.16	0.04	0.04
t-stat	-1.32	-0.10	-0.55	-1.23	-0.83
Real E	-11.44	-4.76	-2.09	0.01	0.28
S.E.	13.38	6.40	0.60	0.14	0.13
t-stat	-0.85	-0.93	-3.07	0.21	2.18
Ini. Inf.	0.04	0.02	0.02	0.17	0.03
S.E.	0.05	0.02	0.00	0.03	0.10
t-stat	0.82	1.67	7.32	6.11	0.59

Notes:

C: Constant.

Depr: Accumulated depreciation over the different time periods.

IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.

Ini. Inf.: Initial Inflation.

Table A.1.III Increasing Windows Estimated Coefficients for Equation (2) for Chile

One month Accumulated Rates

	1996	1999	2000	2001	2002
C	0.65	0.43	0.38	0.35	0.31
S.E.	0.15	0.09	0.08	0.07	0.07
t-stat	4.44	4.71	4.74	4.79	4.63
Depr.	0.02	-0.01	-0.02	-0.02	0.00
S.E.	0.05	0.04	0.03	0.03	0.03
t-stat	0.30	-0.37	-0.59	-0.61	-0.10
IPI	0.01	0.00	0.17	0.00	0.00
S.E.	0.01	0.01	0.01	0.01	0.01
t-stat	0.57	0.11	-0.07	-0.22	-0.48
Real E	0.00	0.02	0.02	0.01	0.01
S.E.	0.03	0.02	0.02	0.02	0.02
t-stat	0.07	0.95	0.83	0.80	0.34
Ini. Inf.	0.30	0.43	0.46	0.48	0.50
S.E.	0.14	0.10	0.09	0.08	0.08
t-stat	2.20	4.43	5.19	5.71	6.31

Three-months Accumulated Rates

	1996	1999	2000	2001	2002
C	2.67	1.54	1.29	1.15	1.06
S.E.	0.43	0.27	0.24	0.22	0.21
t-stat	6.29	5.71	5.40	5.21	5.07
Depr.	0.18	0.11	0.07	0.05	0.01
S.E.	0.07	0.06	0.05	0.05	0.04
t-stat	2.55	1.93	1.33	0.99	0.21
IPI	0.00	0.01	0.01	0.01	0.00
S.E.	0.03	0.02	0.02	0.02	0.02
t-stat	-0.12	0.24	0.48	0.32	0.01
Real E	0.15	0.19	0.16	0.14	0.04
S.E.	0.09	0.07	0.07	0.06	0.05
t-stat	1.65	2.70	2.44	2.31	0.74
Ini. Inf.	-0.01	0.28	0.36	0.40	0.42
S.E.	0.13	0.10	0.09	0.09	0.08
t-stat	-0.07	2.80	3.95	4.66	5.08

Six-months Accumulated Rates

	1996	1999	2000	2001	2002
C	3.96	1.54	1.19	1.04	0.92
S.E.	0.76	0.46	0.39	0.36	0.35
t-stat	5.21	3.33	3.03	2.86	2.65
Depr.	0.26	0.18	0.14	0.10	0.04
S.E.	0.07	0.06	0.05	0.05	0.04
t-stat	3.86	3.05	2.64	2.12	1.14
IPI	-0.04	0.01	0.03	0.03	0.03
S.E.	0.04	0.03	0.03	0.03	0.03
t-stat	-1.02	0.45	1.19	1.26	1.17
Real E	0.22	0.25	0.25	0.21	0.07
S.E.	0.11	0.10	0.09	0.08	0.07
t-stat	1.94	2.61	2.72	2.47	0.99
Ini. Inf.	0.18	0.52	0.58	0.61	0.65
S.E.	0.11	0.08	0.07	0.06	0.06
t-stat	1.62	6.50	8.44	9.56	10.42

Nine Months Accumulated Rates

	1996	1999	2000	2001	2002
C	2.68	0.62	0.44	0.48	0.36
S.E.	0.58	0.35	0.32	0.29	0.29
t-stat	4.59	1.75	1.40	1.65	1.24
Depr.	0.23	0.16	0.12	0.10	0.05
S.E.	0.04	0.03	0.03	0.03	0.02
t-stat	6.31	4.83	3.88	3.51	2.25
IPI	-0.03	0.00	0.02	0.02	0.02
S.E.	0.03	0.02	0.02	0.02	0.02
t-stat	-1.14	-0.07	0.75	0.82	0.75
Real E	0.20	0.24	0.22	0.21	0.12
S.E.	0.07	0.07	0.06	0.06	0.05
t-stat	2.87	3.60	3.56	3.70	2.36
Ini. Inf.	0.50	0.69	0.72	0.73	0.75
S.E.	0.06	0.04	0.03	0.03	0.03
t-stat	9.01	18.04	20.98	23.02	23.8

Twelve-months Accumulated Rates

	1996	1999	2000	2001	2002
C	3.77	0.87	0.57	0.66	0.69
S.E.	0.44	0.36	0.35	0.32	0.33
t-stat	8.52	2.41	1.66	2.08	2.12
Depr.	0.25	0.18	0.13	0.11	0.05
S.E.	0.02	0.03	0.03	0.02	0.02
t-stat	10.65	6.17	4.57	4.47	2.33
IPI	0.01	0.02	0.03	0.02	0.03
S.E.	0.02	0.02	0.02	0.02	0.02
t-stat	0.26	0.89	1.24	1.23	1.26
Real E	0.32	0.34	0.30	0.27	0.18
S.E.	0.06	0.07	0.07	0.06	0.05
t-stat	5.77	5.15	4.43	4.85	3.21
Ini. Inf.	0.45	0.64	0.67	0.67	0.68
S.E.	0.03	0.03	0.03	0.02	0.02
t-stat	15.52	24.29	26.43	29.31	28.6

Notes:

C: Constant.

Depr: Accumulated depreciation over the different time periods.

IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.

Ini. Inf.: Initial Inflation.

Table A.1.IV Rolling Windows Estimated Coefficients for Equation (2) for Chile

One month Accumulated Rates

	1996	1999	2000	2001	2002
C	0.70	0.41	0.33	0.32	0.22
S.E.	0.14	0.08	0.07	0.07	0.06
t-stat	4.88	5.05	4.71	4.59	3.62
Depr.	0.02	-0.04	-0.04	-0.02	0.03
S.E.	0.05	0.03	0.03	0.02	0.02
t-stat	0.48	-1.56	-1.48	-0.69	1.24
IPI	0.02	0.00	0.00	0.00	-0.01
S.E.	0.01	0.01	0.01	0.01	0.01
t-stat	1.20	-0.11	-0.38	-0.54	-0.77
Real E	0.00	0.01	0.00	0.00	-0.01
S.E.	0.03	0.02	0.02	0.02	0.01
t-stat	-0.09	0.41	0.18	0.20	-0.96
Ini. Inf.	0.19	0.20	0.26	0.16	0.19
S.E.	0.14	0.13	0.13	0.14	0.14
t-stat	1.35	1.54	1.92	1.13	1.41

Three-months Accumulated Rates

	1996	1999	2000	2001	2002
C	2.64	1.52	1.30	1.25	1.21
S.E.	0.40	0.20	0.17	0.16	0.15
t-stat	6.58	7.57	7.65	7.86	7.92
Depr.	0.11	-0.05	-0.07	-0.05	-0.02
S.E.	0.07	0.04	0.03	0.03	0.02
t-stat	1.62	-1.29	-1.97	-1.94	-1.15
IPI	0.01	0.03	0.03	0.02	0.02
S.E.	0.03	0.01	0.01	0.01	0.01
t-stat	0.53	2.16	2.30	1.74	1.83
Real E	0.04	0.07	0.03	0.02	-0.06
S.E.	0.09	0.06	0.05	0.04	0.03
t-stat	0.46	1.16	0.69	0.58	-2.39
Ini. Inf.	-0.01	0.03	0.08	-0.03	-0.25
S.E.	0.13	0.12	0.12	0.12	0.13
t-stat	-0.09	0.29	0.66	-0.23	-1.87

Six-months Accumulated Rates

	1996	1999	2000	2001	2002
C	4.23	2.03	1.64	1.64	2.00
S.E.	0.77	0.33	0.31	0.27	0.32
t-stat	5.52	6.34	5.27	6.01	6.34
Depr.	0.23	-0.06	-0.05	-0.07	-0.06
S.E.	0.07	0.04	0.04	0.03	0.02
t-stat	3.33	-1.75	-1.47	-2.31	-2.96
IPI	-0.04	0.04	0.04	0.03	0.03
S.E.	0.04	0.02	0.02	0.01	0.01
t-stat	-0.86	2.05	2.65	2.23	1.82
Real E	0.14	0.14	0.12	0.01	-0.12
S.E.	0.12	0.07	0.07	0.06	0.04
t-stat	1.26	1.96	1.81	0.22	-2.99
Ini. Inf.	0.14	0.33	0.42	0.36	0.08
S.E.	0.12	0.08	0.09	0.09	0.13
t-stat	1.20	4.20	4.67	4.15	0.67

Nine Months Accumulated Rates

	1996	1999	2000	2001	2002
C	2.70	1.66	1.41	2.13	2.11
S.E.	0.58	0.50	0.52	0.37	0.46
t-stat	4.60	3.37	2.85	5.86	4.73
Depr.	0.23	0.05	-0.04	-0.06	-0.05
S.E.	0.04	0.04	0.04	0.03	0.02
t-stat	6.29	1.41	-1.15	-2.33	-2.55
IPI	-0.03	0.01	0.02	0.02	0.00
S.E.	0.03	0.02	0.02	0.02	0.02
t-stat	-1.15	0.25	1.09	1.51	0.30
Real E	0.20	0.27	0.13	0.09	-0.01
S.E.	0.07	0.08	0.07	0.05	0.05
t-stat	2.83	3.40	1.81	1.93	-0.08
Ini. Inf.	0.50	0.52	0.61	0.44	0.36
S.E.	0.06	0.07	0.09	0.07	0.11
t-stat	8.92	7.21	6.86	6.17	3.30

Twelve-months Accumulated Rates

	1996	1999	2000	2001	2002
C	3.77	0.45	1.81	2.59	2.95
S.E.	0.44	0.74	0.85	0.56	0.52
t-stat	8.52	0.38	2.19	4.77	5.74
Depr.	0.25	0.13	-0.03	-0.05	-0.07
S.E.	0.02	0.04	0.04	0.03	0.02
t-stat	10.65	3.68	-0.70	-1.82	-3.46
IPI	0.01	0.00	0.01	0.02	0.01
S.E.	0.02	0.02	0.02	0.02	0.02
t-stat	0.26	0.05	0.51	1.00	0.57
Real E	0.32	0.37	0.21	0.17	0.09
S.E.	0.06	0.08	0.08	0.05	0.05
t-stat	5.77	4.81	2.68	3.16	1.85
Ini. Inf.	0.45	0.68	0.58	0.47	0.38
S.E.	0.03	0.08	0.10	0.07	0.08
t-stat	15.52	9.88	6.15	6.67	4.49

Notes:

C: Constant.
Depr: Accumulated depreciation over the different time periods.
IPI: Deviation from industrial production from H-P trend.
Real E: Real exchange rate deviation from H-P trend.
Ini. Inf.: Initial Inflation.

Table A.1.V Increasing Windows Estimated Coefficients for Equation (2) for Mexico

	1996	1999	2000	2001	2002
One month Accumulated Rates					
C	0.63	0.57	0.53	0.49	0.48
S.E.	0.20	0.16	0.15	0.14	0.13
t-stat	3.10	3.61	3.61	3.59	3.75
Depr.	0.16	0.15	0.15	0.15	0.15
S.E.	0.02	0.02	0.02	0.02	0.02
t-stat	6.69	7.45	7.68	7.87	8.00
IPI	0.10	0.10	0.10	0.09	0.08
S.E.	0.04	0.03	0.03	0.03	0.03
t-stat	2.74	3.37	3.38	3.35	3.28
Real E	0.06	0.06	0.05	0.05	0.05
S.E.	0.02	0.01	0.01	0.01	0.01
t-stat	3.59	4.20	4.23	4.26	4.25
Ini. Inf.	0.62	0.63	0.64	0.64	0.65
S.E.	0.05	0.05	0.05	0.04	0.04
t-stat	11.3	13.19	13.94	14.64	15.31
Three-months Accumulated Rates					
C	1.90	1.84	1.75	1.65	1.61
S.E.	0.65	0.50	0.46	0.42	0.39
t-stat	2.95	3.70	3.84	3.92	4.12
Depr.	0.36	0.35	0.35	0.36	0.35
S.E.	0.04	0.03	0.03	0.03	0.03
t-stat	9.71	11.0	11.48	11.93	12.31
IPI	0.20	0.21	0.20	0.18	0.17
S.E.	0.12	0.10	0.09	0.08	0.08
t-stat	1.70	2.12	2.17	2.09	2.15
Real E	0.22	0.21	0.21	0.21	0.21
S.E.	0.05	0.04	0.04	0.04	0.04
t-stat	4.45	5.24	5.39	5.51	5.68
Ini. Inf.	0.44	0.45	0.45	0.46	0.46
S.E.	0.06	0.05	0.05	0.04	0.04
t-stat	7.99	9.29	9.77	10.24	10.75
Six-months Accumulated Rates					
C	2.82	2.96	2.92	2.81	2.78
S.E.	1.26	0.96	0.87	0.80	0.74
t-stat	2.24	3.10	3.34	3.51	3.76
Depr.	0.55	0.54	0.54	0.54	0.54
S.E.	0.04	0.04	0.03	0.03	0.03
t-stat	13.1	14.98	15.66	16.36	16.93
IPI	0.24	0.27	0.28	0.25	0.25
S.E.	0.23	0.19	0.18	0.16	0.15
t-stat	1.04	1.47	1.58	1.56	1.67
Real E	0.47	0.46	0.46	0.45	0.45
S.E.	0.09	0.08	0.07	0.07	0.07
t-stat	5.03	5.93	6.20	6.39	6.63
Ini. Inf.	0.35	0.35	0.35	0.36	0.36
S.E.	0.05	0.04	0.04	0.04	0.04
t-stat	7.08	8.19	8.57	8.97	9.38
Nine Months Accumulated Rates					
C	2.26	2.66	2.84	2.98	3.06
S.E.	1.76	1.36	1.23	1.13	1.03
t-stat	1.28	1.96	2.31	2.65	2.96
Depr.	0.73	0.72	0.71	0.71	0.71
S.E.	0.04	0.03	0.03	0.03	0.03
t-stat	18.53	20.85	21.73	22.69	23.5
IPI	-0.28	-0.07	-0.04	-0.01	0.01
S.E.	0.32	0.26	0.25	0.23	0.21
t-stat	-0.86	-0.25	-0.16	-0.06	0.06
Real E	0.75	0.70	0.70	0.70	0.70
S.E.	0.13	0.11	0.10	0.10	0.09
t-stat	5.91	6.64	7.00	7.30	7.58
Ini. Inf.	0.28	0.29	0.29	0.29	0.29
S.E.	0.04	0.04	0.03	0.03	0.03
t-stat	7.11	8.21	8.56	8.90	9.28
Twelve-months Accumulated Rates					
C	3.09	2.45	2.87	3.24	3.57
S.E.	2.28	1.82	1.66	1.52	1.39
t-stat	1.39	1.35	1.74	2.14	2.57
Depr.	0.89	0.86	0.86	0.86	0.85
S.E.	0.04	0.03	0.03	0.03	0.03
t-stat	24.89	26.30	27.23	28.33	29.4
IPI	-0.61	-0.28	-0.25	-0.20	-0.16
S.E.	0.41	0.34	0.32	0.30	0.28
t-stat	-1.52	-0.81	-0.77	-0.67	-0.57
Real E	1.55	1.22	1.21	1.21	1.21
S.E.	0.17	0.14	0.13	0.13	0.12
t-stat	8.90	8.61	8.97	9.33	9.70
Ini. Inf.	0.20	0.22	0.22	0.22	0.22
S.E.	0.03	0.03	0.03	0.03	0.03
t-stat	5.89	7.15	7.42	7.66	7.91

Notes:

C: Constant.

Depr: Accumulated depreciation over the different time periods.

IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.

Ini. Inf.: Initial Inflation.

Table A.1.VI Rolling Windows Estimated Coefficients for Equation (2) for Mexico

	1996	1999	2000	2001	2002
	One month Accumulated Rates				
C	0.47	0.65	0.43	0.23	0.25
S.E.	0.14	0.17	0.15	0.13	0.10
t-stat	3.36	3.87	2.92	1.81	2.44
Depr.	0.06	0.06	0.04	0.01	0.00
S.E.	0.01	0.01	0.02	0.02	0.02
t-stat	7.61	6.32	2.73	0.41	0.20
IPI	0.03	0.05	0.04	0.04	0.02
S.E.	0.02	0.02	0.02	0.02	0.01
t-stat	1.92	2.58	1.89	2.03	1.16
Real E	0.04	0.05	0.04	0.02	0.01
S.E.	0.01	0.01	0.01	0.01	0.01
t-stat	4.33	5.21	3.55	1.61	0.83
Ini. Inf.	0.62	0.54	0.65	0.77	0.70
S.E.	0.08	0.09	0.09	0.09	0.10
t-stat	7.48	5.96	6.88	8.14	7.31
	Three-months Accumulated Rates				
C	4.86	6.34	4.01	1.79	1.34
S.E.	0.70	0.78	0.57	0.50	0.35
t-stat	6.95	8.10	7.06	3.58	3.87
Depr.	0.18	0.16	0.20	0.16	0.13
S.E.	0.02	0.02	0.04	0.05	0.04
t-stat	7.37	6.83	5.46	3.20	3.00
IPI	-0.06	0.00	0.08	0.13	0.13
S.E.	0.10	0.10	0.09	0.06	0.05
t-stat	-0.58	-0.04	0.97	2.03	2.86
Real E	0.27	0.29	0.22	0.12	0.09
S.E.	0.04	0.04	0.03	0.04	0.04
t-stat	6.62	7.66	6.34	3.45	2.46
Ini. Inf.	-0.28	-0.37	-0.04	0.39	0.44
S.E.	0.14	0.14	0.11	0.12	0.11
t-stat	-1.98	-2.74	-0.26	3.30	4.15
	Six-months Accumulated Rates				
C	7.18	9.44	7.39	2.96	2.18
S.E.	1.32	1.57	1.16	0.80	0.63
t-stat	5.45	6.04	6.34	3.70	3.50
Depr.	0.27	0.23	0.27	0.25	0.24
S.E.	0.03	0.03	0.05	0.06	0.05
t-stat	8.58	7.74	6.43	4.30	4.32
IPI	0.01	0.08	0.19	0.23	0.25
S.E.	0.19	0.22	0.17	0.10	0.08
t-stat	0.06	0.35	1.22	2.40	3.37
Real E	0.35	0.35	0.29	0.21	0.17
S.E.	0.07	0.06	0.06	0.06	0.07
t-stat	5.08	5.50	5.17	3.47	2.51
Ini. Inf.	-0.07	-0.10	0.03	0.41	0.47
S.E.	0.14	0.14	0.11	0.09	0.09
t-stat	-0.52	-0.70	0.49	4.62	5.22

	1996	1999	2000	2001	2002
	Nine Months Accumulated Rates				
C	6.35	9.70	7.61	2.93	1.59
S.E.	1.95	2.13	1.49	0.67	0.61
t-stat	3.34	4.55	5.32	4.41	2.58
Depr.	0.34	0.29	0.39	0.29	0.33
S.E.	0.03	0.03	0.03	0.04	0.04
t-stat	10.76	9.17	12.34	7.03	7.34
IPI	0.06	0.20	0.34	0.28	0.25
S.E.	0.22	0.25	0.19	0.08	0.07
t-stat	0.26	0.81	2.04	3.28	3.61
Real E	0.36	0.38	0.33	0.16	0.23
S.E.	0.08	0.08	0.06	0.05	0.07
t-stat	4.39	5.10	6.25	3.16	3.46
Ini. Inf.	0.20	0.14	0.21	0.47	0.57
S.E.	0.13	0.11	0.08	0.05	0.05
t-stat	1.54	1.24	3.09	10.50	10.9
	Twelve-months Accumulated Rates				
C	7.35	13.33	12.53	6.44	3.51
S.E.	2.88	2.52	1.89	0.99	0.91
t-stat	2.65	5.28	6.77	6.49	3.89
Depr.	0.41	0.34	0.41	0.40	0.33
S.E.	0.03	0.03	0.03	0.05	0.06
t-stat	12.70	11.15	15.34	8.72	5.33
IPI	0.28	0.45	0.05	0.04	0.06
S.E.	0.24	0.25	0.20	0.12	0.10
t-stat	1.19	1.82	0.20	0.30	0.59
Real E	0.64	0.66	0.50	0.28	0.17
S.E.	0.11	0.08	0.07	0.07	0.10
t-stat	6.24	7.97	7.57	4.89	1.71
Ini. Inf.	0.21	0.08	0.08	0.29	0.44
S.E.	0.14	0.09	0.07	0.04	0.05
t-stat	1.45	0.97	1.19	6.69	8.29

Notes:

C: Constant.
Depr: Accumulated depreciation over the different time periods.
IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.
Ini. Inf.: Initial Inflation.

Table A.1.VII Increasing Windows Estimated Coefficients for Equation (2) for Brazil

(No Hyperinflation Sub-Sample)

One month Accumulated Rates

	1999	2000	2001	2002
C	0.068	0.129	0.160	0.176
S.E.	0.094	0.078	0.072	0.068
t-stat	0.748	1.644	2.207	2.592
Depr.	0.007	0.007	0.005	0.005
S.E.	0.006	0.006	0.006	0.006
t-stat	1.177	1.042	0.856	0.798
IPI	-0.004	-0.002	-0.003	-0.003
S.E.	0.008	0.007	0.007	0.006
t-stat	-0.501	-0.320	-0.403	-0.500
Real E	-0.036	-0.025	-0.028	-0.029
S.E.	0.034	0.021	0.020	0.019
t-stat	-1.080	-1.177	-1.440	-1.505
Ini. Inf.	0.742	0.724	0.686	0.670
S.E.	0.100	0.089	0.084	0.081
t-stat	7.465	8.130	8.142	8.280

Three-months Accumulated Rates

	1999	2000	2001	2002
C	0.386	0.448	0.533	0.572
S.E.	0.368	0.282	0.251	0.225
t-stat	1.065	1.598	2.125	2.538
Depr.	0.039	0.037	0.034	0.032
S.E.	0.015	0.013	0.012	0.011
t-stat	2.659	2.930	2.772	2.999
IPI	-0.003	0.001	-0.003	0.000
S.E.	0.026	0.023	0.021	0.019
t-stat	-0.138	0.054	-0.121	0.026
Real E	0.031	0.001	-0.034	-0.037
S.E.	0.102	0.069	0.058	0.055
t-stat	0.295	-0.007	-0.585	-0.681
Ini. Inf.	0.679	0.642	0.586	0.581
S.E.	0.099	0.091	0.086	0.081
t-stat	6.859	7.020	6.807	7.199

Six-months Accumulated Rates

	1999	2000	2001	2002
C	3.514	3.538	3.447	3.417
S.E.	0.946	0.584	0.431	0.371
t-stat	3.747	6.179	8.012	9.220
Depr.	0.008	0.009	0.010	0.012
S.E.	0.035	0.025	0.022	0.019
t-stat	0.215	0.346	0.434	0.651
IPI	-0.001	-0.004	-0.012	-0.013
S.E.	0.069	0.055	0.047	0.041
t-stat	-0.013	-0.084	-0.264	-0.307
Real E	-0.142	-0.136	-0.162	-0.169
S.E.	0.243	0.161	0.121	0.110
t-stat	-0.587	-0.880	-1.338	-1.529
Ini. Inf.	0.056	0.056	0.057	0.057
S.E.	0.015	0.013	0.011	0.010
t-stat	3.618	4.415	5.165	5.640

Nine Months Accumulated Rates

	1999	2000	2001	2002
C	4.402	5.280	5.525	5.496
S.E.	1.559	0.943	0.627	0.546
t-stat	2.836	5.861	8.825	10.069
Depr.	0.000	-0.012	-0.014	-0.008
S.E.	0.044	0.029	0.025	0.022
t-stat	-0.055	-0.411	-0.542	-0.336
IPI	0.104	0.063	0.053	0.042
S.E.	0.091	0.073	0.062	0.055
t-stat	1.127	0.860	0.853	0.751
Real E	-0.619	-0.417	-0.347	-0.336
S.E.	0.389	0.256	0.172	0.154
t-stat	-1.593	-1.659	-2.025	-2.186
Ini. Inf.	0.015	0.013	0.012	0.012
S.E.	0.004	0.003	0.002	0.002
t-stat	3.763	4.957	6.465	7.163

Twelve-months Accumulated Rates

	1999	2000	2001	2002
C	-13.740	-8.489	-1.348	-1.098
S.E.	3.163	2.723	1.980	1.700
t-stat	-4.334	-2.999	-0.680	-0.645
Depr.	0.531	0.398	0.363	0.356
S.E.	0.055	0.053	0.053	0.048
t-stat	9.570	7.483	6.847	7.421
IPI	0.288	-0.075	-0.144	-0.162
S.E.	0.221	0.212	0.201	0.178
t-stat	1.306	-0.355	-0.718	-0.910
Real E	-4.381	-3.366	-1.470	-1.456
S.E.	0.838	0.769	0.564	0.487
t-stat	-5.223	-4.314	-2.614	-2.988
Ini. Inf.	0.023	0.021	0.015	0.015
S.E.	0.003	0.003	0.002	0.002
t-stat	7.822	7.760	7.130	8.261

Notes:

C: Constant.

Depr: Accumulated depreciation over the different time periods.

IPI: Deviation from industrial production from H-P trend.

Real E: Real exchange rate deviation from H-P trend.

Ini. Inf.: Initial Inflation.

Table A.1.VIII Variability Analysis of the Nominal Exchange Rate, International Reserves and the Nominal Interest Rate for Developed IT Countries

	Probability that the Monthly Percent Change in				Probability that the Monthly Change of the Nominal Interest Rate			
	Depreciation		International Reserves					
	Falls Within				Falls Within		is Higher than	
Australia 84:01 - 99:04	28	70.3	23.9	50	28.1	53.9	0	0
Canada 70:06 - 99:04	68.2	93.6	15.9	36.6	36.1	61.9	2.8	2.1
New Zealand 85:03 - 99:04	39.1	72.2	11.8	31.4	40.0	59.4	1.8	0.6
Sweden 92:11 - 99:04	35.1	75.5	8.9	33.3	71.8	91.1	1.3	0.0

Note: Extracted from Calvo and Reinhart (2000)

APPENDIX 2

Table A.2.I. Value for the Parameters Used in the Simulation.

Parameter	Value	Parameter	Value
ρ	0.5	δ	0.40
r	4%	γ	0.80
α	1	θ	0.90
κ	0.5	ψ	1
ε^*	1	μ	6%
i^G	12%	Π (target)	6%

APPENDIX 3

This appendix presents a discrete time version of the inflation framework presented in Chapter IV. This framework is used to illustrate the differences between the nominal exchange rate pass-through effects into inflation observed under a managed fixed exchange rate regime and under an Inflation Targeting (IT) regime.

As in the continuous time version of the inflation framework presented in Chapter III, here the law of one price is assumed to hold for the traded good price, the foreign price of the traded good is assumed to be one and therefore the nominal exchange rate is equal to the domestic price of the traded good.

The natural log expression for the overall price index is

$$P_t = \rho E_t + (1-\rho)P_t^h \qquad \text{(A.1)}$$

where P_t represents the natural log of the overall price level, E_t denotes the natural log of the nominal exchange rate, and the natural log of the non-traded good price is represented by P_t^h. Once again I assume that the non-traded good price responds sluggishly, specifically as a function of the changes in the nominal exchange rate, and the difference between the traded and the non-traded good price levels in the previous period. The specific natural log expression for the non-traded good price level is the following:

$$P_t^h = P_{t-1}^h + (E_t - E_{t-1}) + \gamma(E_{t-1} - P_{t-1}^h) \qquad \text{(A.2)}$$

After substituting the non-traded good price level in expression (A.1) with expression (A.2), the overall price level expression can be rewritten as

$$P_t = E_t + (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}] \qquad \text{(A.3)}$$

When the central bank is implanting an inflation target, the natural log of the overall price level at each point in time is determined by:

$$P_t = P_0 + at \qquad \text{(A.4)}$$

where P_0 denotes the initial overall price level, a denotes the rate at which the overall price level increases, in other words the inflation target, and t simply represents time. When an exogenous shock causes an increase in the nominal exchange rate, the central bank is forced to manage the nominal exchange rate in order to comply with the overall inflation target. The path that the nominal exchange rate should follow is determined by substituting P_t in expression (A.3) with expression (A.4) and isolating the nominal exchange rate, E_t.

$$E_t = P_0 + at - (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}] \qquad \text{(A.5)}$$

For the case of the managed fixed exchange rate regime, the central bank sets a rate of depreciation for the domestic currency and the natural log of the nominal exchange rate at each point in time is determined by:

$$E_t = E_0 + at \qquad \text{(A.6)}$$

where E_0 denotes the initial value for the nominal exchange rate and a corresponds in this case to the rate of depreciation set by the central bank. In this case the path for the overall price level is determined by substituting (A.6) in (A.3).

$$P_t = E_0 + at + (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}] \qquad \text{(A.7)}$$

In order to analyze the nominal exchange rate pass-through effect into inflation under each regime, after an exogenous shock causes a sudden once an for all increase in the nominal exchange rate, it is possible to look at the ratio between the overall price level and the nominal exchange rate for both regimes.

$$r_1 = \frac{P_t}{E_t} = \frac{E_0 + at + (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}{E_0 + at} \quad \text{(A.8)}$$

$$r_2 = \frac{P_t}{E_t} = \frac{P_0 + at}{P_0 + at - (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]} \quad \text{(A.9)}$$

Expression (A.8), r_1, denotes the ratio between the overall price level and the nominal exchange rate for the managed fixed regime, while expression (A.9), r_2, denotes the corresponding ratio for the IT regime. It is possible to compare the pass-through effects between the two regimes by looking at $R = r_1 / r_2$.

Proposition 1. The pass-through effect under the managed fixed regime is greater or equal to the pass-through effect under IT, $r_1 \geq r_2$.

Proof. In order for this proposition to be true, R must be greater or equal to 1.

$$R = \frac{r_1}{r_2} \geq 1$$

$$\frac{E_0 + at + (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}{E_0 + at} \geq \frac{P_0 + at}{P_0 + at - (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}$$

(A.10)

When the shock takes place, the nominal exchange rate for both regimes increases by α, while the overall price level only increases only by $\alpha\rho$, therefore

$$E_0 + at = P_0 + at + \alpha(1-\rho) \quad \text{(A.11)}$$

Plugging (A.11) into (A.10),

$$\frac{P_0 + at + \alpha(1-\rho) + (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}{P_0 + at + \alpha(1-\rho)} \geq \frac{P_0 + at}{P_0 + at - (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]} \text{(A.12)}$$

$$1 + \frac{(1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}{P_0 + at + \alpha(1-\rho)} \geq \frac{P_0 + at}{P_0 + at - (1-\rho)(1-\gamma)[P_{t-1}^h - E_{t-1}]}$$

$$1 - \frac{P_0 + at}{P_0 + at + (1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]} \geq \frac{(1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]}{P_0 + at + \alpha(1-\rho)}$$

$$\frac{(1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]}{P_0 + at + (1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]} \geq \frac{(1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]}{P_0 + at + \alpha(1-\rho)}$$

$$P_0 + at + \alpha(1-\rho) \geq P_0 + at + (1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h] \qquad \text{(A.13)}$$

$$\alpha(1-\rho) \geq (1-\rho)(1-\gamma)[E_{t-1} - P_{t-1}^h]$$

$$\frac{\alpha}{[E_{t-1} - P_{t-1}^h]} \geq (1-\gamma) \qquad \text{(A.14)}$$

The right hand side of expression (A.14) will always be greater or equal to 1, since the difference between the nominal exchange rate and the non-traded good price level will always be equal or less than α.

The difference between the ratios depend on ρ, γ, and the initial shock α. If ρ is equal to one, then from expression (A.10) it is possible to show that both ratios are equal to one. When $0 \leq \rho < 1$, then the ratio will depend on the value of γ. From expression (A.13), if $\gamma = 0$, then $r_1 = r_2$ since the difference between the nominal exchange rate and the overall price level, after the shock, will always be equal to α. For the case in which $\gamma = 1$, using expression (A.10) again it is possible to see that $r_1 = r_2$. Finally, when $0 < \gamma < 1$ the pass-through effect under the managed fixed regime, r_1, will always be greater than the one observed under IT, r_2, since the difference between the nominal exchange rate and the non-traded good price level will always be equal or less than α. In this case, the right hand side of expression (A.14) will always be greater than one and the left hand side will always be less than one.

VITA

NAME:	Javier Arturo Reyes Altamirano
DATE OF BIRTH:	February 4th, 1975
EDUCATION:	(ITESM-CEM) Instituto Tecnologico y de Estudios Superiores de Monterrey, Campus Estado de México, 1994 – 1998. *B.A., Economics* Texas A&M University, 1998 – 2003 *Ph.D. Economics*
FIELDS OF SPECIALIZATION:	Monetary Theory International Economics Econometrics
PERMANENT ADDRESS:	Cto. Circunvalacion Ote. # 44 – A Jardines de la Florida, Naucalpan Estado de México, C.P. 53100 México.