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Assessing the Impact of Real Shocks on Small Dollarized Economies

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Abstract

This paper compares the impact of real shocks on small open economies operating under two opposite corner solutions: flexible exchange rates and official dollarization. Using an asymmetric two-country model of policy coordination, we show that although a pegged regime like dollarization is an effective device to achieve price stability, small open economies might be better off under a flexible exchange rate regime than under dollarization following any symmetric or asymmetric real shock. We also consider the claim that many small economies have only a limited ability to use their own monetary policy effectively and contrast the dollarization regime with one in which a small open economy follows "fear of floating" practices. In this case, we observe that unless its size is trivial, maintaining monetary policy sovereignty—even if it is not fully exploited—allows the domestic economy to experience lower losses from stabilization in the face of symmetric shocks. Only when an economy is negligibly small, are the costs of stabilization following "fear of floating" practices the same as those under dollarization.

Key words: Credibility problems; dollarization; fear of floating; real shocks
JEL Classification: E52, E58, E61, F15

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1 Introduction

During the 1990s several Emerging Market Economies (EMEs) operating under intermediate regimes (i.e. fixed but adjustable arrangements) suffered severe crises following the appearance of speculative attacks. A number of currencies, including the Mexican peso (in 1994), the East Asian currencies (starting in 1997) and the Brazilian real (in 1999) experienced considerable capital flow reversal that produced an astounding toll on their economies.

These crisis episodes led to the 'two-corner solutions' approach to exchange rate policy, which suggests that countries should either float freely or implement a strong (non-adjustable) pegged regime in order to avoid credibility problems.[1] The logic for the two-corner solution is that, to prevent speculation, policymakers should give a clear signal that they will avoid market intervention by allowing their currencies to float freely or by giving up monetary independence altogether.

As the two-corner solutions approach to the exchange rate became more popular, many small and not-so-small open economies were encouraged to move into the firm-fix corner under the argument that they had little ability to manage their own monetary policy. Particularly in Latin America, official dollarization suddenly appeared as the "rational choice'' for those small open economies for which, according to Salvatore (2001), "the US is their dominant economic partner and which have a poor monetary performance, and hence have low economic-policy credibility".[2] Following this recommendation, Ecuador (in 2000), El Salvador and Guatemala (both in 2001) adopted the US dollar as their own currency, aiming to gain credibility, stabilize their economies against high rates of inflation, prevent speculation and avoid economic crises.[3]

Except for Panama, which has been dollarized since 1904, those countries or territories using the dollar or another foreign currency as their own money used to be insignificantly small in relation with the size of the US economy. In fact, the size of today's three largest dollarized economies in Latin America, Ecuador (0.37%), El Salvador (0.24%) and Guatemala (0.46%), is still very small with respect to the US economy.[4] Indeed, these three recently dollarized Latin American countries match fairly well the description of a good candidate for dollarization presented by Salvatore (2001). They are not only small but also have strong ties to the US economy in terms of trade, investment, labour mobility through illegal immigration,

[1] The alternatives in the fixed corner are the full adoption of a foreign currency (i.e. official dollarization), implementing a currency board with full convertibility and joining a monetary union.

[2] Although for explanatory purposes we refer to "the adoption of a foreign currency as a country's money" with the term dollarization, alternative currency substitutions other than the US dollar—like, for instance, the adoption of the euro (i.e. euroization) by transition economies—present the same distinctive features as the regime examined here.

[3] Before these economies adopted the regime, the main costs and benefits of dollarization versus other regimes were promisingly examined in a number of papers (see, for instance, Alesina and Barro, 2001; Chang, 2000; Salvatore, 2001; Edwards and Magenzo, 2001; Calvo, 2002).

[4] Numbers in parentheses refer to the size of these economies' GDP as a proportion of US GDP. This proportion is only 0.17% in the case of Panama.

remittances from that illegal immigration, etc. Moreover, these economies also had severe credibility problems and presented poor macroeconomic performance at the time they decided to adopt the US dollar as their own currency (Eichengreen, 2001).

In spite of the support that the regimes in the firm-fixed corner have received, not everyone has welcomed the view that a pegged regime, such as dollarization, is preferable to a flexible one. Particularly since the collapse of Argentina's currency board in 2002, the long-term stability of strong pegs in Latin America has been seriously questioned. Critics of dollarization argue that, due to the lack of an independent monetary policy, the ability of a country to react to asymmetric shocks is greatly reduced under a dollarized regime. They also claim that this happens because, in the presence or absence of economic shocks, the US monetary authority pursues an independent policy, which lacks of any commitment towards the dollarized economies (Cohen, 2004). Eventually, the inability of policymakers to accommodate macroeconomic shocks results in additional instability which in the absence of a lender of last resort can cause the collapse of the regime and of the economy.

In this chapter we attempt to shed some light on this debate by comparing the impact of real shocks on small open economies operating under the two opposite corner solutions: flexible exchange rates and official dollarization. We introduce into the analysis two important features from the definition of a good candidate for dollarization cited above: (i) the size asymmetries between the follower and the leader country, and (ii) the extent of economic integration (i.e. openness) of the follower with respect to the leader. In doing so, we argue that—in an open economy environment—size matters for macroeconomic stabilization because it changes the relative incentives of a country to use its monetary policy to optimally affect the exchange rate.

In this analysis, we attempt to differentiate between economies that suffer credibility problems and those that are capable of eliminating or at least reducing those problems to reasonable boundaries. We start by analysing the implications of adopting the two corner regimes on credibility. Using a stylized two-country model of policy coordination, we show that although a pegged regime like dollarization is an effective device to achieve price stability for a small open economy, when discipline prevails to a certain extent, price stability might be achieved effectively without having to give up monetary independence. Following the credibility assessment, we focus our attention on examining the effects of adopting a dollarization regime on macroeconomic stabilization. We first assess the effect of stabilization policies neglecting the time inconsistency problems that might arise within each country with respect to the interaction between the monetary authorities and the private sector. In this case, we analytically show that not just asymmetric but also symmetric real shocks result in dissimilar effects, which impinge more heavily on a small open economy that opts for dollarization. We find that by exploiting its enhanced ability to adjust the real exchange rate, a small open economy may be better off under a flexible exchange rate regime than under dollarization after a symmetric or asymmetric shock.

Following those analytical results, we employ a numerical solution to assess the impact of real shock in the presence of time inconsistency problems. In this case, we observe that only when the policymaker of the small economy shows poor discipline in controlling inflation (i.e. by aiming at highly expansionary policies which seriously compromise price stability), does the flexible regime become more costly than dollarization in terms of stabilization after a symmetric shock. In the presence of asymmetric shocks, however, a small economy that adopts the dollar as its own legal tender is condemned to endure the consequences of the resulting macroeconomic distortions. In this instance, the stabilization cost of giving up monetary independence under dollarization unambiguously exceeds that of low discipline in controlling inflation under a flexible exchange rate regime.

After comparing dollarization versus a flexible regime, we assess dollarization *vis-à-vis* a different benchmark. Recognizing that many economies have only a limited ability to use their own monetary policy effectively, we analyse the case of a small open economy that conducts monetary policy under what Calvo and Reinhart (2002) call "fear of floating" practices. In this situation, we find that, unless the size of the small economy is trivial, maintaining monetary sovereignty—even if it is not fully exploited—allows a better stabilization of the small economy following a symmetric shock.

The rest of this chapter is organized as follows. Section 2 presents the model employed, derives some general reduced forms and describes the timing of events. Section 3 uses the asymmetric framework presented in Section 2 to analyse the inflationary bias in the absence of shocks. Section 4 focuses on the analysis of stabilization polices under a floating regime and dollarization with and without time inconsistency problems. Section 5 compares the stabilization effects of dollarization against those under "fear of floating" practices. Finally, Section 6 presents the conclusions of this chapter.

2 The model

The literature on policy coordination has analysed monetary policymaking among interdependent economies under different exchange rate arrangements. However, most of the literature employs frameworks in which countries have the same size and structure. Since economies adopting a foreign currency (e.g. the dollar or the euro) as their own legal tender are considerably smaller than the issuer country (i.e. the US economy or the EU), symmetric models are not adequate to examine a regime like dollarization.[5] As we observe later, due to the difference in size of the economies, the incentives, strategies and reactions of the policymakers involved in different regimes are not the same as in a symmetrical set-up.

Taking this issue into consideration, the basic model we employ is based on Canzoneri and Henderson (1991) two-country model. Asymmetric features are adopted

[5]From game theory we know that the size of the players influences the equilibrium strategies and economic outcomes of a game.

from Ghironi and Giavazzi (1998) who have used this model to analyse the optimal size of a currency union. We adapt and extend those models to consider dollarization as an alternative exchange rate regime for a small open economy in the presence of credibility problems and symmetric and asymmetric real shocks.

2.1 General framework

Except for the interest rate, all variables in the model are expressed in natural logarithms. Unstarred variables correspond to the domestic small country and starred variables refer to the large foreign economy. Each country specializes in the production of a single tradable good and both goods are imperfect substitutes. The domestic and foreign aggregate supplies (y and y^*) are increasing functions of the employment rates (n and n^*) and decreasing functions of a symmetric productivity disturbance, x:

$$y = (1-\alpha)n - x, \qquad y^* = (1-\alpha)n^* - x \tag{1}$$

where $0 < \alpha < 1$. For simplicity and tractability, we assume that the elasticity of output with respect to employment is the same in both countries.

Total labour demand in both economies is determined by profit maximizing firms for which labour demand is complete when the marginal productivity of labour is equal to the real wage:

$$w - p = -\alpha n - x, \qquad w^* - p^* = -\alpha n^* - x \tag{2}$$

where w and w^* are the domestic and foreign nominal wage rates and p and p^* are the domestic and foreign prices. Equations (1) and (2) are derived from a Cobb–Douglas production function with a fixed stock of capital normalized to unity (see Appendix A.1 for details).

Consumer Price Indices (CPIs) are weighted averages of the prices of domestic and foreign goods. Residents in the domestic country spends a fraction $(1-\beta)$ of their income on domestic goods and a fraction β on foreign goods. On the other hand, consumers in the foreign country spend a fraction β of their income on their own goods and a fraction $(1-\beta)$ on goods produced by the small country. The CPIs are then described by

$$q = (1-\beta)p + \beta(p^* + e) = p + \beta z$$

$$q^* = \beta p^* + (1-\beta)(p - e) = p^* - (1-\beta)z \tag{3}$$

where $\frac{1}{2} \leq \beta \leq 1$, q and q^* denote the domestic and foreign CPIs and e and $z = e + p^* - p$ are the nominal and real exchange rates, respectively.

In (3), β is an indicator of the size of the two economies and of their integration toward each other. Notice that when $\beta = \frac{1}{2}$ both economies are identical. As β rises, the size of the foreign country increases and that of the domestic economy shrinks. In the extreme case in which $\beta = 1$ the domestic country becomes simply a trivially small open economy. In this scenario the domestic country is so small that it is unable to affect the foreign country CPI at all.

Demand is affected positively by domestic and foreign output according to the proportion of income allocated by each country. The marginal propensity to spend ϵ is the same for both goods and in both countries. Residents in the two countries reduce expenditure by the same amount ($0 < v < 1$) after an increase in the nominal interest rate.[6] The market equilibrium conditions for the two countries are given by

$$y = \delta\beta z + \epsilon(1-\beta)y + \epsilon\beta y^* - vr - u$$
$$y^* = -\delta(1-\beta)z + \epsilon(1-\beta)y + \epsilon\beta y^* - vr^* + u \tag{4}$$

Clearly, a depreciation of the real exchange rate shifts demand from the foreign toward the domestic economy. Notice that when, for instance, $\beta = 1$ (i.e. when the domestic country becomes a negligible small open economy) the real exchange rate does not affect the foreign demand. Finally, the parameter u represents an asymmetric disturbance that affects both countries in opposite ways, shifting demand from the domestic to the foreign country when $u > 0$.

Assuming constant velocity money demand functions in both countries, the equilibrium condition in the domestic and foreign money markets are given by

$$m - p = y, \qquad m^* - p^* = y^* \tag{5}$$

where m and m^* represent the domestic and foreign nominal money supplies.

A priori, the expected real interest rate in each country is defined as the nominal interest rate minus the expected rate of change in its consumer price index:

$$r = i - E(q_{+1}) + q, \qquad r^* = i^* - E(q^*_{+1}) + q^* \tag{6}$$

Finally, using the interest parity condition, expected interest rates measured in a common currency are equal to

$$i = i^* + E(e_{+1}) - e \tag{7}$$

2.2 Semi-reduced forms

We start by obtaining the semi-reduced forms for employment and inflation employed later to formulate the loss functions of the policymakers. Combining equations (1), (2) and (5) we can compute the employment semi-reduced form for the domestic and the foreign country as

$$n = m - w, \qquad n^* = m^* - w^* \tag{8}$$

In each country, employment rises with an expansion of their money supplies and declines with increases in their nominal wage rates. Price reduced forms are obtained by solving the profit maximizing conditions of the firms in (2) for p and p^* and then substituting the employment reduced forms on those expression. Thus, we obtain

$$p = \alpha m + (1-\alpha)w + x, \qquad p^* = \alpha m^* + (1-\alpha)w^* + x \tag{9}$$

[6] We assume that agents can borrow in both regions. Thus, due to the identical consumer patterns across the two countries and perfect capital mobility, interest rates are equalized, $r = r^*$.

The price of home-produced goods increases after a monetary expansion, a rise in the nominal wage rate and following a positive productivity shock.

The real exchange rate reduced form is obtained by subtracting the foreign demand equilibrium condition in (4) from the domestic, substituting the aggregate supplies in (1) on the resulting expression and solving for z:

$$z = \frac{(1-\alpha)}{\delta}\left[(m-w)-(m^*-w^*)\right] + \frac{2}{\delta}u \tag{10}$$

Finally, we obtain the inflation semi-reduced forms normalizing $q_{-1} = 0$ and substituting the prices and real exchange rate reduced forms in (3). These are given by

$$\begin{aligned} \pi = q &= \alpha m + (1-\alpha)w + x + \theta[(m-w)-(m^*-w^*)] + \frac{2\beta}{\delta}u \\ \pi^* = q^* &= \alpha m^* + (1-\alpha)w^* + x - \xi[(m-w)-(m^*-w^*)] - \frac{2(1-\beta)}{\delta}u \end{aligned} \tag{11}$$

where $\theta = (1-\alpha)\beta/\delta$ and $\xi = (1-\alpha)(1-\beta)/\delta$. The reduced forms in (8) and (11) are adapted later according to the regime considered and the assumptions we make regarding the presence of time inconsistency problems.

From (11), notice that when, for instance, the economies contract their money supplies, they are able to export inflation abroad and promote domestic price stability. The larger θ and ξ are, the higher the incentives of the economies to export inflation and the more effective they become attaining price stability.

2.3 Union and central bank preferences

In each country there is a single trade union that sets the nominal wage rate one period in advance. Trade unions with full information about the model choose nominal wages by minimizing the deviations of employment from its full employment target (which, here we normalize to zero). Hence, in setting wages, unions minimize the following functions:

$$V = -\frac{1}{2}E_{-1}(n)^2, \qquad V^* = -\frac{1}{2}E_{-1}(n^*)^2 \tag{12}$$

Substituting (8) into (12), minimizing with respect to n and n^*, and taking expectations, we obtain that domestic and foreign trade unions set wages equal to the expected money supplies:

$$w = m^e, \qquad w^* = m^{*e} \tag{13}$$

Money supplies are the policymakers' only instrument to stabilize employment and inflation following a symmetric or asymmetric disturbance. They choose their instruments (m and m^*) to minimize the quadratic loss functions given by

$$L = -\frac{1}{2}[\sigma(n-k)^2 + \pi^2], \qquad L^* = -\frac{1}{2}[\sigma(n^*-k^*)^2 + \pi^{*2}] \tag{14}$$

where k and k^* are, respectively, the domestic and foreign targets for employment and the inflation parameter $\pi = q - q_{-1}$.

In principle, monetary policy is subject to a time inconsistency problem in both countries whenever k and k^* are different from zero. Essentially, the policymakers' losses increase with deviations of employment from their target level and positive changes in their CPIs. The parameter σ reflects the weight that each policymaker attaches to employment deviations from its target, relative to the inflation deviations from zero. For simplicity, σ is assumed to be the same in both countries.

2.4 Timing of events

As mentioned above, both trade unions set wages one period in advance. They have full information about the preferences and reaction functions of the policymakers and take them into account in setting the nominal wage rates. Following the wage setting process, central banks choose their monetary policy.[7]

Under a flexible exchange rate regime both central banks decide on their monetary policy simultaneously. They play Nash against each other taking the wage rate set by the unions as given. On the other hand, under dollarization the small economy gives up its monetary policy. After the adoption of this regime, the central bank in the large foreign country chooses the world money supply observing only its own interests. Any monetary policy implemented by the large country is transferred to the small country immediately through trade and financial market transactions.

3 Inflationary bias in the absence of shocks

Enhancing credibility is regarded as one of the most important benefits of pegging the exchange rate to another country's money. In general, higher credibility provides a smaller inflationary bias, less volatility, lower real interest rates, etc. Before concentrating our attention on stabilization policies, in this section we employ our asymmetric model to revise the credibility gains that result from fixing the exchange rate through dollarization.

3.1 Flexible exchange rate regime

The inflation bias under a flexible regime arises from the government incentives to engineer a surprise monetary expansion to drive employment, n, closer to its target, k. Assuming that trade unions have perfect foresight, minimizing the loss functions of each policymaker in (14) with respect to its own money supply, we obtain that the inflationary biases of the domestic and foreign economies for the flexible exchange rate regime are

$$\pi = \frac{\sigma}{\alpha + \theta} k \tag{15}$$

[7] In the absence of shocks (i.e. $x = 0$ and $u = 0$) policymakers only use their money supply to achieve their employment target.

$$\pi^* = \frac{\sigma}{\alpha + \xi} k^* \tag{16}$$

Notice that the parameters θ and ξ, the incentives to affect the exchange rate under flexible rates for the domestic and foreign country, are functions of the relative size of the two economies. In the event that $\beta = \frac{1}{2}$ (i.e. when the domestic and the foreign economies are symmetric in size) both countries may experience the same level of inflation because in that case $\theta = \xi$. However, if the domestic country's employment target, k, is higher than that of the foreign country, k^*, the inflation bias in the domestic country is greater than that in the foreign ($\pi > \pi^*$). This is a well-known result in the symmetric set-up (Giavazzi and Giovannini, 1989).

This result, however, does not hold in our asymmetric framework. Notice that if $\frac{1}{2} < \beta \leq 1$ (i.e. as long as asymmetries in the size of the economies exist), a real depreciation entails a high inflation cost for the small domestic economy. This happens because due to its consumption patterns a small open economy faces a higher exchange rate pass-through (see equation (3)). For a given σ this weakens the small economy policymaker's willingness to engineer surprise inflation through a monetary expansion and might even result in a smaller inflation bias for the domestic economy when k is close or equal to k^*.

3.2 Dollarization

The analysis of the inflation bias in this section is equivalent for a traditional fixed exchange rate regime and for dollarization. In a fixed exchange rate regime the domestic country commits to keep the exchange rate unchanged. From equation (10) this implies that the small economy accommodates any change in m^* with a similar change in m. Under dollarization, however, a small open economy makes use of its international reserves to substitute its currency in circulation with foreign money. Following this conversion, changes in the money supply of the large country are transferred to the small country through trade and the financial system transactions.

Assuming again that trade unions have perfect foresight and utilizing that $m = m^*$, the minimization of losses for both policymakers leads to the following inflationary biases in equilibrium:

$$\pi^d = \frac{\sigma}{\alpha} k^* \tag{17}$$

$$\pi^{d\,*} = \frac{\sigma}{\alpha} k^* \tag{18}$$

where the superscript d refers to the outcomes under dollarization.

As Giavazzi and Giovannini (1989) showed, under a pegged exchange rate regime the follower country reaches the same level of inflation as the foreign country. Here we find that this result is valid regardless of the size of the economy that fixes the exchange rate.

Consequently, for the fixed exchange rate regime to be superior to the flexible, the credibility gap should be higher than the domestic country's incentive to export

inflation to the rest of the world: that is,

$$\frac{k - k^*}{k^*} - \frac{\theta}{\alpha} > 0 \tag{19}$$

For a sufficiently high value of k, the domestic country is better off under dollarization than under a flexible exchange rate regime. However, as the value of β tends to 1, the difference between the credibility gap and the domestic economy's incentive to export inflation to the rest of the world narrows. This happens because the openness of the small country prevents the domestic policymaker from creating inflation by expanding the domestic money supply. Again, the policymaker knows that an increase in its money supply would lead to an appreciation of the exchange rate, which increases the price of foreign goods and significantly affects overall price stability.[8]

The analysis in this section demonstrates that a pegged regime like dollarization is an effective device to achieve price stability for a small open economy with credibility problems. Indeed, this has been the reason why economies like Ecuador, Guatemala and El Salvador recently adopted the dollar as their own currency. However, it also shows that when discipline can be imposed (i.e. when k is close or equal to k^*), credibility problems can be controlled and price stability might be achieved effectively without giving up monetary independence.[9]

4 Stabilization policies

In this section, we shift our attention to the assessment of stabilization polices. Because of the difference that the presence of the inflation bias can make in our assessment, we examine stabilization policies in two different scenarios. First, we look at stabilization leaving aside time inconsistency problems (i.e. we assume $k = k^* = 0$). This allows us to obtain some analytical conclusions with respect to the performance of employment, inflation and losses under both regimes when discipline (through, for instance, granting independence to the central bank) can be achieved. Thereafter, we employ a numerical solution to combine the presence of shocks and the inflation bias in the analysis of stabilization polices.

We start by describing the reduced forms and reaction functions of the two policymakers under the flexible and dollarization regimes. After that, we proceed to derive the equilibrium outcomes and losses that result from the presence of symmetric and asymmetric shocks.

[8] Provided $\theta > \xi$, it is easy to observe how inflation in the domestic economy can be actually smaller than in the foreign when the domestic policymaker targets the same employment target as the foreign (compare (15) and (16) when $k = k^*$).

[9] For a review of the policies that some EMEs have employed to regulate their policymakers under flexible exchange rate regimes (e.g. delegating monetary policy to independent, conservative central banks and adopting explicit inflation targets) and the effects of those policies on price stability, see Mishkin (1999) and Mishkin and Savastano (2002).

4.1 Reduced forms and reaction functions

Flexible regime The general reduced forms presented in Section 2 are completed by defining the way in which wages are set by unions and firms. Assuming perfect foresight, trade unions that minimize the expected square deviations of employment from their full employment value of zero use all the information they have to set wages accordingly (i.e. $w = m^e = \frac{\sigma}{\alpha+\theta}k$ and $w^* = m^{*e} = \frac{\sigma}{\alpha+\xi}k^*$). Following this assumption, using (8) and (11) the employment and inflation reduced forms under the flexible exchange rate regime are simply given by

$$n = m - \frac{\sigma}{\Gamma}k, \qquad n^* = m^* - \frac{\sigma}{\Delta}k^* \tag{20}$$

$$\pi = \Gamma m + (1-\Gamma)\frac{\sigma}{\Gamma}k + x - \theta(m^* - \frac{\sigma}{\Delta}k^*) + \Omega u$$

$$\pi^* = \Delta m^* + (1-\Delta)\frac{\sigma}{\Delta}k^* + x - \xi(m - \frac{\sigma}{\Delta}k) - \Psi u \tag{21}$$

where $\Gamma = \alpha + \theta$, $\Delta = \alpha + \xi$, $\Omega = 2\beta/\delta$ and $\Psi = 2(1-\beta)/\delta$.

Employing these reduced forms, each policymaker minimizes his/her loss function in (14) with respect to his/her own money supply taking as given the money supply of the other policymaker. Solving the two resulting first-order conditions for m and m^*, their reaction functions are given by

$$m = \frac{\theta\Gamma}{(\Gamma^2+\sigma)}\left(m^* - \frac{\sigma}{\Delta}k^*\right) - \frac{\Gamma}{(\Gamma^2+\sigma)}x - \frac{\Omega\Gamma}{(\Gamma^2+\sigma)}u + \frac{\sigma}{\Gamma}k$$

$$m^* = \frac{\xi\Delta}{(\Delta^2+\sigma)}\left(m - \frac{\sigma}{\Gamma}k\right) - \frac{\Delta}{(\Delta^2+\sigma)}x + \frac{\Psi\Delta}{(\Delta^2+\sigma)}u + \frac{\sigma}{\Delta}k^* \tag{22}$$

Each policymaker raises his/her money supply in response to a monetary expansion by his/her counterpart and to achieve its own employment target. Meanwhile, they contract their money supply in response to the symmetric shock, x, and the employment target of their neighbour. Finally, the domestic policymaker decreases its money supply as a result of the demand shock, u, while the foreign policymaker increases it.

Dollarization A small economy that chooses to adopt the dollar as its own currency relinquishes the control of its monetary policy to the central bank that issues the foreign currency. Thereafter, the foreign policymaker has full command over the world money supply. As a result, changes in the money supply in the small home economy are the same as in the foreign economy (i.e. $m = m^*$).

Assuming perfect foresight, now both trade unions set wages according to their expectations regarding the monetary policy decision of the foreign central bank (i.e. $w = w^* = m^{*e} = \frac{\sigma}{\alpha}k^*$). Following this assumption, using (8) and (11), the employment and inflation reduced forms under dollarization are simply:

$$n = m^* - \frac{\sigma}{\alpha}k^*, \qquad n^* = m^* - \frac{\sigma}{\alpha}k^* \tag{23}$$

$$\pi = \alpha m^* + (1-\alpha)\frac{\sigma}{\alpha}k^* + x + \Omega u$$

$$\pi^* = \alpha m^* + (1-\alpha)\frac{\sigma}{\alpha}k^* + x - \Psi u \tag{24}$$

The only difference between the reduced forms of the two economies resides in the way that asymmetric shocks affect them through the real exchange rate. Just as with the flexible regime, the demand shock increases inflation in the domestic economy and produces deflationary pressure on the foreign.

Since dollarization is a unilateral strategy, the foreign country policymaker does not internalize the preferences of the small economy. Instead, he reacts exclusively to the factors that affect his own macroeconomic environment. This implies that the large economy behaves to some extent as a closed economy and the role of the small economy is reduced to the one played by a small region inside the large foreign country.

Minimizing the loss function of the foreign economy policymaker in (14) using the reduced forms presented above ((23) and (24)), his/her reaction function is simply given by

$$m^* = \frac{\sigma}{\alpha}k^* + \frac{2\alpha(1-\beta)}{\delta(\alpha^2+\sigma)}u - \frac{\alpha}{\alpha^2+\sigma}x \tag{25}$$

Under dollarization, the foreign economy engineers a monetary contraction in response to the symmetric shock, x, and an expansion in response to the asymmetric shock, u. It also raises the money supply to achieve its employment target, k^*.

4.2 Stabilization without time inconsistency problems

In order to focus our attention on the role of strategic interactions between the two economies and in the importance of size asymmetries in the choice of a particular exchange rate regime, in this section we assume that the policymakers' preferences are identical and free from time inconsistency problems (i.e. we assume that $k^* = k = 0$). Neglecting time inconsistency problems allows us to obtain analytical results with respect to the stabilization properties of small open economies in the presence of symmetric and asymmetric shocks.

Notice that because the numerical solutions that we employ later include the inflation bias and the shocks, the equilibrium levels of employment, inflation and losses presented in this section contain the employment targets (i.e. k^* and k). However, in order to obtain analytical solutions, both employment targets are assumed to be equal to zero.

4.2.1 Symmetric shocks

In the general framework of our model, symmetric disturbances are represented by a negative productivity shock x, which affects both economies in the same fashion. This symmetric disturbance gives rise to a stabilization game between the domestic and foreign policymakers. Following the symmetric shock, both policymakers have an incentive to contract their money supply to fight inflation; a strategy that will

affect the other country through the exchange rate. For instance, a decrease in the domestic money supply will cause the exchange rate to appreciate and then increase inflation in the foreign country.

Flexible exchange rate regime Substituting the foreign reaction function in (22) into the domestic and vice versa, the equilibrium money supplies under the flexible exchange rate regime are simply given by

$$m = \frac{\sigma}{\Gamma}k - \left[\frac{\Gamma(\Delta^2+\theta\Delta+\sigma)}{(\Delta^2+\sigma)(\Gamma^2+\sigma)-\theta\Gamma\xi\Delta}\right]x$$

$$m^{*x} = \frac{\sigma}{\Delta}k^* - \left[\frac{\Delta(\Gamma^2+\xi\Gamma+\sigma)}{(\Delta^2+\sigma)(\Gamma^2+\sigma)-\theta\Gamma\xi\Delta}\right]x \tag{26}$$

As expected, both policymakers contract their money supplies following the symmetric shock and increase them according to the size of their employment target. Comparing the outcomes in (26), it becomes clear that the ability of the two policymakers to react to the shock depends on their relative size. Proposition 1 formalizes the relation between the size of an economy and its ability to respond to a given shock.[10]

Proposition 1 *In general, a relatively smaller open economy is capable of responding more aggressively against a shock than a relatively larger economy.*

Proof. For the contraction of the small domestic economy in response to the shock to be more aggressive than that of the foreign economy we need $m < m^*$, which implies that $-\Gamma(\Delta^2+\theta\Delta+\sigma) < -\Delta(\Gamma^2+\xi\Gamma+\sigma)$. Substituting the expressions for θ, Γ, ξ, and Δ into this inequality and simplifying, we obtain the following expression: $\frac{\sigma(1-\alpha)}{\delta}(\beta-(1-\beta)) > 0$. This unambiguously holds when $\beta > \frac{1}{2}$; that is, when the domestic economy is smaller than the foreign one. ■

The intuitive explanation for the more aggressive response of the small economy to the shock rests on its consumption patterns. A relatively smaller country consumes more of the goods produced by the large economy; hence, the reduction of inflation induced by a contraction of its money supply, which causes the exchange rate to appreciate, is larger. This effect is not that significant for the foreign economy that only consumes a small proportion of goods produced by the domestic economy. The policymaker in the large economy has fewer incentives to use monetary policy strategically to stabilize his economy because his CPI inflation depends less on the exchange rate than in the small economy. Notice that as the size of the domestic economy shrinks, its monetary policy decisions have a smaller impact on the foreign economy (i.e. ξ is reduced as β increases). This decreases the incentives of the foreign policymaker to react to the monetary contractions of the small country.

[10] The result that a small open economy possesses an enhanced ability to exploit the exchange rate to stabilize itself better in the presence of symmetric shocks has been shown before by Giavazzi and Giovannini (1998), Martin (1994, 1995), Ghironi and Giavazzi (1998) and Eichengreen and Ghironi (2002), among others.

Table 1: Inflation, Output and Losses Following a Symmetric Shock

Domestic	Flexible	Dollarization
n	$-\frac{\Gamma\left[(\Delta^2+\sigma)+\theta\Delta\right]}{N}x$	$-\frac{\alpha}{\alpha^2+\sigma}x$
q	$\frac{\sigma}{\Gamma}k+\frac{\sigma\left[(\Delta^2+\sigma)+\theta\Delta\right]}{N}x$	$\frac{\sigma}{\alpha}k^*+\frac{\sigma}{\alpha^2+\sigma}x$
L	$\frac{1}{2}\sigma(\Gamma^2+\sigma)\left(\frac{\left[\Delta^2+\sigma)+\theta\Delta\right]}{N}x+\frac{1}{\Gamma}k\right)^2$	$\frac{1}{2}\sigma(\alpha^2+\sigma)\left(\frac{1}{(\alpha^2+\sigma)}x+\frac{1}{\Delta}k^*\right)^2$

Foreign	Flexible	Dollarization
n^*	$-\frac{\Delta\left[(\Gamma^2+\sigma)+\xi\Gamma\right]}{N}x$	$-\frac{\alpha}{\alpha^2+\sigma}x$
q^*	$\frac{\sigma}{\Delta}k^*+\frac{\sigma\left[(\Gamma^2+\sigma)+\xi\Gamma\right]}{N}x$	$\frac{\sigma}{\alpha}k^*+\frac{\sigma}{\alpha^2+\sigma}x$
L^*	$\frac{1}{2}\sigma(\Delta^2+\sigma)\left(\frac{\left[(\Gamma^2+\sigma)+\xi\Gamma\right]}{N}x+\frac{1}{\Delta}k^*\right)^2$	$\frac{1}{2}\sigma(\alpha^2+\sigma)\left(\frac{1}{(\alpha^2+\sigma)}x+\frac{1}{\Delta}k^*\right)^2$

where $N=(\Delta^2+\sigma)(\Gamma^2+\sigma)-\theta\xi\Omega\Gamma$

Employment, Inflation and Losses. Substituting the above equilibrium money supplies into the corresponding employment and inflation reduced forms and then the resulting expressions into the loss function of each authority, we obtain the equilibrium policy outcomes presented in Table 1. The resulting equilibrium employment outcomes are given by the monetary contractions engineered by policymakers in response to the symmetric shock (i.e. $n=m$ and $n^*=m^*$). Hence, as a result of Proposition 1, employment losses are larger in the small than in the large economy after the symmetric shock takes place.

In the absence of time inconsistency problems (i.e. assuming $k=k^*=0$), the small economy is capable of reducing inflation by more than the large economy. The intuitive explanation for this outcome rests also on Proposition 1. The small economy policymaker contracts his money supply more aggressively, shifting the inflation burden arising from the shock to the large economy and reducing its own inflation more effectively. Given these equilibrium outcomes, the ranking of employment, inflation and losses are formalized in the next proposition.

Proposition 2 *Following the greater contraction of its money supply, the small economy experiences a higher unemployment but lower inflation than the foreign one. As a result, it is able to achieve better stabilization in the face of symmetric shocks; ultimately suffering lower losses than the large economy.*

Proof. The fact that $n<n^*$ follows from Proposition 1. To show that $q<q^*$ need $(\Delta^2+\sigma)+\theta\Delta<(\Gamma^2+\sigma)+\xi\Gamma$. Substituting θ, Γ, ξ, and Δ, the inequality is simplified to $\alpha(\theta-\xi)+(\theta^2-\xi^2)>0$, which clearly holds for $\beta>\frac{1}{2}$. Finally, to prove that $L<L^*$ it is necessary to show that $\left((\alpha+\theta)^2+\sigma\right)\left[(\alpha+\xi)^2+\sigma)+\theta\Delta\right]^2<\left((\alpha+\xi)^2+\sigma\right)\left[\left((\alpha+\theta)^2+\sigma\right)+\xi\left(\alpha+\theta\right)\right]^2$. Rearranging this expression we obtain

the condition $(\alpha^2+\sigma^2)(\theta^2-\xi^2)+2\alpha(\theta^3-\xi^3)+\sigma(\theta^4-\xi^4)>0$, which unambiguously holds for $\beta>\frac{1}{2}$. ■

To summarize, we observe that, following a symmetric shock, a small open economy that conducts its own monetary policy is better able to adjust the exchange rate and achieve superior stabilization than a relatively larger economy.

Dollarization Using the reaction function presented above for the large economy under the dollarization regime, the equilibrium money supply chosen by the foreign policymaker is given by

$$m^{d*}=m^d=\frac{\sigma}{\alpha}k^*-\frac{\alpha}{\alpha^2+\sigma}x \tag{27}$$

where m^{d*} and m^d are the equilibrium money supplies under dollarization for the foreign and domestic economies. As with the flexible regime, the large economy reduces the world money supply in response to the symmetric shock, x, and increases it to accomplish its employment target, k^*.

The following proposition formally compares the equilibrium money supplies experienced by a small open economy under a flexible exchange rate regime and under dollarization in the face of a symmetric shock.

Proposition 3 *Following a symmetric shock, the world money supply reduction engineered by the policymaker in the large leader economy under dollarization is smaller than the optimal contraction chosen by the policymaker of a small open economy that operates under a flexible exchange rate regime.*

Proof. Cross-multiplying the two money supply expressions and assuming a value of β consistent with that of a small economy considered as good candidate for dollarization (i.e. $\beta=1$), for m to be smaller than m^d, it is only necessary to demonstrate that $-\Gamma(\alpha^2+\sigma)-\Gamma\theta\alpha<-\alpha(\Gamma(\alpha+\theta)+\sigma)$. This simplifies to $-(1-\alpha)\sigma/\delta<0$, a condition that unambiguously holds for positive expected values of the structural parameters α, δ and σ. ■

The reason for the smaller money supply contraction under dollarization is that when the domestic economy lacks monetary policy, it does not export inflation to the foreign economy by tightening its own money supply. Therefore, the foreign economy policymaker reacts only to the shock, without having to counteract the actions of the domestic economy policymaker.

Employment, Inflation and Losses. Since the contraction of the money supply by the policymaker in the foreign economy is less aggressive under dollarization, the small domestic economy benefits from a smaller employment loss under this regime than under the flexible one. However, due to the smaller monetary contraction, equilibrium inflation under dollarization is higher than under the flexible regime. Clearly, this outcome is inconsistent with the aim of a small economy that relinquishes its monetary policy in order to achieve price stability.

As a result of higher inflation, the losses for the small economy under dollarization are ultimately larger than under a flexible regime. The next proposition

formalizes the ranking of employment, inflation and losses under the two arrangements following the symmetric shock.

Proposition 4 *Following a symmetric shock, a small open economy suffers less unemployment under dollarization than under a flexible exchange rate regime. However, it experiences considerably higher inflation. The combination of these two outcomes results in the small open economy enduring higher losses after the adoption of the foreign currency.*

Proof. The fact that $n < n^d$ follows from Proposition 3. To prove that $q < q^d$ assume again that $\beta = 1$. Then comparing the two resulting expressions we arrive at a condition given by $(\alpha^2+\sigma)(\alpha+\theta)\theta > 0$, an identity that unambiguously holds for positive expected values of the structural parameters α, δ and σ. ■

By giving up its monetary policy, the domestic economy loses its ability to employ the exchange rate for purposes of stabilization against shocks. For a small domestic economy, dollarization results in a worse outcome than staying under a flexible exchange rate regime. This finding contrasts with the Canzoneri and Gray (1985) and Canzoneri and Henderson (1991) results for equal size economic where, in the presence of symmetric shocks, a fixed exchange rate regime provides a Pareto efficient outcome with respect to the flexible regime.

4.2.2 Asymmetric shock

The asymmetric shock is given by the demand shift parameter $u > 0$. This disturbance generates inflationary pressure in the domestic economy and deflationary pressure in the foreign economy (see (21)). Consequently, the domestic policymaker has an incentive to contract his/her money supply in order to fight inflation, while the foreign policymaker has an incentive to expand his/her money supply and stop deflation. In the case of asymmetric shocks, by following an independent monetary policy, both economies generate a positive externality on each other. For instance, when the domestic policymaker tightens his/her money supply, the real exchange rate appreciates and decreases domestic inflation. At the same time, that appreciation of the exchange rate helps the foreign economy to fight deflation.

Flexible exchange rate regime Combining the reaction functions described in (22), following the asymmetric shock the equilibrium money supplies chosen by both policymakers are described by

$$m = \frac{\sigma}{\Gamma}k - \left[\frac{\Gamma\left[\Omega(\Delta^2+\sigma) - \Psi\Delta\theta\right]}{(\Delta^2+\sigma)(\Gamma^2+\sigma) - \theta\Gamma\xi\Delta}\right]u$$

$$m^* = \frac{\sigma}{\Delta}k^* + \left[\frac{\Delta\left[\Psi(\Gamma^2+\sigma) - \xi\Gamma\Omega\right]}{(\Delta^2+\sigma)(\Gamma^2+\sigma) - \theta\Gamma\xi\Delta}\right]u \tag{28}$$

The asymmetric shock leads to a contraction of the money supply in the domestic country and to an expansion in the foreign country. Just as with symmetric shocks,

the reaction of the two policymakers to the asymmetric shock will depend on their relative size. Indeed, Proposition 1 is also valid in the case of asymmetric shocks (see Appendix A.2 for proof). Due to its smaller size, the reaction of the domestic economy to the asymmetric shock is more aggressive than that of the foreign economy.

Notice that, due to the nature of asymmetric shocks in our model, the burden of the shift in the demand affects the small domestic economy more heavily. This is because the domestic economy depends more on the consumption of foreign products than does the large economy on products from the domestic economy. In fact, in the case when the domestic economy is trivially small (i.e. $\beta = 1$), the shift in the demand has an insignificant effect on the large economy. In such a scenario, the foreign policymaker does not respond to the asymmetric shock at all and the burden of the disturbance is only endured by the domestic economy.

Employment, Inflation and Losses. Substituting the above money supplies in the corresponding employment and inflation reduced forms under the flexible exchange rate regime, we obtain the equilibrium policy outcomes and losses for the domestic and foreign economy presented in Table 2. Due to its more aggressive reaction to the asymmetric shock, the domestic employment loss is comparatively larger than the employment gain in the foreign country (i.e. $\mid n \mid > n^*$).

As mentioned above, the asymmetric shock increases inflation in the domestic economy and causes deflation in the foreign. In this case, the presence of the inflation bias intensifies the inflationary pressure experienced by the domestic economy and ameliorates the deflationary pressure endured by the foreign country. Nevertheless, even in the absence of the inflation bias (i.e. under our assumption that $k = k^* = 0$), the magnitude of the inflation experienced by the small domestic economy is actually larger than the deflation suffered by the large economy (i.e. $\mid q \mid > q^*$). The explanation for this result lies in the nature of asymmetric shocks. As explained above, due to the distribution of its consumption patterns, asymmetric shocks have a more powerful impact on the small domestic economy.

The next proposition establishes the ranking of employment, inflation and losses for the two economies under flexible regimes in the face of an asymmetric shock.

Proposition 5 *Following the more aggressive reaction of the small open economy to an asymmetric shock, its employment loss is greater than the foreign economy's employment gain. Meanwhile, the inflationary pressure experienced by the small economy is actually larger than the deflation endured by the large economy. It follows from the higher unemployment and inflation suffered by the small economy that its losses clearly exceed those experienced by the foreign economy.*

Proof. The larger employment loss for the small economy relative to the employment gain of the large economy comes from its more aggressive reaction to the shock established in Proposition 1. Meanwhile, for the inflationary pressure in the small domestic economy to be greater than the deflationary pressure in the foreign large economy, $\mid q \mid > q^*$ must hold. Contrasting these two expressions,

Table 2: Inflation, Output and Losses Following an Asymmetric Shock

Domestic	Flexible	Dollarization
n	$-\frac{\Gamma[\Omega(\alpha\Delta+\sigma)]}{N}u$	$\frac{2\alpha(1-\beta)}{\delta(\alpha^2+\sigma)}u$
q	$\frac{\sigma}{\Gamma}k+\frac{\sigma[\Omega(\alpha\Delta+\sigma)]}{N}u$	$\frac{\sigma}{\alpha}k^*+\frac{2(\alpha^2+\beta\sigma)}{\delta(\alpha^2+\sigma)}u$
L	$\frac{1}{2}\sigma(\Gamma^2+\sigma)\left(\frac{[\Omega(\alpha\Delta+\sigma)]}{N}u+\frac{1}{\Gamma}k\right)^2$	$\frac{1}{2}\sigma(\alpha^2+\sigma)\left(\frac{2\beta}{\delta(\alpha^2+\sigma)}u+\frac{1}{\alpha}k^*\right)^2$ $+\frac{1}{2}(\alpha^2+\sigma)\left(\frac{2\alpha}{\delta(\alpha^2+\sigma)}u\right)^2$

Foreign	Flexible	Dollarization
n^*	$\frac{\Delta[\Psi(\alpha\Gamma+\sigma)]}{N}u$	$\frac{2\alpha(1-\beta)}{\delta(\alpha^2+\sigma)}u$
q^*	$\frac{\sigma}{\Delta}k^*-\frac{\sigma[\Psi(\alpha\Gamma+\sigma)]}{N}u$	$\frac{\sigma}{\alpha}k^*-\frac{2(1-\beta)\sigma}{\delta(\alpha^2+\sigma)}u$
L^*	$\frac{1}{2}\sigma(\Delta^2+\sigma)\left(\frac{[\Psi(\alpha\Gamma+\sigma)]}{N}u+\frac{1}{\Delta}k^*\right)^2$	$\frac{1}{2}\sigma(\alpha^2+\sigma)\left(\frac{2(1-\beta)}{\delta(\alpha^2+\sigma)}u-\frac{1}{\alpha}k^*\right)^2$

the inequality is satisfied when $[\Omega(\alpha\Delta+\sigma)]>[\Psi(\alpha\Gamma+\sigma)]$. Simplifying that yields $(\alpha^2+\sigma)(\beta-(1-\beta))>0$, which unambiguously holds when $\beta>\frac{1}{2}$. ■

In this case, despite its enhanced ability to exploit the exchange rate to respond to shocks, the nature of its consumption patterns prevents the small domestic economy from achieving superior stabilization.

Dollarization Following the asymmetric shock, the equilibrium money supply chosen by the foreign country policymaker is simply described as

$$m^d=m^{d*}=\frac{\sigma}{\alpha}k^*+\frac{2\alpha(1-\beta)}{\delta(\alpha^2+\sigma)}u \tag{29}$$

In the absence of a reaction from the domestic economy, the foreign policymaker responds more aggressively to the deflationary effects provoked by the asymmetric shock. This response is, however, decreasing for β; the smaller the domestic economy, the less is the reaction of the foreign country policymaker to the asymmetric shock. In this expression, it is easy to notice that when the domestic economy is trivially small (i.e. when $\beta=1$), the foreign economy is unaffected by the asymmetric shock and as a result it does not respond to it at all.

Employment, Inflation and Losses. Table 2 also reports the equilibrium levels of inflation, employment and output that result from the dollarization regime. In this case, the foreign policymaker chooses a policy (i.e. a monetary expansion) that goes in the opposite direction to what is optimal for the small open economy when it conducts an independent monetary policy (i.e. a monetary contraction). After the expansion of the world money supply, the domestic economy is able to increase its employment level. However, it clearly suffers a considerably larger level of inflation than under the flexible regime.

When the domestic economy is trivially small (i.e. $\beta=1$), the foreign policymaker does not react at all to the asymmetric shock. However, devoid of monetary

policy instruments, the small economy is incapable of responding to ameliorate inflation provoked by the demand shift. The implications of the dollarization equilibrium on the losses experienced by a small economy are summarized in the following proposition.

Proposition 6 *In the presence of asymmetric shocks a small dollarized economy experiences an increase—rather than a fall—in employment but considerably higher inflation than under a flexible regime. As a result, a small economy that adopts a foreign currency as its own legal tender suffers higher welfare losses than when it maintains its monetary independence and allows its currency to float freely.*

Proof. For a small open economy considered as a good candidate for dollarization (i.e. $\beta = 1$), it is evident that the employment loss it suffers operating under a flexible regime is larger than the one it endures operating under dollarization. Now, continuing with that assumption and cross-multiplying, inflation under a flexible regime is smaller than under dollarization ($q < q^d$) if $\frac{2\sigma}{\delta} < \frac{2}{\delta}(\Gamma^2 + \sigma)$. Simplifying, this only requires that $\frac{2}{\delta}(\alpha + \theta)^2 > 0$. On the other hand, following the same procedure, the small economy losses under a floating regime are smaller than under dollarization ($L < L^d$) if $(\alpha + \theta)^2 > 0$. Both of these conditions unambiguously hold for positive values of α and δ. ■

Once again, as in the case of symmetric shocks, its inability to employ the exchange rate for purposes of stabilization makes the small open economy worse off. In the next section, we combine the presence of shocks and the inflation bias to observe the properties of the regimes when both factors interact simultaneously.

4.3 Stabilization policies and the inflation bias

In comparing the analytical solutions presented above, we have assumed that the small and the large economies experience no credibility problems by making the employment targets equal to zero (i.e. $k = k^* = 0$). However, given that one of the main aims of an economy that decides to dollarize is precisely to reduce its credibility problems, at first sight this assumption might seem inadequate. Clearly, the existence of a higher domestic inflation bias increases the losses of the domestic economy that conducts monetary policy under a floating regime.

In this section we assess the robustness of the analytical results presented above by incorporating into the analysis the effect of the inflation bias. Since the comparison of the equilibrium outcomes presented in Tables 1 and 2 is analytically intractable in the presence of shocks and the inflation bias interacting together, we employ a numerical solution to observe how the losses suffered by the small economy change at different levels of the inflation bias.

For the numerical solution presented, the values of the structural parameters employed are $\alpha = 0.34$, $\delta = 0.7$, $\sigma = 0.5$, $\beta = 1$ and $k^* = 0$. Shocks are for convenience normalized to unity. Structural parameters are not assigned arbitrarily; they may be justified on the basis of empirical evidence or are set to reflect the environment faced by the policymakers. A value of $\alpha = 0.34$ implies that—from the

original Cobb–Douglas production function where capital is constant and normalized to unity—labour requires two-thirds of the total inputs. Empirical evidence suggests that elasticity of the demand with respect to imports and exports are usually below unity; hence, by employing a value of $\delta = 0.7$ we intend to reflect a high sensitivity of trade to variations in the real exchange rate.[11] Setting $\sigma = 0.5$ implies that the central banks care more about inflation than employment.[12] For simplicity, we set $k^* = 0$; this suggests that the large foreign country, to which the small economy anchors its monetary policy, has no credibility problems. Finally, considering that the countries that have dollarized so far are significantly smaller than the economy to which they have relinquished their monetary policy, we employ an initial value of $\beta = 1$ to reflect the fact that the size of the domestic economy is negligible in relation to that of the foreign economy. Acknowledging that the results in this section apply to a reasonable set of parameter values but might not be valid for a complete parameter space, we complement the assessment by presenting a sensitivity analysis that examines the effect of changes in some of the key parameters of the model.

4.3.1 Symmetric shocks

Figure 1 plots the losses for the small economy associated with different values of the employment target, k, under the flexible (L) and dollarization regimes (L^d). According to this parametrization of our model, only in the case where the policymaker in the small economy aims at excessive employment targets which seriously compromise price stability, would dollarization be preferred to a flexible exchange rate regime. Despite the presence of the inflation bias, the ability of the small economy to use its monetary policy prevents it from incurring large losses over the range $k < \kappa$.

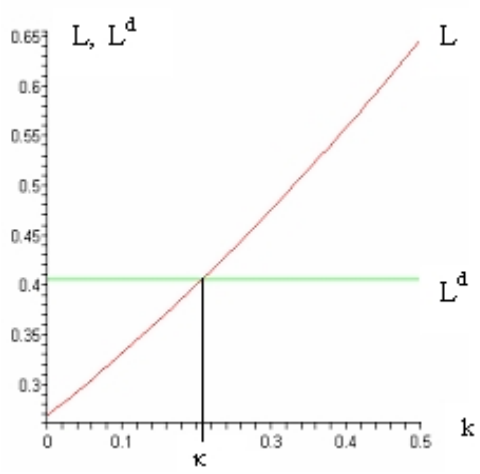
Sensitivity analysis As mentioned above, the numerical solution presented applies to a reasonable set of parameter values but might not be valid for a complete parameter space. Since variations in the parameters employed might have an effect over the ranking of losses associated with the two regimes at different employment targets, in this section we briefly observe how changes in the parameters that constitute the domestic inflation bias can affect the ranking presented in Figure 1.

We consider how a change in the size of the domestic economy, β, the elasticity of the demand with respect to the real exchange rate, δ, and the conservatism of the central bank, σ, influence the position of κ in Figure 1. Providing that the ranking of

[11] The Marshall–Lerner condition links the effectiveness of a monetary instrument with analysis of the demands for home and foreign goods in the real sector. It suggests that sum of the absolute values of the elasticities of home demand for foreign goods and foreign demand for home goods must be greater than one for a depreciation of the exchange rate to have an effect on the trade deficit and ultimately on output. Hence a value of $\delta = 0.7$ clearly suggests that the Marshall–Lerner condition is satisfied.

[12] Implicitly, inflation deviation from its target receives a weight of one, which is twice the weight assigned to the deviation of employment from its target in the loss function.

Figure 1: Welfare Comparison Following a Symmetric Shock $x > 0$

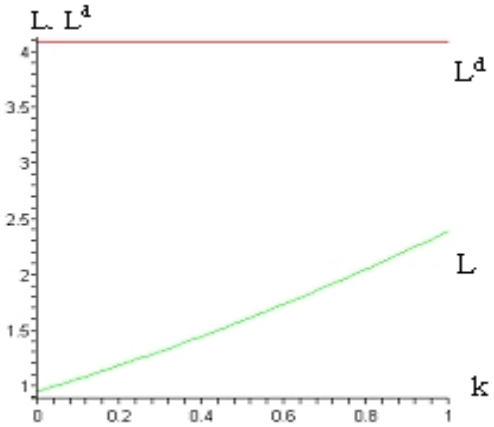


losses for the small economy in the absence of an inflation bias has been established in Proposition 3, we simply need to consider how the inflation bias in (15) changes with the parameters of interest: β, δ and σ. Differentiating the domestic inflation bias with respect to these three parameters, we obtain that $\frac{\partial q}{\partial \beta} < 0$, $\frac{\partial q}{\partial \delta} > 0$ and $\frac{\partial q}{\partial \sigma} > 0$.

Notice that the first two parameters, β and δ, only affect the losses of the domestic economy when it operates under a flexible exchange rate regime (see equilibrium in Table 1). As we observed in Section 3, the first derivative suggests that a comparatively larger domestic economy presents a higher inflation bias. This increases the losses of the domestic economy operating under a flexible exchange rate *vis-à-vis* dollarization. Hence, a reduction in β shifts the locus point, κ, in Figure 1 to the left. In other words, a relatively larger domestic economy would need to be less ambitious in terms of its employment targets, k, to gain from operating under a flexible exchange rate regime. The intuition for this result comes from the fact that a smaller β results in a reduction of the domestic policymaker's incentives to affect the exchange rate (i.e. a reduction in θ), an increase of the inflation bias and ultimately higher losses for the domestic economy.

The interpretation of the second derivative implies that a relatively higher sensitivity of the demand to variations in the real exchange rate, δ, ameliorates the incentives of the domestic economy to affect the exchange rate, θ, increases the inflation bias, and hence the losses associated with the flexible regime at different values of k. Finally, a change in the conservatism of the central bank has an effect on the losses associated with both regimes. In general, the losses under the two exchange rate arrangements are reduced as the central bank becomes more conservative. However, due to the presence of the inflation bias, the impact of increases in the conservatism of the central bank (i.e. a reduction of σ) are more significant for the losses associated with the flexible regime. Overall, an increase of the conservatism of the central bank shifts the locus point κ in Figure 1 (down and) to the

Figure 2: Welfare Comparison Following an Asymmetric Shock $u > 0$



right. To summarize, a relatively larger economy, greater sensitivity of the demand to changes in the real exchange rate and a less conservative central bank all increase the losses associated with the flexible exchange rate regime for a given employment target k.

4.3.2 Asymmetric shocks

Using the same set of parameter values, we calculate the losses resulting from an asymmetric shock at different level of the inflation bias. Figure 2 presents the graphs of the losses experienced by the small domestic economy under the flexible exchange rate regime (L) and dollarization (L^d). It is clear that the losses endured by the small domestic economy increase with the size of the inflation bias (i.e. the size of the employment target k) but never reach the level under dollarization. From the perspective of a policymaker, this result suggests that the cost of the distortions arising from an asymmetric shock in the absence of monetary policy is greater than under independent monetary policymaking, albeit with poor discipline.

Sensitivity analysis Since in the case of asymmetric shocks the parameters β, δ and σ affect the welfare provided by the two regime in a non-linear fashion, we tested the robustness of the ranking of losses in Figure 2 for ranges of parameter values. Figures 3–5 present the resulting changes in the equilibrium level of losses at different values of β, δ and σ for a given target of employment $k = 0.5$.

Figure 3 plots the losses experienced by the domestic economy under the two regimes for all the possible parameters associated with β. The plot shows that, in the presence of asymmetric shocks, not only is a small economy better off under a flexible regime than under dollarization but actually an economy of any size could perform better in terms of stabilization by keeping its own monetary policy.

Figure 4 presents the equilibrium level of losses when σ moves from its present

Figure 3: Sensitivity of the Equilibrium Losses to Changes in β for $u > 0$

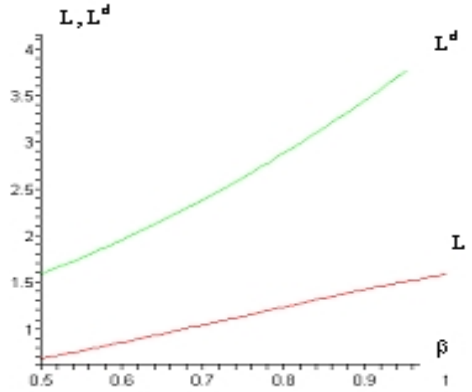
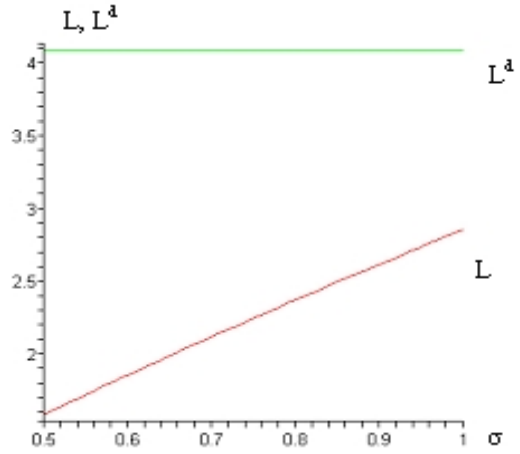


Figure 4: Sensitivity of the Equilibrium Losses to Changes in σ for $u > 0$

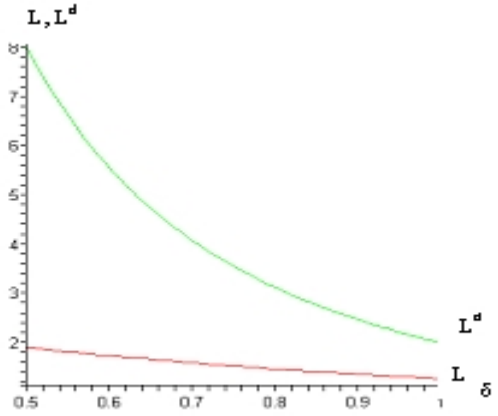


value of 0.5 up to the point where the central bank cares equally for inflation and employment (i.e. $\sigma = 1$). It is clear that the gap between the losses decreases as the central bank become less conservative. Nevertheless, the results remain in line with the ranking presented in Figure 2. As long as the policymakers remain conservative enough, the losses under dollarization exceed those under the flexible regime.[13]

Finally, Figure 5 illustrates the ranking of equilibrium losses for variations in δ, the sensitivity of the demand to changes in the real exchange rate. Consistently with the previous two plots, this figure shows no alteration in the ranking of losses for values of $\delta < 1$.

[13] A value of σ close to 2 (i.e. a central bank that cares twice as much for employment than for inflation) inverts the ranking of losses in Figure 4. Nevertheless, in our view, it is unrealistic to think that modern independent central banks would care more about employment than about inflation.

Figure 5: Sensitivity of the Equilibrium Losses to Changes in δ for $u > 0$



5 "Fear of floating" and dollarization

Calvo and Reinhart (2002) have suggested that although many countries, particularly EMEs, officially classify themselves as free floaters, in reality a number of them employ deliberate policy actions to stabilize their exchange rate against the effect of shocks to their terms of trade. In this scenario, our conjectures about the superior stabilization performance of a small open economy operating under a flexible exchange rate become redundant.

Indeed, economies that employ their monetary policy instruments to prevent exchange rate fluctuations behave more as fixed exchange rate followers than as free floaters. Presumably, in such situations the difference between giving up monetary policy—by dollarizing the economy—and maintaining it, at least in terms of stabilization, is only subtle.

In order to assess this claim, in this section we study the effects of "fear of floating" on stabilization policies by drawing a parallel between fear of floating practices and conducting monetary policy so as to fix the real exchange rate. We consider the case of a small open economy which, despite retaining its own monetary policy, attempts to minimize the variations of the real exchange rate with the aim of adopting the credibility of a larger economy which, for analytical simplicity, experiences no credibility problems.[14]

5.1 Defining fear of floating

In order to make our definition of fear of floating practices more realistic, we model a *de facto* fixed "fear of floating" regime differently to, for instance, Canzoneri and Henderson (1991) or Jansen and Weng (1999) where, due to the symmetry in the

[14] That is, we assume that the foreign policymaker faces no time inconsistency problems (i.e. $k^* = 0$).

size of the countries, a fixed regime implies the commitment of both policymakers.[15] Considering that fear of floating practices are one-sided policies, we rather assume that only the small domestic economy is committed to minimize the volatility of the real exchange rate (i.e. to maintain the real exchange rate fixed) and that the foreign economy takes as given the monetary policy decisions of the small economy.

Since the domestic economy maintains its own legal tender, the reduced forms presented in the previous section for the flexible exchange rate regime are in principle the same as those for an economy that follows fear of floating practices.[16] The difference with respect to the floating regime is that the domestic policymaker adopts a different reaction function. In order to ameliorate his/her credibility problems, the domestic policymaker tries to minimize the variations of the real exchange rate by means of the following reaction function:[17]

$$m = m^* - \frac{2}{1-\alpha}u \tag{30}$$

This reaction function implies that in the absence of asymmetric shocks the domestic economy matches any change in the money supply of the foreign country with a similar variation of its money supply, so as to keep the real exchange rate unaffected. In the presence of an asymmetric shock, however, the domestic economy contracts its monetary policy even further to stabilize the real exchange rate variations around zero.

On the other hand, providing that the small domestic economy retains its monetary sovereignty, the foreign country policymaker presents the same reaction function as under the flexible exchange rate regime:

$$m^* = \frac{\Delta\xi}{\Delta^2+\sigma}m + \frac{\Delta\Psi}{\Delta^2+\sigma}u - \frac{\Delta}{\Delta^2+\sigma}x \tag{31}$$

In what follows we explore the effect of symmetric shocks over a small economy that practices "fear of floating" in conducting its monetary policy. Then, we compare the equilibrium obtained with that resulting in the event that the small economy relinquishes its monetary policy through dollarization.

5.2 Fear of floating equilibrium outcomes

In order to minimize the variations of the real exchange rate resulting from the symmetric supply shock, the small domestic economy simply accommodates any

[15] In Canzoneri and Henderson's (1991) "fixed exchange rate leadership equilibrium" regime, the foreign policymaker commits himself to deliver a particular money supply, and the domestic policymaker commits him/herself to adjust his/her money supply so as to fix the nominal exchange rate. In the presence of size asymmetries it is unrealistic to expect that a large economy will take into account a small economy in deciding about its monetary policy.

[16] This assumption is consistent with the view that many economies let their exchange rate float freely in periods of tranquillity and only adopt fear of floating practices once the regime faces an episode of distress (Levy-Yeyati and Sturzenegger, 2005).

[17] This reaction function can be obtained from making the real exchange rate reduced form in (10) equal to zero and solving it for m.

Table 3: Dollarization and Fear of Floating Outcomes

	Fear of Floating	Dollarization
n	$-\frac{\Delta}{\alpha\Delta+\sigma}x$	$-\frac{\alpha}{\alpha^2+\sigma}x$
q	$\frac{\sigma}{\alpha\Delta+\sigma}x$	$\frac{\sigma}{\alpha^2+\sigma}x$
L	$\frac{\sigma(\Delta^2+\sigma)}{2(\alpha\Delta+\sigma)^2}x^2$	$\frac{\sigma}{2(\alpha^2+\sigma)}x^2$

change in m^* by changing m accordingly (see equation (30)). Substituting the reaction function of the domestic economy (30) for that of the foreign economy (31), the money supply chosen by the policymaker in the foreign country is only given by

$$m^{*ff} = m^{ff} = -\frac{\Delta}{\alpha\Delta+\sigma}x \tag{32}$$

where m^{ff} and m^{*ff} are the equilibrium money supplies under fear of floating for the domestic and foreign economies. As before, both policymakers reduce their respective money supplies following the presence of the symmetric shock. Substituting the equilibrium money supplies in the corresponding employment and inflation reduced forms and then those two expressions into the loss function of each authority, we obtain the equilibrium policy outcomes presented in Table 3 for the small domestic economy that conducts its monetary policy under fear of floating.

5.3 Dollarization

The dollarization outcomes presented in Table 3 are taken from the previous section. The only difference here is that, as mentioned above, we now assume *a priori* that the foreign central bank experience no time inconsistency problems (i.e. $k^* = 0$). The equilibrium world money supply chosen by the foreign economy is then given by

$$m^d = m^{*d} = -\frac{\alpha}{\alpha^2+\sigma}x \tag{33}$$

By comparing (32) and (33), it is straightforward to show that the contraction under fear of floating is larger than under dollarization whenever $(1-\beta) \leqslant \beta < 1$. This happens because, by responding with a similar reduction of its money supply, the domestic economy that conducts monetary policy under "fear of floating" increases inflation pressure on the foreign country. Consequently, the policymaker of the foreign central bank counteracts by tightening his/her money supply more aggressively.

The small economy equilibrium levels of employment, inflation and losses corresponding to the dollarization regime are also presented in Table 3. Given the larger contraction of the money supply under fear of floating, it immediately follows that the employment loss under this regime is larger than under dollarization. However, due to this larger contraction, inflation under fear of floating is lower than under dollarization.

Only when the domestic economy is trivially small with respect to the size of the foreign economy (i.e. when $\beta = 1$), is the equilibrium of employment and inflation the same under dollarization and fear of floating. Considering the combination of employment and inflation outcomes, the next proposition formalizes the ranking of losses under the two regimes following the symmetric shock.

Proposition 7 *As a result of fear of floating, the small open economy endures a larger employment loss than under dollarization but, at the same time, it experiences lower inflation. The combination of these two outcomes results in the small open economy experiencing higher losses after the adoption of a foreign currency whenever* $(1-\beta) \leq \beta < 1$. *Only when the domestic economy is trivially small (i.e.* $\beta = 1$*), are the equilibrium level of inflation, employment and losses the same under both regimes.*

Proof. To find that $-n^x < -n^d$, it is only necessary to cross-multiply both expressions to find that this is true when $\sigma\xi > 0$. To prove that $q^d > q^x$ we also cross-multiply to get that this is true when $\xi^2 > 0$. The same conclusion is obtained when we compare the losses of the two regimes. For those two condition to be true it is only necessary to be sure that $\xi > 0$, which is always the case when $\beta < 1$. ■

In terms of stabilization, there does not seem to be a major difference between conducting fear of floating practices and dollarization for trivially small open economies. Nevertheless, as the size of the domestic economy becomes non-trivial, then the ability to maintain monetary sovereignty, even if it is not fully exploited, seems to matter for stabilization purposes. This happens because in our model a non-trivially small open economy is capable of exerting some pressure on the decision that a large economy takes with respect to the management of its monetary policy.

6 Conclusions

In this chapter we have shown that although dollarization might be an effective regime to achieve price stability, giving up monetary independence might be costly in terms of stabilization. We find that, in the presence of both symmetric and asymmetric real shocks, a small open economy without time inconsistency problems is capable of achieving superior stabilization under a flexible exchange rate regime than under dollarization. This contrasts with previous findings in the policy coordination literature for symmetric size economies which suggested that a fixed exchange regime provides a Pareto efficient outcome following a symmetric shock.

In the presence of time inconsistency problems we observe that, only when the policymaker of the small economy faces serious credibility problems, does stabilization following a symmetric shock become more costly under a flexible regime than under dollarization. For asymmetric shocks, we find that, regardless of the size of the inflation bias, the cost of giving up monetary independence under dollarization exceeds that of the low discipline in controlling inflation under the flexible regime.

These results suggest that a small open economy capable of imposing a reasonable degree of discipline and of using its monetary polices effectively is always better off maintaining its monetary independence to confront economic disturbances. In our view, these results are consistent with the demise of the dollarization debate at a time when, due to the improvement of macroeconomic institutions and the benevolent world macroeconomic environment, inflation has settled down in most of the EMEs that contemplated the possibility of dollarization in the late 1990s.

We have also compared the dollarization regime with one in which a small open economy follows 'fear of floating' practices. In this case, we observe that unless its size is trivial, maintaining monetary policy sovereignty—even if it is not fully exploited—allows a small economy to experience lower losses in terms of stabilization against symmetric shocks. Only when an economy is negligibly small are the costs of stabilization following fear of floating practices the same as those under dollarization.

With respect to the two-corner solution approach to exchange rate policy, our analysis in this chapter does not intend to suggest that a floating corner solution is optimal for a small economy but rather that—from a purely monetary perspective—it is preferable to the other corner solution, namely dollarization, in terms of macroeconomic stabilization. In fact, as has been pointed out by empirical evidence, pure flexibility is hardly achievable by a small open economy with credibility problems. Nevertheless, we have shown that even when a country is not able to fully exploit its monetary independence, it might still be better off maintaining the autonomy of its economic policy than renouncing it.

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Appendices

A1. Derivation of equations (1) and (2)

In each economy a representative competitive firm faces a Cobb–Douglas production function with constant capital given by

$$Y = \frac{1}{1-\alpha}\frac{N}{X}^{1-\alpha} \tag{A.1}$$

The natural logarithm of this function is $\ln Y = \ln(\frac{1}{1-\alpha}) + (1-\alpha)\ln N - \ln X$. Subtracting $\ln(\frac{1}{1-\alpha})$ from $\ln Y$ and using small letters to represent natural logarithms, we obtain the aggregate supply equation in (1): $y = (1-\alpha)n - x$. Now, a profit maximizing firm using the Cobb–Douglas production function presented above will face the following maximization problem:

$$\Pi = P\frac{1}{1-\alpha}\frac{N}{X}^{1-\alpha} - WN \tag{A.2}$$

Maximizing this with respect to N, we obtain

$$\frac{\partial \Pi}{\partial N} = \frac{PN^{-\alpha}}{X} - W = 0 \tag{A.3}$$

Rearranging and taking logs from this expression provides the profit maximization condition in (2): $w - p = -\alpha n - x$

A2. Proof of Proposition 1 for asymmetric shocks

In the absence of credibility problems, for the small open economy to respond more aggressively to the asymmetric shock (i.e. $\mid m \mid > m^*$), it is necessary to show that

$$\mid m = -\frac{\Gamma\left[\Omega(\Delta^2+\sigma) - \theta\Psi\Delta\right]}{N}x \mid > m^* = -\frac{\Delta\left[\Psi(\Gamma^2+\sigma) - \xi\Gamma\Omega\right]}{N}x \tag{A.4}$$

which implies that $\Gamma\left[\Omega(\alpha\Delta+\sigma)\right] > \Delta\left[\Psi(\alpha\Gamma+\sigma)\right]$. Substituting the expressions for Ω, Γ, Ψ, and Δ the condition can be simplified to $\alpha(\Delta\Gamma+\sigma)(\Omega-\Psi)+\sigma(\theta\Omega-\xi\Psi) > 0$ with $(\Omega-\Psi) = \frac{2}{\delta}\left(\beta-(1-\beta)\right)$ and $\theta\Omega - \xi\Psi = \frac{2(1-\beta)}{\delta}\left(\beta^2-(1-\beta)^2\right)$. Thus, it is required only that $\beta > \frac{1}{2}$ for the inequality to hold. That is, the domestic economy has to be smaller than the foreign one.