Monetary Policy Rules for Financially Vulnerable Economies

Eduardo Morón*
Universidad del Pacifico
emoron@up.edu.pe

Diego Winkelried
Banco Central de Reserva del Perú
dwinkelried@bcrp.gob.pe

First draft: December 20, 2000

This version: November 10, 2001

Abstract

One distinguishable characteristic of emerging economies is that they are not financially robust. These economies are incapable to smooth out large external shocks as sudden capital outflows or terms of trade shocks imply large and abrupt swings in the real exchange rate. This could be very costly if the real exchange rate swings trigger a financial crisis as in the case of highly un-hedged liability dollarized economies. Using a small open economy model this paper examines alternative monetary policy rules for economies with different degrees of liability dollarization. The paper aims to answer the question of how efficient is to use inflation targeting when the liability dollarization ratio is high. Our findings suggest that it might be optimal to follow a non-linear policy rule that defends the real exchange rate in a financially vulnerable economy.

JEL Codes: E52, E58, F41

Keywords: *Liability Dollarization, Inflation Targeting, Monetary Policy Rules, Latin America.*

This paper has benefited by conversations with staff at the Research Department at the IMF, the Macro Discussion Group of Consorcio de Investigación Económica y Social and seminar participants at LACEA 2001, Central Bank of Peru, SPEEA 2001, and Universidad del Pacifico. We are grateful for the financial support of the Global Development Network and LACEA. This paper only reflects the personal views of the authors not necessarily of the institutions.

* Corresponding author. The paper has been written while this author was a Visiting Scholar at the Research Department at the International Monetary Fund.

1. *Motivation*

One offspring of the recent, yet recurring, debate on the optimal exchange rate regime for emergent economies is the so-called hollowing out hypothesis.[1] The choices are either a fully dollarized economy or a flexible exchange rate within an inflation-targeting (IT, henceforth) framework.[2] Those emerging countries that do not favor the dollarization option face a shortened menu. The currency board option is discarded as Argentina is still trying to find a way out. The fixed exchange rate regime has been banned after the Tequila episode and the collapse of the Asian tigers. What are left are the flexible exchange regimes.

In Latin America, Brazil, Chile, Colombia, and recently Mexico have adopted flexible regimes but with a different flavor. All of them have inflation targeting schemes, meaning flexible exchange rates but with a strong commitment that the inflation rate will not exceed (or fall below) certain target.[3] Along with that pack, Peru and Uruguay are discussing and/or preparing the formal adoption of a similar framework.

The crucial difference between this group of countries (LA inflation targeters) and Peru and Uruguay is that they are not heavily dollarized.[4] The main question of the paper is which are the consequences of adopting an IT framework in economies that are liability dollarized and therefore having a fully flexible exchange rate regime might imply a larger trade-off.[5] We will focus in evaluating alternative monetary policy rules that might be implemented within this framework rather than comparing the IT option with other possibilities.[6]

Masson et. al. (1997) suggest that economies should at least satisfy two requisites if they wish to consider the possibility of adopting IT. First, the ability to conduct independent monetary policy and, second, develop a quantitative framework linking policy instrument to inflation. The second requirement is not very restrictive, as the Brazilian case has shown how fast an economy can implement it.[7] However, the first requirement encompasses a non-fiscal dominance condition and the absence of commitments to another nominal anchor. Most of the emerging economies cannot satisfy entirely such conditions. However, it's hard to argue that the fiscal dominance is

[1] The hollowing out hypothesis is tested using different methodologies in Frankel et. al (2000) and Masson (2000). Williamson (2000) argues against this hypothesis and defends the intermediate regimes for emerging economies. Velasco (2000) also supports the idea that the corners are not the best options to follow.

[2] The last LACEA 2000 meeting was a good example of this. Stanley Fischer at the inaugural lecture defended the flexible option and Rudi Dornbusch closed the event advising to switch to a fully dollarized regime. Mishkin and Savastano (2000) discuss, within the context of Latin America, which is the optimal monetary policy emphasizing the idea that the focus should be on the monetary policy and not on the exchange rate regime.

[3] See Morandé and Schmidt-Hebbel (2000) for Chile, Bogdansky et. al. (2001) for Brazil and Martínez et. al. (2001) for Mexico.

[4] There are no good measures of financial vulnerabilities for emerging markets. This is an area in which more effort should be put as what matters is the net position of asset and liabilities of each particular sector: banks, firms, households, and government. Aggregate positions might be hiding large sectoral imbalances.

[5] Masson, et. al. (1997) discusses the more general case for developing countries in general and found that Chile, Colombia and Mexico were good candidates to implement IT. As mentioned, all three are now following an IT framework.

[6] Cespedes et. al., (2000), Ghironi and Rebucci (2000) focus more on evaluating the alternative options of fixed, flex, currency board or full dollarization.

[7] See Bogdanski et. al. (2000) for an account of the process of implementing the IT framework in Brazil.

only a key factor in the case of an IT regime. Even a fully dollarized economy that lacks fiscal sustainability will be severely hit when shocks come by. Of course, it will make a lot of sense to reinforce the fiscal stance in all emerging economies not matter what monetary or exchange rate policy are currently following. In terms of our discussion on the optimality of alternative policy rules, we will assume that the government not only engages in a fully credible way into the IT framework but also takes the necessary steps to avoid fiscal dominance.[8] Also, we are not comparing the transition period of an IT regime but the behavior of that regime when we are in a new steady state.

As stressed by Calvo (2000) a remarkable difference between emerging and developed economies lies on the importance of the structure of liabilities and the relationship between exchange rate regimes and financial fragility. Together with Mishkin (2000), he argues that a high degree of liability dollarization may hinder the feasibility of adopting an IT. As real exchange depreciations might trigger financial crisis, the exchange rate might become another target for the Central Bank. This will induce a larger problem as firms and households will expect that the implicit insurance against exchange rate risk will be maintained especially in turbulent times.[9]

Another reason might be a concern for the exchange rate pass-through on inflation. Latin American countries have been known for its high inflationary past. The recent trend of low inflation is something relatively new. In a "truly" flexible exchange rate regime, the exchange rate is supposed to work as an external shock absorber but we are considering rather extreme cases. If the economy has a high degree of pass-through, bad past memories might kick in and inflation will go up, as the real exchange rate is a forward looking variable. Contrary to the common wisdom, pass-through estimates are now very low both in Peru and Uruguay (see section 2 below).[10] However, the data seems to support the hypothesis that the pass-through is regime-dependent[11] hence, the current low estimates should be taken with caution.

Perhaps the most striking distinction between the emerging markets and the developed ones is the fact that the former are incapable of smooth out sudden changes in their external financing needs.[12] Calvo (2000) has argued that those Latin American countries with highly dollarized liabilities will be more exposed to these perils. As nobody could argue that a market-based de-dollarization is feasible in the short or medium-term, we should treat that constraint as a permanent one.

A much more important constraint is the fact that in economies with high levels of liability dollarization, the balance sheet channel dominates the more traditional interest rate channel on aggregate demand. The data shows (see Table No. 1) that as we move towards a more fixed regime, interest rates will be more volatile compared to exchange rates suggesting that is much more costly to freely float than to allow interest rate hikes. Lahiri and Végh (2001) shows that this policy could be rationalized as optimal in the context of a model in which real exchange rate fluctuations are costly.

---

[8] Most of the central banks in the region had improved their independence and autonomy with stricter charters that aim to avoid fiscal dominance.

[9] See Eichengreen and Hausmann (1999) and Caballero (2001).

[10] See Gonzalez (2000) for an estimation of the degree of exchange rate pass-through in a group of Latin American economies.

[11] See Calvo (2000) and Mishkin and Savastano (2000).

[12] For example, Argentina was put out of the market before the *blindaje*, and Peru suffered a severe cut of all banking credit lines after the Russian crisis.

Notwithstanding all of the above, Peru and (in a lesser extent) Uruguay are considering the pros and cons of adopting an inflation targeting framework.[13] Both countries have curbed inflation to one-digit levels after a severe and chronic inflationary history and are among the group of the more dollarized economies in the region and therefore are forced to fear a sudden real depreciation for the problems that a liability-dollarized economy might pose to a vulnerable financial system.[14] This call for an obvious question on how feasible is to have an IT regime in that type of economies.

Table No. 1
Volatility of Interest Rate and Exchange Rate

Type of Exchange Rate Regime	*Probability that the monthly change in nominal exchange rate falls within:*		*Probability that the monthly change in nominal interest rate falls within:*	
	+/- 1.0% band	**+/- 2.5% band**	**+/- 25 bps**	**+/- 50 bps**
Floating	51.7	79.3	33.3	46.7
Managed Floating	60.1	87.5	36.3	49.4
Limited Flexibility	64.6	92.0	47.5	68.7
Fixed	83.1	95.9	52.3	69.3
Memo:				
United States	26.8	58.7	59.7	80.7
Japan	33.8	61.2	67.9	86.4
Peru	45.2	71.4	24.8	32.3
Uruguay	22.7	92.0	2.7	8.0

Source: Calvo and Reinhart (2000)

Despite all these restrictions, these two countries and probably others (for example Turkey) will join the bandwagon and adopt inflation targeting strategies to direct its monetary policy.[15] What will be the consequences of following this option in terms of real exchange rate volatility, output, and inflation? The trade-off of having a wider inflation target band with an implicit narrow real exchange rate band calls to question the credibility of the inflation target. However, a wider real exchange rate band might question the sustainability of the regime, as the real consequences might be widespread bankruptcies and output instability.

Even though the recommendation regarding avoiding mixing inflation targeting with an exchange rate targeting seems completely needed, it's hard to draw a precise line in theory (or in practice) when to lean against the wind and when to let the wind blow.[16] As stressed by Mishkin and Savastano (2000) letting the exchange rate become the *de-*

[13] See Licandro (2001) for a discussion of the Uruguayan case, and Armas et.al. (2001) for the Peruvian case.
[14] Castro and Morón (2000) argued that the Peruvian Central Bank was unable in the 90s to use the flexible exchange rate regime as an external shock absorber due to the presence of a high degree of liability dollarization. See Calvo and Reinhart (2000) for a much broader perspective on the issue of liability dollarization, and Tornell (2000) for a model that describes this issue.
[15] Eichengreen et.al. (1999) discuss IT as an exit strategy for previously fixed exchange rate regimes. However, both in Peru and Uruguay the reason behind the adoption of an IT framework is to consolidate the one-digit inflation rate obtained after a long lasting stabilization program, and keep the credibility gained after that effort.
[16] See Kumhoff (2000) on this. See also Mishkin (2000).

facto nominal anchor of the economy through excessive intervention in a quasi-inflation targeting regime is an example of bad monetary policy under flexible exchange rates.[17]

In a recent policy note Perry (2001) considers that is too difficult to suggest to this type of countries if they should follow the full dollarization option or the inflation targeting strategy. As we said before, we are not aiming to answer such a broad question. The goal of the paper is much more limited. If we take as granted that these two countries will move to an IT, which monetary policy rules should be considered as the closest cousins of optimal rules? Some of the questions that we will try to answers are: (i) should the Central Bank consider the exchange rate within its monetary policy rule? (ii) which are the consequences of a higher level of activism with respect to the exchange rate? (iii) which are the trade-offs of a stricter or a more flexible IT?

Prior to the Asian crisis, there was a very scant literature discussing the optimality of adopting IT for emerging markets. Most of the IT literature was focused on developed economies. Only very recently, the literature on IT has become much more concerned to develop models for small open economies.[18] The survey by Mishkin and Savastano (2000) or the work of Frenkel (1999) showed that much more analytical work need to be done to understand the real benefits from a regime that has not been tried in a partially dollarized environment. Taylor (2000) suggests that models like Svensson (2000) or Battini et. al. (2001) should be adjusted for the emerging markets to be able to grasp the fact that exchange rate fluctuations are more costly than in developed economies due to the presence of currency and maturity mismatches.

Fortunately, the literature on monetary policy rules for emerging economies has been increasing very fast in the last year. Among the most important contributors we have the following papers. Cespedes et. al. (2000) argue that in a model in which balance sheet effects *á la* Bernanke and Gertler (1989) matters, the horse race is won by the flexible exchange rate regime. They show that the contractionary effect of real exchange rate depreciation through that channel will be offset by other channels (i.e. net worth, risk premium, real wages and external debt). Therefore the flexible exchange rates maintain their superiority as shocks absorbers compared to the fixed exchange regime.

Gertler et. al. (2001) provide a comprehensive comparison of fixed versus flexible exchange rate regimes. Perhaps the most important result is that the welfare challenge could go either way depending on the extent that the market value of domestic assets is used to collateralized lending. As the authors suggest if capital markets are shallow, as in some emerging markets, the fixed exchange rate case is much stronger than the flexible exchange regime under the presence of foreign currency debt and a financial accelerator.

Devereux and Lane (2000), following Bernanke et. al. (2000), specify and calibrate a two-sector model using Thailand data. They conclude that when constraints in external financing become more important, the benefits associated with monetary policy rules that include the real exchange rate become smaller. The paper weakness is that the IT rules are simple Taylor rules and not inflation forecast based (IFB) rules. In the same way, Cook (2000) calibrate -using Southeast Asia data- a model in which the entrepreneurs may borrow only in foreign currency and compares it with another model in which there is no liability dollarization. His main findings are that a fixed exchange

[17] A very recent example of this is the mounting pressure on the Central Bank of Brazil officials to intervene in the foreign exchange market after the recent crisis in Argentina.

[18] See Ball (1999), Clarida et. al. (2001) and Svensson (2000). They are just a few of many recent papers in this strand of the literature.

rate regime is better in terms of welfare compared to a simple IT rule. However, these results are assuming that agents do not hedge against the exchange rate risk even though they are fully liability dollarized.

In a similar fashion, Ghironi and Rebucci (2000) use Argentina as a case example to compare in terms of welfare three alternative regimes: a currency board, a full dollarization regime, and an inflation-targeting framework. The ranking of these three options depend heavily on the relationship between currency and default risk that is not included in the model.[19]

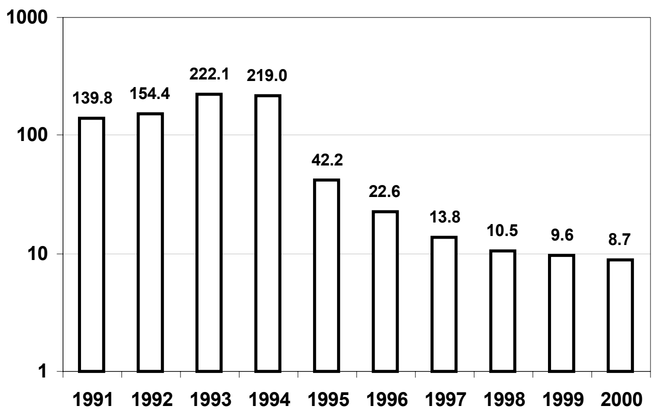
In this paper we consider a model that borrows the structure of Svensson (2000) with an explicit role for balance sheet effects as in Céspedes et. al. (2000) and Bernanke et. al. (2000). We calibrate the model for a financially robust and a financially vulnerable economy. For the former we use Australian and New Zealand data, and for the latter we use Peruvian and Uruguayan data.

The structure of the paper is as follows. Section 2 briefly describes the different monetary policy choices followed in Latin America in the last decade. Section 3 presents a small open economy model that will describe the transmission channels and discuss which one is more important. Section 4 presents the model parameterization. Section 5 discusses the optimality of alternative policy rules for both the financially vulnerable and robust economy cases. In addition, we study the optimality of nonlinear policy in the vulnerable economy case. Finally, in Section 6 we conclude and discuss new avenues for further research.

2. *An Overview of Monetary Policy in Latin America*

The long-term quest for one digit inflation is about to become a reality for all Latin American countries. After three decades of high inflation the region has come back on track and the downward trend on inflation looks very promising (see Figure No. 1).[20]

Figure No. 1
Latin American Inflation Rate in the 90s (logarithmic scale)



Source: IMF

[19] Druck et. al. (2001) showed that the sign of the correlation of those risks depend on the presence (or not) of balance sheet effects in the economy.

[20] The only exceptions are Ecuador and Venezuela. Ecuador fully dollarized its economy at the beginning of 2000 and the inflation forecast for 2001 is around 25%, while in Venezuela analysts expect no significant change in the 15% inflation rate for this year.

A key feature of this recent disinflation is that even though the outcome is more or less homogeneous across the board, the policies used have been quite disparate. Table No. 2 shows that a variety of nominal anchors and exchange rate regimes have been used. Just to add to the differences, Ecuador and El Salvador dollarized its economies while others are moving toward the recent trend of setting inflation targets as a framework for monetary policy (Mexico, Peru).[21] However, Latin America has not been the exception in the worldwide trend toward more flexible exchange rates.[22]

Table No. 2
Monetary and Exchange Rate Policy in Latin America in the 90s

Country	1	2	3	4	5	
	Current Nominal Anchor	Explicit Anchor?	Year of Reform	Exchange Rate Regime, Levy Yeyati & Sturzenegger (2000) Classification	Inflation	
					1990	2000
Argentina	e	Yes	1991	Fixed	1343.9	-0.7
Bolivia	m	No	1995	Managed - Bands	18.0	3.8
Brasil	π	Yes	1999	Managed - Floating	1584.6	5.5
Chile	π	Yes	1989 - 1999	Floating	27.3	4.7
Colombia	π	Yes	1991 - 1999	Bands - Floating	32.4	8.8
Costa Rica	m	No	1995	Floating - Managed	27.3	10.4
Ecuador	$	Yes	1992 - 2000	Managed - Fixed	49.5	96.6
El Salvador	$	No	2001	Managed - Bands	19.3	3.4
Guatemala	m	Yes	1995	Floating - Managed	59.6	4.2
México	π	In transition	1995 - 2001	Managed - Floating	29.9	8.9
Nicaragua	m	No	1992	Not available	13490.2	9.2
Panama	$	Yes	1907	Fixed	0.8	1.4
Paraguay	m	No	1995	Managed - Floating	44.1	9.6
Perú	π	In transition	1994	Managed - Floating	7649.6	3.7
Uruguay	e	Yes	1995	Fixed (Bands) - Floating	129.0	5.8
Venezuela	e	No	1992	Fixed (Bands) - Floating	36.5	14.2

Notes: *The first three columns are based on Corbo (2000), Mishkin and Savastano (2000) and several Central Bank reports. The third column refers to years in which there has been a substantial reform in the Charter of the Central Bank or the startup of target announcements. The fourth column might show two regimes as some transition has happened. The fifth column is the annual variation of CPI, according to World Bank reports.*

Another key characteristic of Latin America is a by-product of the high inflation experience. In Table No. 3 we show a raw measure of liability dollarization. The differences are quite marked across the countries. This combination (liability dollarization and flexible exchange rates) does not seem to be the best one. Berg and Borenzstein (2000) suggest that highly liability dollarized economies should move towards a more fixed regime (full dollarization) whereas the rest of the economies should choose a more flexible exchange rate regime.[23] As discussed by Calvo and Végh (1996) the distinction between currency and asset (liability) substitution is crucial.[24] The macroeconomic instability of Latin American economies linked to real exchange rate

[21] However, there is still work to do with respect to central bank independence, operational transparency and accountability. For further discussion see Mishkin and Savastano (2000) and Mishkin (2000).
[22] Another caveat is the real meaning of fixed and flexible when we discuss exchange rate regimes. As Calvo and Reinhart (2000) and Levy and Sturzenegger (2000) have pointed out, there is a big gap between what countries say about their exchange rate regimes and what they actually do. In Table No. 2 we use Levy and Sturzenegger (2000) classification index to take into account these considerations.
[23] Calvo (1999) and Hausmann et. al (1999) are also in the same line.
[24] Morón (1997) test the Calvo and Végh (1996) hypothesis for Peru and found a very distinguishable behavior for estimated currency substitution and asset substitution ratios based in a Divisia-type model.

fluctuations is not related to the standard argument that is impossible to pursue an independent monetary policy when currency substitution is widespread. The macroeconomic fluctuations are mostly the consequence of the effects of real exchange rate fluctuations in a liability dollarized banking system and through it in firms and households.

Table No. 3
Dollarization in Latin America (%)

Country	1995	1996	1997	1998	1999	Average	Average Growth Rate
Argentina	43.85	44.81	44.35	56.25	50.81	**48.02**	**2.99**
Bolivia	78.22	80.09	81.12	84.01	87.22	**82.13**	**2.20**
Chile	5.89	4.08	3.74	6.11	8.51	**5.67**	**7.64**
Colombia	9.21	15.70	16.32	13.99	10.46	**13.14**	**2.56**
Costa Rica	31.00	31.50	34.86	36.95	39.94	**34.85**	**5.20**
Ecuador	24.27	28.05	36.84	44.65	71.28	**41.02**	**24.04**
El Salvador	4.32	5.95	7.91	7.88	7.95	**6.80**	**12.97**
Guatemala	11.81	11.57	14.13	12.64	12.93	**12.62**	**1.82**
México	15.76	15.93	13.02	10.89	8.52	**12.82**	**-11.57**
Nicaragua	54.12	60.04	61.13	64.22	62.80	**60.46**	**3.02**
Paraguay	33.25	38.40	42.53	48.15	54.39	**43.34**	**10.34**
Perú	62.48	68.21	66.63	69.54	70.06	**67.38**	**2.32**
Uruguay	82.06	83.26	84.57	84.94	85.07	**83.98**	**0.72**

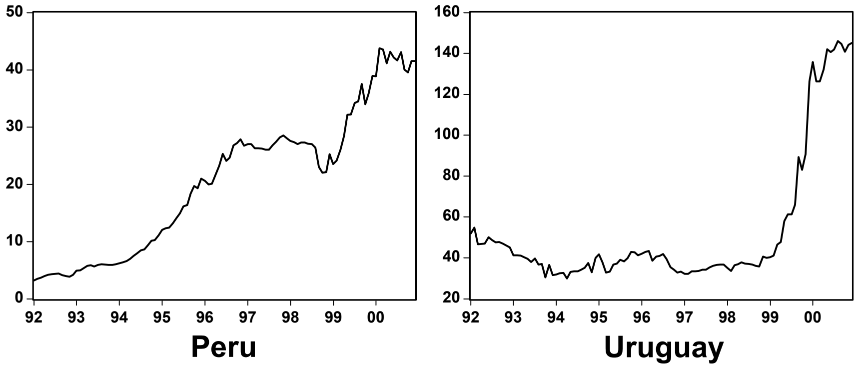
Notes: *The figures correspond to the ratio of dollar deposits at the banking system to M3. All data is from the World Bank except Argentina, Colombia, Guatemala and Uruguay in which the data comes from their Central Banks. We could not find data for Brazil and Venezuela.*

It is not clear which should be the optimal choice of monetary and exchange rate policy if an economy is liability dollarized. Much of the earlier literature focused only in the currency substitution case in which the choice is much easier.[25] However, that is no longer the most critical problem. The low inflation period that the region has enjoyed has regained much weight to the domestic currency in the typical transaction motive for holding money across countries. So, it seems that the hysteresis hypothesis is valid in the asset and liability dollarization but not in the currency substitution process.

Another pain in the neck for those emergent economies that wish to have a floating exchange rate cum inflation targeting is the pass-through coefficient from exchange rate to domestic prices. We calculate 10-year rolling estimates of this coefficient for Peru and Uruguay.[26] The results are in Figure 2. Surprisingly, the half-life of an exchange rate shock has been increasing substantially in the 90s. This could be interpreted as a significant reduction in the inflationary inertia after successful disinflation programs or as an improvement in the credibility of the central banks. These results goes against what is the conventional wisdom that suggest that emergent economies that have experienced high and recurrent inflation periods should be characterized as economies with high pass-through coefficients.

[25] If an economy faces nominal [real] shocks more often than real [nominal] shocks, the optimal regime is a fixed [flexible] exchange rate. See Mundell (1961).
[26] We followed Gonzales (2000) methodology but used 10-year rolling samples.

Figure No. 2
Half-life (in months) of an Exchange Rate Shock for Peru and Uruguay
10-year Rolling Sample (monthly data, 1992 - 2000)



3. A Small Open Economy Model

Based on the previous work of Ball (1999), Leitemo (1999) and specially Svensson (2000) for open economies, we propose a small open economy model that will help us to derive quantitative results about the transmission mechanisms that underlie a liability dollarized economy and discuss the policy options in such economy. The model is a standard forward-looking, rational expectations model, in which the monetary authority has a flexible exchange rate regime and cares about inflation and output variability. We explicitly include the financial vulnerability characteristic as in Bernanke et. al. (1998) and Céspedes et. al. (2000).

We want to answer the question of which is the optimal way to instrument monetary policy for a given set of economy characteristics as discussed in Poole (1970). In our case, the defining characteristic would be the financial robustness or weakness of the economy.

3.1 Supply, Demand and Prices

All variables except the interest rate are in logs and measured as deviations from their long run equilibrium level, in order to work with a stationary system. We use the notation $z_{t+k/t}$ for the rational expectation of z_{t+k} with all the information available at t.

The short run supply curve, the Phillips Curve, of the economy could be written as[27]

$$\pi_{t+2} = \alpha_\pi \pi_{t+1} + (1-\alpha_\pi)\pi_{t+3/t} + \alpha_y y_{t+1/t} + \alpha_q q_{t+2/t} + \varepsilon_{t+2} \qquad \textbf{[1]}$$

where π_t is the domestic inflation at period t, a predetermined variable two periods ahead, while y_t is the output gap. All coefficients of **[1]** are positive constants (α_π is less than one) and the term ε_{t+2} represent zero mean *i.i.d. cost push shock.*

---

[27] In a Calvo price-setting framework, the typical aggregate supply curve from the intertemporal maximization of a representative agent that demands domestic and foreign goods is

$$\pi_t = \theta\pi_{t+1/t} + \omega_y y_t + \omega_q q_t$$

In order to enrich the model dynamics, it's imposed a partial adjustment mechanism and it's also considered a two-period ahead predetermined inflation.

The real exchange rate, q_t, is defined by

$$q_t = s_t + p_t^* - p_t \quad \textbf{[4]}$$

where p_t is the domestic price level, p^*_t is the foreign price level and s_t denotes the nominal exchange rate. On the other hand, aggregate demand could be expressed[28]

$$y_{t+1} = \beta_y y_t - \beta_r r_{t+1/t} + \beta_y^* y_{t+1/t}^* + \beta_q q_{t+1/t} - \beta_\varphi \varphi_{t+1/t} + \eta_{t+1} \quad \textbf{[5]}$$

where y^*_t is the foreign demand and φ_t is the risk premium, which will be a crucial variable on the following analysis. All coefficients in **[5]** are positive and η_{t+1} represents a zero mean *i.i.d.* demand shock. The Fisher equation holds,

$$r_t = i_t - \pi_{t+1/t} \quad \textbf{[6]}$$

and define r_t , as the short term real interest rate (i_t is the short term nominal interest rate). The nominal exchange rate satisfy the uncovered interest parity condition,

$$i_t - i_t^* = s_{t+1/t} - s_t + \varphi_t \quad \textbf{[7]}$$

where i^*_t is the foreign interest rate. Using **[4]** and **[7]** the real interest parity condition is obtained,

$$q_{t+1/t} = q_t + i_t - \pi_{t+1/t} - i_t^* + \pi_{t+1/t}^* - \varphi_t \quad \textbf{[8]}$$

Finally, we assume that foreign output, inflation and interest rate are all exogenous. To keep things simple, the first two follow a first-order autoregressive process, while the third one is determined by a Taylor rule:

$$\pi_{t+1}^* = \gamma_\pi^* \pi_t + \varepsilon_{t+1}^* \quad \textbf{[9]}$$

$$y_{t+1}^* = \gamma_y^* y_t + \eta_{t+1}^* \quad \textbf{[10]}$$

$$i_t^* = f_\pi^* \pi_t^* + f_y^* y_t^* + \xi_{i,t}^* \quad \textbf{[11]}$$

where coefficients are positive (γ^*_π and γ^*_y are less than one) and disturbances are *i.i.d.*

3.2 *Risk Premium and Contractionary Depreciations*

In a general equilibrium setting under price rigidities, the risk premium comes from the correlation between household consumption and the exchange rate.[29] Instead of assuming the risk premium as an exogenous process as in many studies we link its behavior with the net worth of entrepreneurs that are liability dollarized.

An attempt to endogenize the risk premium within a closed economy with asymmetric information and principal-agent problems is presented by Bernanke et. al. (2000). They rely on the premise that the deterioration of domestic credit market conditions not only reflects problems at the real side of the economy, but also there are frictions that might constitute the main depressing factor of economic activity. In other words the credit market works as an amplifier of both nominal and real shocks as in Kiyotaki and Moore (1997). The core of this mechanism, known as the *financial accelerator*, consists of an inverse relation between the external finance premium and the net worth of potential

[28] A micro founded derivation of a similar aggregate demand curve is available in Svensson (2000).
[29] See Chang and Velasco (2000). See also footnote 19.

borrowers. The external finance premium is defined as the difference between the cost of external funds and the opportunity cost of firms to finance their operations with internal resources. The net worth of borrowers is the value of their liquid assets (internal funds) plus the collateral value of their illiquid assets minus non-performing liabilities. Under an underdeveloped domestic financial market and when creditors have limited resources to finance investment projects, the equilibrium implies that lenders will have to be compensated with a larger financial risk premium.

Céspedes et. al. (2000) and Gertler et. al. (2001) extend the previous analysis to an open economy framework in which firms demand dollar-denominated foreign loans and the external finance premium may be thought as an exchange rate risk premium. These authors model the links between the real exchange rate, the net worth of firms and the risk premium, focusing on balance sheet effects and taking as a starting point the budget constraint of firms that engage in investment Considering that the risk premium is an inverse function of the value of the firms' net worth and as the cost of external financing comes as given by the foreign interest rate plus the risk premium, Céspedes et. al. (2000), determine that the evolution of the risk premium follows:

$$\varphi_{t+1} - \varphi_t = -\psi_2 x_t + \psi_2 (y_t - q_t) - \psi_3 [(y_t - y_{t/t-1}) - (q_t - q_{t/t-1})] \quad \textbf{[12]}$$

where all coefficients are positive constants. The change in the risk premium depends on three factors. The first term is related with changes in the demand for exports, denoted as x_t; given an output level, a rise in exports is compensated by a lower investment that requires less external financing and therefore a lower risk premium. The second term captures the effects of changes in output and the real exchange rate, or in real output valued in dollars. A decrease in $y_t - q_t$ (either due a lower y_t or a higher q_t) implies lower levels of investment and again lower financing needs and lower risk premium. Finally, the third term represents the unexpected changes in output measured in dollars, closely linked to firms' net worth. An unanticipated real depreciation increases the burden of the debt (denominated in dollars) that lowers the firms' net worth.

A higher real exchange rate increases the cost of investment relative to firms' net worth. Moreover, lower output levels will reduce the return of previous realized investments. In that sense, a real depreciation or a decline in output might generate positive effects over the risk premium.[30]

Assuming that exports are a linear function of foreign demand and the risk premium is subject to *i.i.d.* disturbances $\xi_{\varphi\, t}$, equation **[12]** could be written as

$$\varphi_{t+1} = \varphi_t - \psi_1 y_t^* + (\psi_2 - \psi_3)(y_t - q_t) + \psi_3 (y_{t/t-1} - q_{t/t-1}) + \xi_{\varphi, t+1} \quad \textbf{[13]}$$

As in Céspedes et. al. (2000) we distinguish two types of economies regarding the impact that balance sheet effects might have. A *financially robust economy* is one in which the transmission channel of a real exchange rate depreciation to output is dominated by the price effect predicted in the textbook case of open economies. A real depreciation increases output in the short run as the external competitiveness of the economy improves. In the other hand, in a *financially vulnerable economy* the depreciation is contractionary, basically due to the dominance of the negative wealth effect over the price effect above mentioned. A real depreciation increases the

[30] Powell and Sturzenegger (2000) use an event study approach to test the relationship between financial fragility and country risk. Excepting Chile and Colombia, the authors find that the country risk will reduce significantly if countries (Argentina, Brazil, Ecuador and Mexico) dollarize.

competitiveness of the economy but at the same time reduces the net worth of firms, as they are liability dollarized.

Using equation **[13]**, the *elasticity of the risk premium to the real exchange* rate is given by:

$$\frac{\partial(\varphi_{t+1}-\varphi_t)}{\partial q_t}=\psi_3-\psi_2=\lambda \qquad \textbf{[14]}$$

In a financially vulnerable economy λ is positive while in a robust one, λ is negative so the direct comparison of the values of ψ_2 and ψ_3 characterize the financial vulnerability. Consequently, there is a mechanism by which the potential positive effect of a real depreciation over the risk premium generates, by the interest parity condition, a higher local interest rate and therefore a recession. Likewise, Hausmann et. al. (2000) suggest that, in a liability dollarized economy with incomplete pass-through, the exchange rate fluctuations have an impact on output via two channels, a direct wealth effect (the balance sheet channel) and a credit channel through an increase in the interest rate. If the first one dominates the second, the depreciation will be contractionary.[31]

Céspedes et.a al. (2000) find that the steady state value of λ is proportional to the ratio dollar-debt to investment (see the first three columns of Table No. 4). A higher dollar debt-to-capital ratio will imply that λ is nonnegative and therefore the economy is more vulnerable.

An alternative approach is suggested by Calvo and Reinhart (2000) with emphasis on the degree of capital mobility. The approach is motivated by depreciations in emerging economies that have suffered from sudden stops in the access to external funding as in Brazil in 1999. Under imperfect capital mobility, there are real balance restrictions that drive consumers to limit their expenditure in non-tradable goods after a real depreciation (assuming inelastic tradable goods), provoking a negative wealth effect. As in the previous case, if this effect dominates the substitution effect, the depreciation will be contractionary. Moreover, these authors suggest that this dominance is empirically plausible as in emergent economies domestic output has a large services component, which are complementary with respect to tradable goods (both capital and consumption goods), as is shown in the fourth column of Table No. 4. The wealth effect is reduced under perfect capital mobility as the real balance and external financing restrictions are relaxed.[32]

The fifth column of Table No. 4 shows the estimated using a specification close to equation **[14]**. A first observation is that 7 LA economies (out of 14 analyzed) satisfied the definition of financial vulnerability. This illustrates the importance of modeling the wealth effect of depreciations, at least for this group of countries. On the other hand, the ratio of the NPV of debt to investment (second column), a more adequate measure of the debt to investment ratio at the steady state, has a clear relationship with the financial

[31] Faced with a negative external shock the Central Bank will tighten the monetary policy (i.e. increasing the interest rate) that will partially offset the exchange rate depreciation. According to Hausmann et.al. (2000), the monetary authority will respond to both nominal and real *shocks*. In an extreme case, when the *pass-through* is zero [one] the interest rate [the exchange rate] loses its role as an effective instrument.

[32] Caballero (2000) argues that two common factors in fragile emergent economies are the weak links with the international financial system and the limited development of the domestic financial markets. Hausmann et. al. (2000) pushes forward the idea that the financial vulnerability of these economies is linked to what he call the *original sin*, i.e. the inability to borrow international in the national currency.

vulnerability measure of these economies as lower ratios correspond to the more robust economies.

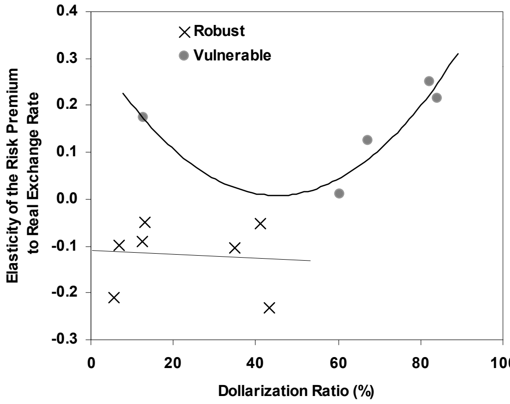
Table No. 4
Financial Vulnerability in Latin America

Country	1 Debt / Investment		2 NPV of Debt to Investment Ratio	3 Private Debt to Investment Ratio	4 GDP Services (% of GDP)		5 Elasticity of Risk Premium to Real Exchange Rate		
	1998	1999	1998	1999	1998	1999	1991.01 - 2000.12		
Bolivia	3.10	3.92	2.51	0.43	62.4	63.5	0.2497	(0.1704)	
Brasil	1.38	1.33	1.31	0.38	62.8	59.9	0.3349	(0.0314)	*
Chile	1.64	2.39	1.96	1.35	57.4	57.4	-0.2105	(0.1638)	
Colombia	1.72	3.07	1.68	1.09	61.0	62.9	-0.0492	(0.0210)	**
Costa Rica	1.40	1.68	1.33	0.55	56.7	56.8	-0.1044	(0.0402)	*
Ecuador	3.11	6.57	2.92	3.45	55.2	50.3	-0.0523	(0.0817)	
El Salvador	1.74	1.85	1.55	0.19	60.4	60.0	-0.0979	(0.0371)	*
Guatemala	1.31	1.44	1.41	0.20	56.6	56.8	-0.0897	(0.0257)	*
México	1.58	1.47	1.54	0.95	66.3	66.8	0.1726	(0.0605)	*
Nicaragua	8.40	6.63	7.38	0.42	45.4	45.7	0.0110	(0.0048)	**
Paraguay	1.17	1.65	1.10	0.06	48.8	46.1	-0.2323	(0.1348)	
Perú	2.12	2.62	2.20	0.67	56.1	55.5	0.1244	(0.0545)	**
Uruguay	3.87	4.13	2.08	1.02	65.3	68.0	0.2136	(0.0462)	*
Venezuela	1.83	2.33	1.86	1.73	59.6	58.5	0.2517	(0.1248)	**
Memo:									
Australia							-0.0994	(0.0377)	*
New Zeland							-0.1082	(0.0406)	*

Notes: *The term "Debt" refers to "External Debt". Columns 1 to 4 correspond to World Bank figures. In column 5 we show estimates of equation **(17)** with monthly data from the IMF, from January 1991 to December 2000 (see Appendix B2 for further details), except Peru and Costa Rica (from January 1992 to December 2000) and Brazil (from January 1994 to December 2000). Figures in parenthesis are standard errors of estimated coefficients, * denotes statistical significance at 5% and ** at 10%.*

Moreover, excluding Chile and Ecuador, the degree of financial vulnerability could be expressed as a function of the ratio of private debt to investment (third column). This is consistent with Céspedes et. al. (2000). Finally, combining information in Tables 3 and 4, we plot in Figure 3 the relationship between liability dollarization and financial vulnerability. The conclusion is as follows; once emergent economies surpass a threshold (40%) the potential contractionary effects of a depreciation are much higher.

Figure No. 3
Dollarization and Financial Vulnerability in Latin America



The model dynamics replicates several stylized facts related to monetary policy and external variables in emergent economies. First of all, the effect of the exchange rate on aggregate demand through **[8]** and **[5]** has a one-period lag. The expectations effect of this variable has even a longer lag as shown in **[1]**. On the monetary policy side, movements in the interest rate generate short run responses in output in the following period. While from **[5]**, the effect on inflation has a two-period lag. This mechanism is consistent with the short run expansionary effect of monetary policy and with the fact that monetary policy has a long control lag.

Finally, in a financially vulnerable economy, the negative wealth effect of a real exchange rate depreciation is observed one period after the substitution effect. An increase in q_t increases $q_{t+1/t}$, y_{t+1} and φ_{t+1}, according to **[8]**, **[5]** and **[14]**, respectively. The lift in the risk premium increases i_{t+1}, r_{t+1} and therefore reduces y_{t+2}, following **[7]**, **[6]**, and **[5]**. In the medium term, the positive substitution effect is lower than the negative wealth effect if $\beta_q < \beta_r$, which is reasonable and plausible.

3.3 *The Central Bank, the Inflation Target and the Optimal Policy*

The Central Bank intervenes in the money market setting a reference interest rate. It's period preferences are represented by a quadratic loss function *á la* Barro-Gordon, in which all variables are expressed as deviations from their target values[33],

$$L_t = \pi_t^{c\,2} + \chi\, y_t^2 \qquad \textbf{[17]}$$

where π^c_t is the CPI inflation at period t. We are assuming that the inflation target measure is a weighted sum between domestic goods and imported goods inflation, which is the common practice among ITers and will probably be the case both in Peru and Uruguay.[34]

The parameter χ in equation **[17]** is a measure of the central bank's concern about targeting just inflation. Depending on its value we have a central bank that strictly cares about the CPI inflation ($\chi = 0$) or adopt a more flexible position ($\chi > 0$). It can also be included more intermediate regimes if the central bank has other objectives as the smoothness of interest rates or the path of the real exchange rate.[35]

In order to introduce the CPI inflation into the model framework, we must suppose a share of imported goods inflation, w, in the CPI index so

$$\pi_t^c = (1-w)\pi_t + w\pi_t^f$$

Considering that $p_t^f = p_t^* + s_t$, the CPI inflation is given by

$$\pi_t^c = \pi_t + w(q_t - q_{t-1})$$

[33] We will assume that target values coincide with equilibrium levels.

[34] Calvo (2000) and Mendoza (2000) argue that the inflation targeting is just a fixed exchange rate regime in disguise as the target is a weighted average of domestic prices and the exchange rate.

[35] Corbo (2000) finds that in the nineties, Chile, Colombia, Costa Rica, El Salvador and Peru, have managed their monetary policies not just looking the inflation rate. He claims that the attention given to other variables (output growth and the real exchange rate) is not just because of improving the predictive power of the inflation rate but those variables represent non formally accepted targets of the monetary policy.

Given the target variables, to find the optimal rule, the Central Bank problem is set *i* to minimize,

$$E_t \sum_{\tau=0}^{\infty} \delta^{\tau} L_{t+\tau} \quad \textbf{[17]}$$

subject to the dynamics of the economy presented above. As usual, $\delta \in (0,1)$ is the discount rate and as known, if $\delta \to 1$, the limit of **[17]** is given by the unconditional expectation, that is,

$$E[L_t] = \mathrm{var}(\pi_t^c) + \lambda\, \mathrm{var}(y_t) \quad \textbf{[18]}$$

Since Kydland and Prescott (1977) the discretionary powers of central bank authorities have been under debate. The problem of minimizing **[17]** is a clear example of that type of behavior and, in a rational expectations framework; we will have a dynamic inconsistency problem. However, the optimality of the discretionary policy is an interesting baseline to evaluate the different strategies that a Central Bank might adopt.

The literature about evaluating alternative monetary policy "fixed" rules has exploded in the last years. However, as we mentioned before there are certain characteristics of the economy that we are considering that warrants the comparison of six different rules, encompassed in the following expression

$$i_t = f_\pi \pi_t + f_{\pi 1} \pi_{t+1/t} + f_y y_t + f_{q1} q_{t-1} + f_q q_t \quad \textbf{[19]}$$

A first group of rules could be dubbed extended Taylor (1993) rules. In all of them set $f_{\pi 1} = 0$. A first example is the simplest Taylor rule given by (we set $-f_{q1} = f_q = f_\pi w$):

$$i_t = f_\pi \pi_t^c + f_y y_t$$

A second possibility is to include real exchange movements as a guide in monetary policy decisions ($-f_{q1} = f_q$)[36], this will render:

$$i_t = f_\pi \pi_t + f_y y_t + f_q (q_t - q_{t-1})$$

A third rule is to let all parameters free except for $f_{\pi 1} = 0$. Therefore the rule could be written as:

$$i_t = f_\pi \pi_t + f_y y_t + f_{q1} q_{t-1} + f_q q_t$$

A second group of rules are closer cousins of Ball (1999) real interest rate targeting. He emphasizes the importance of considering the exchange rate as an informational variable in a small open economy that is normally buffeted by external shocks, through a Monetary Condition Index.[37] In order to do so, we set $f_{\pi 1} = 1$. In this way, our fourth rule could be expressed as:

$$i_t = \pi_{t+1/t} + f_\pi \pi_t + f_y y_t + f_{q1} q_{t-1} + f_q q_t$$

As before, we could restrict this rule to take into account real exchange rate movements and therefore impose the following restrictions ($f_{\pi 1} = 1$, $-f_{q1} = f_q$) to get:

$$i_t = \pi_{t+1/t} + f_\pi \pi_t + f_y y_t + + f_q (q_t - q_{t-1})$$

[36] See Battini et.al. (2000).

[37] In Latin American central banks the MCI is used only as an indicator and not as an intermediate target.

Our last rule is one in which all parameters are free, equation **[19]**.

4. Model Parameterization

The model has to be solved numerically as the solution could not be characterized analytically. We calibrate the parameters of the model with estimates from four different countries. In Appendix 1 we show the results of those estimations for Australia, New Zealand, Peru and Uruguay. On one hand, we used Australia and New Zealand as a benchmark for a financially robust economy. On the other hand, we considered Peru and Uruguay estimates to parameterize the financially vulnerable economy.

The estimated values of the model parameters reflect important differences in the model dynamics of each type of economy. As it is shown in Table No. 5, robust economies show less inflationary inertia and a higher forward looking component in the inflation rate (α_π is 0.3 in the robust and 0.5 in the vulnerable economy). Also, movements in the real exchange rate are more important in vulnerable economies, even though that all four economies used in this study show similar openness ratios and have been subject to the same external shocks (i.e, Asian crisis) in the sample period. In the robust economy, the impact of the exchange rate on the inflation rate in the Phillips curve is 3.5% of the inertia coefficient (α_π) whereas in a vulnerable economy this effect is almost 5 times (17%).

Table No. 5
Model Dynamics Relationships of the Robust and Vulnerable Economies

	Australia	N. Zealand	**Robust**	Peru	Uruguay	**Vulnerable**
Aggregate Supply						
$1-\alpha_\pi$	0.73	0.69	**0.70**	0.55	0.52	**0.50**
α_q / α_π x 100	4.9	2.4	**3.5**	19.0	15.7	**17.0**
α_y / α_π x 100	30.3	23.1	**25.0**	13.1	7.5	**10.0**
$\alpha_y \times \beta_y$ x 100	6.6	6.0	**6.0**	2.4	2.0	**2.2**
Aggregate Demand						
β_q / β_y x 100	3.9	4.1	**4.0**	7.0	6.9	**7.0**
β_{y^*} / β_y x 100	11.0	12.2	**11.5**	87.9	72.8	**80.0**
β_q / β_r x 100	39.1	41.6	**40.0**	82.3	80.7	**80.0**
$\beta_\varphi / \beta_q \times \lambda_{\varphi q}$	-0.02	-0.01	**0.0**	0.64	1.11	**1.08**
Risk Premium Equation						
$\lambda_{\varphi q} = \psi_3 - \psi_2$	-0.08	-0.09	**-0.09**	0.12	0.21	**0.17**
ψ_1 / β_{y^*} x 100	80.5	17.9	**50.0**	167.2	133.9	**150.0**
α_q / ψ_2 x 100	6.4	3.0	**4.5**	27.7	21.5	**25.0**

Note: *Based on the estimates in Appendix 1*

In a similar fashion, the impact of the real exchange rate on the output gap, measured in the aggregate demand equation, are quite different. The ratio β_q/β_y is 4% in the robust case and 7% in the vulnerable one. The ratio β_q/β_r captures the relative importance of two different channels in the aggregate demand. One is the typical price effect of a real depreciation that increases exports and therefore increases aggregate demand, the other is the impact of monetary policy decisions in the aggregate demand through the typical credit channel. In the robust economy the dominant effect is the latter while in the vulnerable economy the former dominates.

In the same vein, the ratio β_φ / β_q measures the importance of the balance sheet channel. The ratio in the robust economy is 0%, whereas in the vulnerable economy the impact of the real exchange rate relative to the impact of the interest rate on aggregate demand is 1.08%. Finally, while in a robust economy the impact of external demand shock represents 11.5% of the domestic shocks (β_{y^*} / β_y) in the vulnerable economy this figure is 80%.

The ratio ψ_1 / β_{y^*} could be thought as the basis points decreased (increased) in the risk premium vis-à-vis an increase (decrease) in output given a positive (negative) shock in the external demand. In a robust economy this ratio is 50% while in a vulnerable economy is 150%. Finally, the ratio α_q / ψ_2 reflect the increase in inflation vs. the increase in the risk premium in the event of a real depreciation. While for the robust economy the ratio is 4.5%, a vulnerable economy has a ratio of 25%.

Based on these ratios and relationships the parameter values used for the simulations are reported in Table No. 6. It is important to emphasize that the differences between a robust and a vulnerable economy lie on the differences in the risk premium equation and in the importance of domestic *vis-à-vis* external shocks. In order to compare the simulated variances, we set all shock variances to 0.5, excepting the Phillips curve and aggregate demand that are set to 1.0. Finally, the share of imported goods in the CPI inflation is set to w = 0.3.

Table No. 6
Baseline Parameters for the
Robust and Vulnerable Economies

Aggregate Supply and Aggregate Demand
[1], **[5]** and **[3]**

	Robust	Vulnerable		Robust	Vulnerable
α_π	0.300	0.500	β_r	0.032	0.031
α_y	0.075	0.050	β^*_y	0.092	0.352
α_q	0.011	0.085	β_q	0.013	0.025
β_y	0.800	0.440	β_φ	0.000	0.148

Risk Premiun Equation and External Variables
[16], **[11]**, **[12]** and **[13]**

	Robust	Vulnerable		Both
ψ_1	0.046	0.528	γ^*_π	0.95
ψ_2	0.233	0.340	γ^*_y	0.90
ψ_3	0.148	0.509	f^*_π	0.76
$\lambda_{\varphi q}$	-0.086	0.169	f^*_y	0.43

5 Model Solution and Simulations

In this section we present three exercises in order to answer the question of which is the best way to conduct an IT regime conditional on the economy type. First of all, we compute the optimal policy rule without restrictions on the set of policy indicators. Then, we restrict our attention to fixed rules in which a much narrow set of indicators is used to guide monetary policy. Instead of calibrate the parameters associated with those rules we compute optimized coefficients for each rule. Finally, we study the optimality of a non linear policy rule for the financially vulnerable economy case.

5.1 The Optimal Rule

Given a baseline assumption that $\chi = 0.5$, the optimal policy rule for each case is shown in Table No. 7. As the central bank cares about the CPI inflation, the reaction function includes almost all variables in the system as the real exchange rate is a forward looking variable.[38]

Table No. 7
Optimal Rule for Robust and Vulnerable Economies

Economy	π_t	y_t	π_t^*	y_t^*	i_t^*
Robust	1.508	0.643	-0.447	0.086	0.440
Vulnerable	1.369	0.067	-0.587	0.432	0.524
Economy	φ_t	q_{t-1}	$\pi_{t+1/t}$	$q_{t/t-1}$	$y_{t/t-1}$
Robust	0.590	-0.422	0.244	-0.065	0.022
Vulnerable	1.197	-0.411	0.071	-0.291	0.343

The coefficient on expected inflation is larger in the robust economy as we expect because of less inflationary inertia in the robust economy *vis-à-vis* the vulnerable economy. One of the most important variables in the vulnerable economy is the risk premium. This is completely as expected as fluctuations in the risk premium transmit that volatility to the output gap, the real exchange rate and inflation. In general, the vulnerable economy shows higher coefficients in all external variables. One striking result is the fact that the output gap plays almost no role in the reaction function in the vulnerable economy case.

The variances of the most relevant variables under an optimal rule are:

Table No. 8
Unconditional Standard Deviations under the Optimal Rule

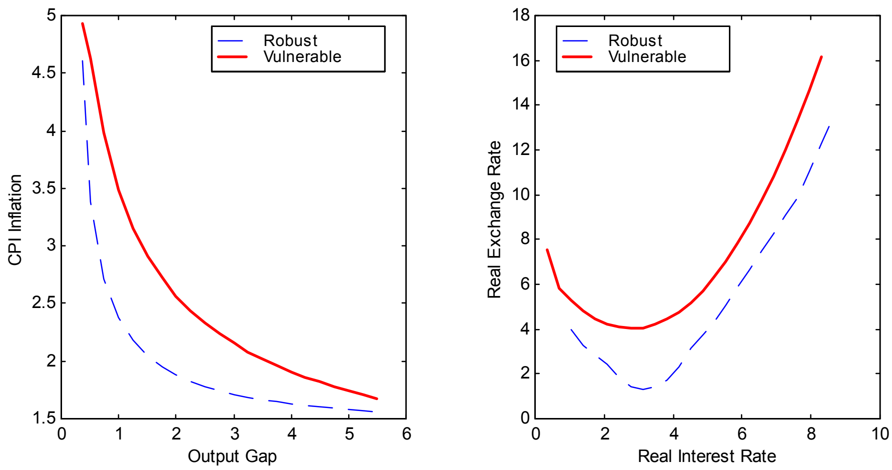
Economy	π_t^c	π_t	y_t	i_t	r_t	q_t	$E[L_t]$
Robust	1.868	1.440	1.930	2.331	3.971	3.768	**3.936**
Vulnerable	3.265	2.044	2.189	3.216	5.410	8.888	**6.574**

[38] This represents a trade-off for the Central Bank as it is much more transparent to target the CPI inflation but is much easier to comply with a domestic inflation target. In a heavily dollarized economy is obvious that market participants will question the response of the Central Bank regarding the exchange rate.

As expected the robust economy is significantly less volatile than the robust one. There is more structural volatility in the robust economy. In particular, the major source of volatility in the vulnerable economy comes from real exchange rate fluctuations. We simulate in Figure No. 4 the variance frontiers for both economies with different preferences in the loss function. A low value of χ represents a "hawkish" central, while a value of χ = 1 represents a "dove" central bank that is more concerned about the output gap instead of the inflation rate. A first result is the variance dominance of the robust economy compared to a financially vulnerable economy. As shown in Figure 4 a central bank too hawkish may exacerbate the volatilities of the real exchange rate and the real interest rate. The reason behind might be that the central bank has to behave in a much more discretionary form if chooses to be too hawkish. In particular, it will be willing to intervene in the money market and in the exchange rate market to stop any deviation in the inflation target. This evidence suggests that it might be optimal to have a flexible IT regime (as the baseline assumption) instead of a strict one.

<u>Figure No. 4</u>

Variance Frontiers for Robust and Vulnerable Economies under the Optimal Rule



5.2 Alternative Rules

As our goal is try to shed some light in which type of rules might be optimal for economies in which balance sheet effects matter we simulate the six types of rules presented in the above section for both classes of economy. The results (optimized coefficients) are presented in Table No. 9 and in Table No. 10 we present the variances associated with those optimized rules.

We can draw several conclusions out of this simulation exercise. First of all, in both economies Ball-type rules are superior. However, this is much clearer in the vulnerable economy where the difference of including the real exchange rate depreciation is significant. Another expected and clear result is that simpler rules come with a price in terms of higher volatility. Again the difference is much stronger in the vulnerable economy. This might support the hypothesis that in vulnerable economies make sense to look a wider set of indicators to design the monetary policy, with special attention in the exchange rate

Table No. 9

Simple Fixed Rules for Robust and Vulnerable Economies

Robust Economy		π_t	$\pi_{t+1/t}$	y_t	q_{t-1}	q_t
Rule 1	$f_{\pi 1}=0, \quad -f_{q1}=f_q=f_\pi w$	1.217	-	0.208	-0.365	0.365
Rule 2	$f_{\pi 1}=0, \quad -f_{q1}=f_q$	1.152	-	0.259	-0.228	0.228
Rule 3	$f_{\pi 1}=0$	0.836	-	0.380	-0.202	0.549
Rule 4	$f_{\pi 1}=1, \quad -f_{q1}=f_q$	1.878	1.000	0.830	-0.536	0.536
Rule 5	$f_{\pi 1}=1$	1.106	1.000	0.396	-0.236	0.507
Rule 6	Unrestricted parameters	0.741	0.783	0.440	-0.338	0.403
Vulnerable Economy		π_t	$\pi_{t+1/t}$	y_t	q_{t-1}	q_t
Rule 1	$f_{\pi 1}=0, \quad -f_{q1}=f_q=f_\pi w$	0.787	-	0.056	-0.236	0.236
Rule 2	$f_{\pi 1}=0, \quad -f_{q1}=f_q$	0.761	-	0.066	-0.190	0.190
Rule 3	$f_{\pi 1}=0$	1.139	-	0.173	-0.099	0.610
Rule 4	$f_{\pi 1}=1, \quad -f_{q1}=f_q$	0.723	1.000	0.052	-0.280	0.280
Rule 5	$f_{\pi 1}=1$	1.142	1.000	0.159	-0.198	0.650
Rule 6	Unrestricted parameters	1.168	0.526	0.104	-0.050	0.613

Table No. 10

Unconditional Standard Deviations under Alternative Fixed Rules

Robust Economy	π_t^c	π_t	y_t	i_t	r_t	q_t	$E[L_t]$
Rule 1	1.874	1.989	2.177	5.331	6.081	4.876	**4.362**
Rule 2	1.826	1.938	2.173	5.403	5.956	5.060	**4.308**
Rule 3	1.109	1.486	2.190	5.750	6.287	2.619	**3.467**
Rule 4	1.517	1.468	2.183	6.048	6.564	0.771	**4.172**
Rule 5	1.113	1.487	2.190	5.738	6.275	2.638	**3.464**
Rule 6	1.122	1.482	2.189	5.712	6.245	2.653	**3.459**
Optimal	1.951	1.742	1.808	3.215	4.448	3.003	**3.237**
Vulnerable Economy	π_t^c	π_t	y_t	i_t	r_t	q_t	$E[L_t]$
Rule 1	2.610	2.029	2.984	3.702	4.069	4.871	**6.317**
Rule 2	2.644	2.066	2.810	3.645	4.166	4.778	**6.134**
Rule 3	2.128	2.340	2.822	3.180	3.727	2.128	**4.761**
Rule 4	2.078	2.711	2.785	3.163	3.848	3.658	**4.598**
Rule 5	2.113	2.340	2.895	3.200	3.735	2.168	**4.840**
Rule 6	2.086	2.340	2.484	3.171	3.723	2.097	**4.221**
Optimal	2.177	2.315	2.211	3.018	3.331	4.192	**4.047**

5.3 On the Optimality of a (Nonlinear) Fear of Floating Rule

Lahiri and Végh (2001) show that in economies in which fluctuations in the real exchange rate might cause serious damage in terms of output it will be optimal to follow a *fear on floating* rule. This is a non-linear policy rule that calls for a different response conditional on the size of the shock. If the shock is severe the optimal policy is to avoid completely any perturbation of the real exchange rate whereas if the shock is small the rule will suggest "let the currency float".

We try a similar non-linear rule for the vulnerable economy to study if we can find supporting evidence to the theoretical model of Lahiri and Végh (2001). Based on rule 4, we simulate the following non-linear monetary policy rule:

$$i_t = f_\pi \pi_t + f_{\pi 1}\pi_{t+1/t} + f_y y_t + f_q(q_{t+1/t} - q_t) \qquad \text{if} \quad q_{t+1/t} - q_t \leq \bar{q}$$

$$i_t = f_\pi \pi_t + f_{\pi 1}\pi_{t+1/t} + f_y y_t + (f_q + \theta_q)(q_{t+1/t} - q_t) \quad \text{if} \quad q_{t+1/t} - q_t > \bar{q}$$

The idea is that the monetary authority will follow the linear rule only if the real exchange rate depreciation does not exceed to a certain threshold $(\bar{q})$. If the shock is larger than the threshold, the authorities will set a stricter monetary policy stance. The intensity of this response is defined by θ_q. The logic is simple and reminiscent of what central bankers in the region do in turbulent times.

We compare this non-linear policy with the optimal linear policy that we found in our previous analysis. To capture in a simple way we construct a variance ratio:

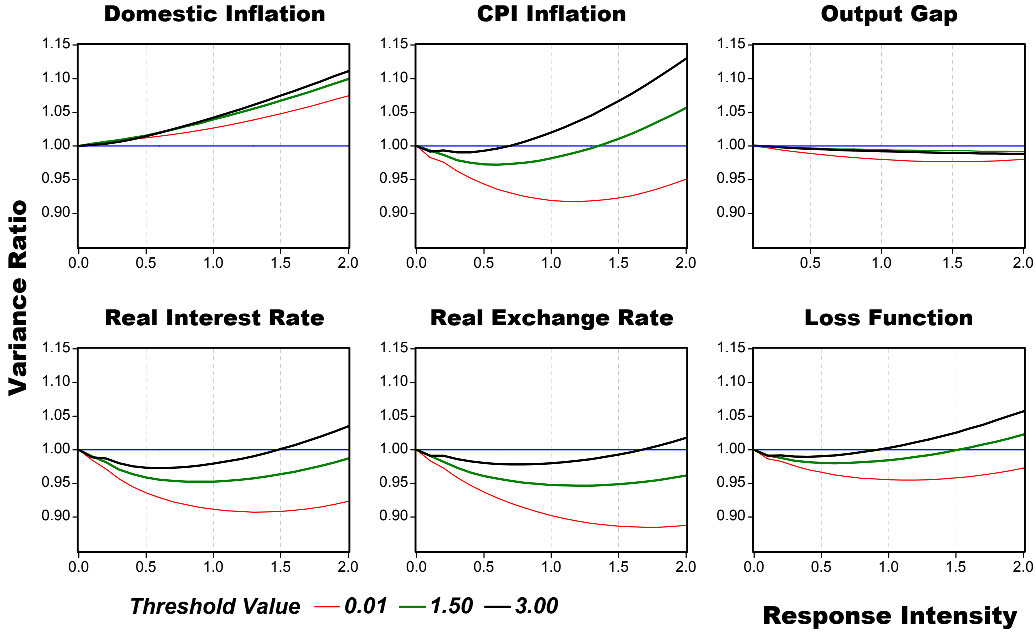
$$\nu = \frac{\text{var}(x^{Nonlinear})}{\text{var}(x^{optimal})}$$

where ***x*** is a particular variable of interest. Therefore when the variance ratio $\nu < 1$ the *non-linear rule* would be better compared to the optimal linear rule. We want to obtain a relationship between the key parameters of the non-linear policy rule $(\theta_q, \bar{q})$ and the optimal policy rule.

With this is mind we simulate T = 1000 periods of the model. We generate data that comes out of the model assuming normal errors with unit variance and nondiagonal var-cov matrix. We did 10,000 repetitions of this experiment and report the mean values. We performed the simulations for three different values of the threshold value (0.01, 1.50, and 3.00) and plot in Figure No.5 the variance ratios for different values of the response intensity parameter.

In each panel, we explore the optimality of the non-linear vis-à-vis the best linear policy. As we can see the non-linear rule is optimal for a significant part of the parameter space. A larger concern for the real exchange rate generates more volatility in domestic inflation, but less volatility on the CPI inflation. This result depends on the pass-through intensity. But it also depends on the adverse effect of the balance sheet channel. As the real exchange rate volatility is lower, the risk premium volatility goes down whereas the output gap volatility is almost the same in both policy rules.

Figure No.5
Comparing a Non-Linear Policy Rule vs.
the Optimal Linear Policy in a Vulnerable Economy



Interestingly, as the threshold value is smaller, the volatilities of all variables are lower. The $\overline{q} = 0.01$ case should be thought as an almost fixed exchange regime. This result should come with a warning. We are not considering in the model the pervasive dynamics that comes out of following a *fear of floating* rule. If the central bank consistently avoids large fluctuations in the exchange rate will incentive firms and households to have a larger exposure to dollar denominated liabilities. Thus, the economy will become even more vulnerable as before. Obviously, this is one issue that we need to explore is the optimality of this policy with a model that takes into account this effect. And for that matter we are also ignoring the possible costs in terms of losing reserves responding to the external shocks.

If we rule out the almost fixed exchange rate case, we will find supporting evidence to the claim that in the case of a financially vulnerable economy it makes sense to have a non-linear monetary policy rule that defends the exchange rate with a stronger response in the case of turbulent times but allows the exchange rate to float in tranquil times. In the last panel we show the behavior of the variance ratio for the loss function of the Central Bank. In that panel we can see that the optimal response intensity is to add an extra 60 basis points to the interest rate given a one percent depreciation in the real exchange rate.

6. Final Remarks

This paper has been written from the perspective of the Central Bank that chooses to adopt an IT regime within a very special set of initial conditions: an emergent economy with highly dollarized liabilities. Therefore, we have addressed the issue assuming that the Central Bank has chosen to "walk the talk" and we explore the optimal way to do it within a simple model that captures the striking characteristics of the economy. For that purpose we compare the optimality of several alternative rules.

We calibrate a small open economy model for two types of economies. Following Céspedes et. al. (2000) and Gertler et. al. (2001) we consider explicitly the possibility of a financially robust and a vulnerable economy. In the last ones, real exchange rate fluctuations may have pervasive real effects. We use data for Australia and New Zealand to calibrate the robust economy and Peruvian and Uruguayan data for the financially vulnerable economy. We found empirical support to the hypothesis of a financially vulnerable economy as suggested by Céspedes et. al. (2000) as the elasticity risk premium-real exchange rate is –0.10 in the robust case and 0.15 in the vulnerable case.

Along that line, our main result suggests the optimality of defending the real exchange rate if the economy is financially vulnerable. However, the real exchange rate cannot be a target of the monetary policy in the long run. There is no way that the monetary policy could influence in the long run a real variable. Even though in the short term there might be some effectiveness in appreciation or depreciation the exchange rate, in the long run all will be reversed.

The perils of following unsustainable policies are that they promote (instead of curb) behavior that will add (in the future) more vulnerability to the economy. For example, if the central bank bails out the banks or firms consistently, they will take a much higher risk increasing the balance sheet issues. The same happens if the central bank has an implicit defense of the exchange rate within a flexible inflation targeting framework, like the nonlinear rule presented in section 5.3. Instead of fostering more hedging they will end up having more open positions in foreign currency. If the inflation targeting turns out to be an exchange rate targeting in disguise the balance sheet effects will tend to be higher. Another peril is that if governments consistently react either bailing out firms and banks after a real exchange rate depreciation or intervening in the exchange rate market to avoid financial distress will provide an incentive to underinsurance against that risk or taking more dollar-denominated debt. The inflation targeting might work in terms of attaining the targets but the consequences might be that firms become more prone to dollar-denominated debts as governments are reluctant to let them go bankrupt. This calls for further research on the feasibility of follow IT regimes in highly dollarized economies.

Even though one possible gain of adopting an IT strategy is that extends the relevant horizon of the monetary policy is still a very imperfect mechanism to tackle unresolved issues in financially vulnerable economies. It might be quite useful to guide inflation expectations but not to reduce liability dollarization problems.

References

[1] Agenor, Pierre-Richard (2000) "Monetary Policy Rules under Flexible Exchange Rates: An Introduction to Inflation Targeting", mimeo, The World Bank.

[2] Armas, Adrian, Francisco Grippa, Zenon Quispe and Luis Valdivia (2001) "De metas monetarias a metas de inflación en una economía con dolarización parcial: El caso peruano", *Revista Estudios Económicos*, 7, Banco Central de Reserva del Peru.

[3] Ball, Lawrence (1999) "Policy Rules for Open Economies", in John. B. Taylor (ed.) *Monetary Policy Rules*, Chicago: University of Chicago Press.

[4] Battini, Nicoletta, Richard Harrison and Stephen Millard (2001) "Monetary Policy Rules for an Open Economy", mimeo, Bank of England.

[5] Bernanke, B., M. Gertler and S. Gilchrist (2000) "The Financial Accelerator in a Quantitative Business Cycle Framework", in John B. Taylor and Michael Woodford (eds.), *Handbook of Macroeconomics*, Vol.3, North Holland.

[6] Bodgansky, Joel, Alexandre Tombini and Sergio Ribeiro da Costa Werlang (2000) "Implementing Inflation Targeting in Brazil", July, Banco Central do Brasil Working Paper No.1.

[7] Bogdansky, Joel, Ilan Goldfajn, Paulo Springer de Freitas and Alexandre Tombini (2001) "Inflation Targeting in Brazil", Working Paper No 10, Banco Central do Brasil.

[8] Caballero, Ricardo and Arvind Krishnamurthy (2000) "Dollarization of Liabilities: Underinsurance and Domestic Financial Underdevelopment", *NBER Working Paper 7792*.

[9] Caballero, Ricardo and Arvind Krishnamurthy (2001) "International and Domestic Collateral Constraints in a Model of Emerging Market Crises", forthcoming in the *Journal of Monetary Economics*.

[10] Calvo, Guillermo (2000) "Capital Markets and the Exchange Rate. With Special Reference to the Dollarization Debate in Latin America", mimeo, University of Maryland at College Park.

[11] Calvo, Guillermo and Carmen Reinhart (2000) "Fear of Floating", *NBER Working Paper 7993*.

[12] Castro, Juan Francisco and Eduardo Morón (2000) "Uncovering the Central Bank's Monetary Policy Objectives: Going Beyond Fear of Floating", Universidad del Pacifico Working Paper.

[13] Céspedes, Luis, Roberto Chang and Andres Velasco (2000) "Balance Sheets and Exchange Rate Policy", *NBER Working Paper 7840*.

[14] Clarida, Richard, Jordi Gali and Mark Gertler (1998) "Monetary Policy Rules in Practice: Some International Evidence", *European Economic Review*, 42, pp. 1033-1067.

[15] Clarida, Richard, Jordi Gali,and Mark Gertler (2000), "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory", *Quarterly Journal of Economics*, 115 (February), pp.147–80.

[16] Clarida , Richard, Jordi Gali and Mark Gertler (2001) "Optimal Monetary Policy in Open versus Closed Economies: An Integrated Approach", mimeo, Columbia University.

[17] Cook, David (2000) "Liability Dollarization and Stability: Monetary Policy and Foreign Currency Debt", mimeo, Hong Kong University of Science and Technology.

[18] Corbo, Vittorio (2000) "Monetary Policy in Latin America", *Central Bank of Chile Working Paper 78*.

[19] Corbo, Vittorio and Klaus Schmidt-Hebbel (2001) "Inflation Targeting in Latin America", mimeo, Central Bank of Chile.

[20] Devereux, Michael and Phillip Lane (2000) "Exchange Rates and Monetary Policy in Emerging Market Economies", mimeo.

[21] Druck, Pablo, Eduardo Morón and Ernesto Stein (2001) "The Twin Risks in the Dollarization Debate: Country and Devaluation Risk", mimeo, CEMA, IADB, and Universidad del Pacifico.

[22] Eichengreen, Barry and Ricardo Hausmann (1999) "Exchange Rates and Financial Fragility", *NBER Working Paper 7418*.

[23] Eichengreen, Barry, Paul Masson, Miguel Savastano and Sunil Sharma (1999) "Transition Strategies and Nominal Anchors on the Road to Greater Exchange Rate Flexibility", *Princeton Essays in International Economics*.

[24] Eika, Kari, Neil Ericsson and Ragnar Nymoen (1997) "Hazards in Implementing a Monetary Conditions Index", in A. Banerjee and D. Hendry (eds.), *The Econometrics of Economic Policy*, Blackwell Publishers.

[25] Frankel, Jeffrey, Sergio Schmukler and Luis Serven (2000) "Verifiability and the Vanishing Intermediate Exchange Rate Regime", mimeo, World Bank.

[26] Garcia, Pablo, Luis Oscar Herrera and Rodrigo Valdés (2000) "New Frontiers for Monetary Policy in Chile", mimeo, Central Bank of Chile.

[27] Gerlach, Stefan and Frank Smets (2000) "MCIs and Monetary Policy", *European Economic Review* 44, 1677-1700.

[28] Gertler, M, S. Gilchrist, and F. Natalucci (2001) "External Constraints on Monetary Policy and the Financial Accelerator", mimeo, NYU.

[29] Ghironi, Fabio and Alessandro Rebucci (2000) "Monetary Rules for Emerging Market Economies", mimeo, Federal Reserve Bank of New York and International Monetary Fund

[30] González, José Antonio (2000) "Exchange Rate Pass-Through and Partial Dollarization: Is there a Link?", mimeo, Stanford University.

[31] Hausmann, Ricardo, Ugo Panizza and Ernesto Stein (2000) "Why do Countries Float the Way They Float?", *IADB Working Paper 418*.

[32] Kiyotaki, Nobuhiro and John Moore (1997) "Credit Cycles", *Journal of Political Economy* 105, 211-248.

[33] Klein, Paul (2000) "Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model", *Journal of Economic Dynamics and Control*, 24, 10, 1405-1423.

[34] Kumhoff, Michael (2000) “A Critical View of Inflation Targeting: Crises, Limited Sustainability, and Aggregate Shocks”, mimeo, Stanford University.

[35] Lahiri, Amartya and Carlos Végh (2001) “Living with the Fear of Floating: An Optimal Policy Perspective”, mimeo, UCLA.

[36] Leitemo, Kai (1999) “Inflation Targeting Strategies for Small Open Economies”, mimeo, Central Bank of Norway.

[37] Levy-Yeyati, Eduardo and Federico Sturzenegger (2000) “Classifying Exchange Rate Regimes: Deeds vs. Words”, mimeo, CIF-UTDT.

[38] Licandro, José Antonio (2000) “The Scope for Inflation Targeting in Uruguay”, mimeo, Banco Central del Uruguay.

[39] Masson, Paul, Miguel Savastano and Sunil Sharma (1997) “The Scope for Inflation Targeting in Developing Countries”, *IMF Working Paper 97/130*.

[40] Masson, Paul (2000) “Exchange Rate Regime Transitions”, *IMF Working Paper 00/134*.

[41] Martínez, Lorenza, Oscar Sánchez and Alejandro Werner (2001) “Consideraciones sobre la Conducción de la Política Monetaria y el Mecanismo de Transmisión en México”, mimeo, Banco de México.

[42] Medina, Juan Pablo and Rodrigo Valdés, (2000), “Optimal Monetary Policy Rules under Inflation Range Targeting”, *Banco Central de Chile Working Paper*.

[43] Mishkin, Frederic (2000) “Inflation Targeting in Emergent Market Countries”, *American Economic Review*, May.

[44] Mishkin, Frederic (2000) “Issues in Inflation Targeting”, mimeo, Columbia University.

[45] Mishkin, Frederic and Miguel Savastano (2000), “Monetary Strategies for Latin America”, *NBER Working Paper 7617*.

[46] Morandé, Felipe and Klaus Schmidt-Hebbel (2000) “Monetary Policy and Inflation Targeting in Chile”, in M. Blejer, A. Ize, A. Leone and S. Werlang (editors): *Inflation Targeting in Practice: Strategic and Operational Issues and Application to Emerging Market Economies*, International Monetary Fund, Washington DC.

[47] Mundell, Robert (1961) “A Theory of Optimum Currency Areas”, *American Economic Review*, 51, 5, 657-665.

[48] Parrado, Eric and Andres Velasco (2001) “Optimal Interest Rate Policy in a Small Open Economy”, mimeo NYU and Harvard University.

[49] Perry, Guillermo (2001) “How much value is there in LAC currencies? Or When is it worth Giving up Your Currency”, mimeo, World Bank.

[50] Powell, Andrew and Federico Sturzenegger (2000) “Dollarization: The Link between Devaluation and Default Risk”, mimeo, UTDT.

[51] Poole, William (1970) “Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model”, *Quarterly Journal of Economics*, 84,2, 197-216.

[52] Robertson, John and Ellis Tallman (1999) “Vector Autoregressions: Forecasting and Reality”, *Federal Reserve Bank of Atlanta Economic Review*, 1st Quarter, 4-19.

[53] Sims, Christopher (1998) “Solving Linear Rational Expectations Models”, mimeo, Princeton University.

[54] Svensson, Lars E.O. (2000) “Open Economy Inflation Targeting”, *Journal of International Economics*, 50, pp.155-183.

[55] Taylor, John B. (1993), “Discretion versus Policy Rules in Practice”, *Carnegie Rochester Conference Series on Public Policy*, 39, 195-214.

[56] Taylor, John B. (ed.) (1999), *Monetary Policy Rules*, Chicago: University of Chicago Press.

[57] Taylor, John B. (2000), “Using Monetary Policy Rules in Emerging Market Economies”, mimeo, Stanford University.

[58] Tornell, Aaron (2000) “Financial and Monetary Policy in an Economy with Balance Sheet Effects”, mimeo, UCLA and NBER.

[59] Velasco, Andres (2000) “Exchange-Rate Policies for Developing Countries: What Have We Learned? What Do We Still Not Know?, *G-24 Discussion Paper Series*, No.5.

[60] Walsh, Carl (2000) “Accountability, Transparency and Inflation Targeting”, mimeo, UC Santa Cruz.

[61] Williamson, John (2000) “Exchange Rate Regimes for Emerging Markets: Reviving the Intermediate Option”, Policy Analysis in International Economics 60, Institute for International Economics.

[62] Woodford, Michael (1994), “Nonstandard Indicators for Monetary Policy: Can Their Usefulness be Judges from Forecasting Regressions?”, in Mankiw, Gregory N. (ed.), *Monetary Policy*, The University of Chicago Press.

Appendix 1
SUR Estimates for Robust and Vulnerable Economies

We use monthly data from the IMF from January 1990 to June 2001, except in the case of Peru in which the database starts in January 1992, because of the high inflation rates at the beginning of the 90s. The variables included are, following IMF definitions, the nominal exchange rate, the discount rate in domestic currency, the CPI inflation, the real GDP (1995=100), the CPI of the USA, the USA index of industrial output, and the 3-month LIBOR rate. In all cases the GDP data is published quarterly, except in Peru in which the GDP index is published monthly by the Central Bank. In order to use monthly data we used the Chow and Lin extrapolation technique, as explained in Robertson and Tallman (1999). With these data, the model variables were computed in the following way:

s log of the nominal exchange rate minus its HP trend.

π year-to-year variation of CPI (demeaned)

π^* year-to-year variation of USA CPI (demeaned)

y demeaned annual growth rate of real GDP.

y^* Demeaned US Industrial Production Index rate of annual growth.

q Computed following [4]

The expected variables were instrumented as in Clarida et. al. (1998, 2000) and are the recursive *h*-step-ahead forecasts from a multivariate VAR with all the variables listed before. Once we determine $s_{t+1/t}$ we calculate the risk premium according to **[7]**.

	Australia		New Zealand		Peru		Uruguay	
	1990.01 - 2001.06		1990.01 - 2001.06		1992.01 - 2001.06		1990.01 - 2001.06	

Aggregate Supply

	Australia		New Zealand		Peru		Uruguay	
α_{π}	0.2653	(2.0356)	0.3056	(16.9260)	0.4504	(15.5192)	0.4814	(49.8197)
α_{y}	0.0804	(3.1163)	0.0706	(3.6475)	0.0588	(3.6618)	0.0363	(1.8892)
α_{q}	0.0131	(2.3037)	0.0075	(0.7614)	0.0854	(2.8162)	0.0754	(2.8249)
Standard Error of ε	**0.2684**		**0.2852**		**0.8890**		**0.7026**	
Residuals Jarque-Bera stat	**4.5925**		**6.6114**		**4.2828**		**6.0723**	
Adjusted R-squared	**0.9642**		**0.9480**		**0.9435**		**0.6580**	
Durbin-Watson stat	**1.7157**		**1.8034**		**1.7547**		**2.0913**	

Aggregate Demand and Output Gap

	Australia		New Zealand		Peru		Uruguay	
β_{y}	0.8262	(15.0738)	0.8546	(28.4530)	0.4025	(2.6326)	0.5387	(9.4623)
β_{r}	0.0813	(1.1106)	0.0842	(1.3258)	0.0344	(1.7842)	0.0462	(1.7945)
β^{*}_{y}	0.0907	(0.9314)	0.1041	(2.4259)	0.3540	(6.8828)	0.3923	(1.6966)
β_{q}	0.0318	(2.0715)	0.0350	(2.7080)	0.0283	(1.1298)	0.0372	(0.4847)
β_{φ}	0.0079	(0.4585)	0.0052	(0.2816)	0.1450	(1.5103)	0.1943	(1.4596)
Standard Error of η	**0.4773**		**0.8506**		**1.8814**		**2.1986**	
Residuals Jarque-Bera stat	**5.3578**		**5.6202**		**4.6391**		**5.1970**	
Adjusted R-squared	**0.6347**		**0.8481**		**0.6892**		**0.6395**	
Durbin-Watson stat	**1.8930**		**2.1975**		**2.2589**		**1.8613**	

Risk Premium Equation

	Australia		New Zealand		Peru		Uruguay	
ψ_{1}	0.0730	(0.9036)	0.0186	(0.1396)	0.5917	(3.3503)	0.5252	(1.4952)
ψ_{2}	0.2040	(5.7531)	0.2503	(0.8253)	0.3080	(4.6531)	0.3514	(2.2765)
ψ_{3}	0.1210	(1.5941)	0.1622	(2.2217)	0.4324	(4.1149)	0.5650	(2.3920)
Standard Error of ξ_{φ}	**1.0946**		**1.1072**		**1.0740**		**1.1632**	
Residuals Jarque-Bera stat	**7.0822**		**5.2754**		**1.3248**		**2.1670**	
Adjusted R-squared	**0.2176**		**0.9118**		**0.8511**		**0.7080**	
Durbin-Watson stat	**2.4573**		**2.3259**		**2.1899**		**2.4804**	

External Variables

			Standard Deviations of Residuals	**Residuals Jarque-Bera**	**Adjusted R-squared**	**Durbin-Watson stat**
Inflation						
γ^{*}_{π}	0.9549	(7.8655)	**0.1559**	**1.6190**	**0.9112**	**1.7268**
Demand						
γ^{*}_{y}	0.8999	(9.4942)	**0.6069**	**3.1658**	**0.7887**	**1.9040**
Interest Rate						
f^{*}_{π}	0.7604	(5.9344)	**0.4853**	**2.2867**	**0.2662**	**0.3350**
f^{*}_{y}	0.4254	(6.8773)				

Appendix 2
The State-Space Form of the Model

To solve the model we must express it in its state-space form. It can be shown that the model has the following representation (see Svensson (2000) and Leitemo (1999) for a similar exposition):

$$\begin{bmatrix} X_{t+1} \\ x_{t+1/t} \end{bmatrix} = A \begin{bmatrix} X_t \\ x_t \end{bmatrix} + B_0 i_t + B_1 i_{t+1/t} + \begin{bmatrix} v_{t+1} \\ 0 \end{bmatrix} \quad \textbf{[A.1]}$$

$$Y_t = C_1 \begin{bmatrix} X_t \\ x_t \end{bmatrix} + C_2 i_t \quad \textbf{[A.2]}$$

$$L_t = Y_t' K Y_t \quad \textbf{[A.3]}$$

where X_t denotes a column vector of predetermined state variables, x_t is a vector of *forward-looking* variables, Y_t is the vector of target variables and v_t is the vector of innovations of X_t,

$$X_t = (\pi_t, y_t, \pi_t^*, y_t^*, i_t^*, \varphi_t, y_t^n, q_{t-1}, i_{t-1}, \pi_{t+1/t}, q_{t/t-1}, q_{t-1/t-2}, \pi_{t/t-1}, \varepsilon_{t-1}, y_{t/t-1})'$$

$$x_t = (q_t, \rho_t, \pi_{t+2/t})'$$

$$Y_t = (\pi_t^c, y_t)'$$

$$v_t = (\varepsilon_t, \eta_t^d - \eta_t^n, \varepsilon_t^*, \eta_t^*, f_\pi^* \varepsilon_t^* + f_y^* \eta_t^* + \xi_{i,t}^*, \xi_{\varphi,t}, \eta_t^n, 0, 0, \alpha_\pi \varepsilon_t + \alpha_y \beta_y (\eta_t^d - \eta_t^n), 0,0,0,0,0)'$$

Additionally if $n_1 = \dim(X_t)$, $n_2 = \dim(x_t)$, $n_3 = \dim(Y_t)$ and $n = n_1 + n_2$, A is a coefficient n matrix, B_0 and B_1 are $n \times 1$ vectors of coefficients, C_1 is a $n_3 \times n$ matrix , C_2 is a $n_3 \times 1$ vector and K is a n_3 diagonal matrix which elements correspond to the weights of equation **[15].**

Given the linearity of the model **[A.1]** – **[A.3]**, the dynamics of this economy could be expressed exclusively in terms of the predetermined variables,

$$X_{t+1} = G_{11} X_t + v_{t+1} \quad \textbf{[A.4]}$$

$$x_t = H X_t \quad \textbf{[A.5]}$$

$$i_t = f X_t \quad \textbf{[A.6]}$$

$$Y_t = (C_{11} + C_{12} H + C_2 f) X_t \quad \textbf{[A.7]}$$

where, following Svensson (2000), the n matrix G is defined as:

$$G = (I - B_1 F)^{-1} \left(A \begin{bmatrix} I & 0 \\ H & 0 \end{bmatrix} + B_0 F \right)$$

with $F = [f, 0, 0, 0]$ and the matrices G and C_1 are partitioned according to X_t and x_t.

The representation [A.4] – [A.7] helps us to understand the logic of the model. From a discretionary perspective, f and H are endogenously determined so as to minimize [19] (like a standard linear-quadratic regulator problem, that implies iterations over a Ricatti equation). Contrarily, if the Central Bank has committed to follow a fixed rule, the vector f is determined exogenously and the system is solved just for H, using the solution algorithms proposed by Sims (1998) and Klein (2000).