FUNDAÇÃO GETULIO VARGAS
EPGE
Escola de Pós-Graduação em Economia

Ensaios Econômicos

Escola de
Pós Graduação
em Economia
da Fundação
Getulio Vargas

Nº 652 ISSN 0104-8910

Monetary Arrangements for Emerging Economies

Aloisio Pessoa de Araújo, Marcia Leon, Rafael Santos

Setembro de 2007

Monetary Arrangements for Emerging Economies*

Aloisio Araujo†- Marcia Leon‡- Rafael Santos §

Abstract

In this paper we look at various alternatives for monetary regimes: dollarization, monetary union and local currency. We use an extension of the debt crisis model of Cole and Kehoe ([3], [4] and [5]), although we do not necessarily follow their sunspot interpretation. Our focus is to appraise the welfare of a country which is heavily dependent on international capital due to low savings, for example, and might suffer a speculative attack on its external public debt. We study the conditions under which countries will be better off adopting each one of the regimes described above. If it belongs to a monetary union or to a local currency regime, a default may be avoided by an inflation tax on debt denominated in common or local currency, respectively. Under the former regime, the decision to inflate depends on each member country's political influence over the union's central bank, while, in the latter one, the country has full autonomy to decide about its monetary policy. The possibility that the government influences the central bank to create inflation tax for political reasons adversely affects the expected welfare of both regimes. Under dollarization, inflation is ruled out and the country that is subject to an external debt crisis has no other option than to default. Accordingly, one of our main results is that shared inflation control strengthens currencies and a common-currency regime is superior in terms of expected welfare to the local-currency one and to dollarization if external shocks that member countries suffer are strongly correlated to each other. On the other hand, dollarization is dominant if the room for political inflation under the alternative regime is high. Finally, local currency is dominant if external shocks are uncorrelated and the room for political pressure is mild. We finish by comparing Brazil's and Argentina's recent experiences which resemble the dollarization and the local currency regimes, and appraising the incentives that member countries would have to unify their currencies in the following common markets: Southern Common Market, Andean Community of Nations and Central American Common Market.

Keywords: optimum currency area, dollarization, speculative attacks, debt crisis.

JEL Classification: F34, F36, F47, H63

*We are grateful to Affonso Pastore, Arilton Teixeira, Carlos Hamilton Araujo, Helio Mori, Ilan Goldfajn, Peter B. Kenen, Renato Fragelli, Ricardo Cavalcanti, Roberto Ellery and Timothy Kehoe for their comments. The views expressed here are those of the authors and do not necessarily reflect those of Banco Central do Brasil or its members.

†Escola de Pós-Graduação em Economia (Fundação Getulio Vargas) and Instituto de Matematica Pura e Aplicada. E-mail: aloisioa@fgv.br; aloisio@impa.br

‡Research Department, Banco Central do Brasil. E-mail: marcia.leon@bcb.gov.br

§Corresponding author. Banco Central do Brasil and Doctorate student at Fundaçao Getulio Vargas. E-mail: rsantos@fgvmail.br

1 Introduction

In this paper, we describe the conditions under which a country chooses one of the following monetary regimes: common currency, local currency or adopts a strong currency unilaterally as in dollarization. This country is an emerging economy whose government obtains loans in the international financial market. According to the level of its external debt, the country is vulnerable to the willingness of the external creditors to keep its debt rolling. If the country is in the crisis zone and if an adverse shock hits the economy that makes the international bankers less confident as to the payment of its reliable debt, then they suspend their credit and the government defaults.

Actually this is the description of an economy according to the Cole and Kehoe ([3], [4], [5]) model on self-fulfilling debt crisis. We use it to characterize an economy under dollarization. According to our definition, a country that dollarizes, finances its public debt by issuing bonds denominated in dollars or any other strong currency and passively follows its monetary policy.

We follow the Cole-Kehoe methodology, but do not use the interpretation of sunspot equilibrium and rely more on the possibility of a shock that affects the fundamentals of an economy. Perhaps, for a country that has a very high savings rate, the best is to drive the economy away from the crisis zone since there are some obvious bad consequences in terms of welfare related to a speculative attack. However, in an economy where the savings rate is low and therefore there is a high value to absorb foreign capital (both in terms of direct investment and also in terms of bank loans) the best is to remain in the crisis zone. Possibly, this is another reason why countries like Brazil and Argentina have historically been in the crisis zone, as shown in the history of serial default reported by Reinhart, Rogoff and Savastano ([10]). With this background in mind, such countries have to look for an optimal monetary arrangement of the type described here.

We present three alternatives for the country to choose from: in the local currency case, public debt denominated in local currency is added to the Cole-Kehoe model to describe a government that controls its monetary policy. This ability, which is absent under dollarization, consists of imposing changes in the real return on local-currency debt. The revenues collected through an inflation tax, for example, can be employed to avoid a default on the denominated dollar debt. On the other hand, the decision to inflate causes a fall in productivity. In the case of local currency we also consider the adverse possibility that the government influences its central bank to create inflation tax for political purposes in the absence of an external crisis.

Furthermore, we also describe a country in a common currency area. As in local-currency regimes, an external default may be avoided by means of an inflation tax on public debt denominated in the common currency. The decision to inflate must be made jointly. Therefore, the decision to join a monetary union depends on the correlation of external shocks among member countries and on the decision process for monetary policy. The stronger the correlation is, the higher the possibility to use monetary policy for the purpose of smoothing shocks under common currency. The way that the decision to inflate is chosen in the monetary union also affects each member ability to smooth disturbances. A country which suffers an adverse external shock would like to have some power to press the union's central bank towards inflation in order to avoid its external default. We explore two types of voting systems: either each member country may veto inflation, or have some political influence over the union's central bank. In both cases, the credibility of the union's monetary policy is enhanced relatively to the local-currency one, since the possibility of a politically motivated central bank decreases when the decision to inflate is shared among its member countries and not from just one.

Traditionally, the issue of an optimum currency area is based on the theoretical underpinnings developed in the 1960s by McKinnon [8], Kenen [7] and mainly Mundell [9], who is concerned with the benefits of lowering transaction costs in relation to adjustments to asymmetrical shocks. In this paper our focus is to address financial aspects of an optimum currency area from the perspective of emerging economies. In this case, gains in credibility of the common currency relative to the loss in flexibility of monetary policy to face asymmetrical disturbances are as relevant as the reduction in transaction costs. Table 1 shows the effects of flexibility in conducting the monetary policy versus currency credibility, according to the three alternative monetary regimes.

Greater autonomy in exercising monetary policy and consequently, in choosing inflation tax, has costs and benefits in terms of welfare. On one hand, welfare gains are associated with inflation as means of avoiding an external default when the indebted economy is hit by an adverse shock. On the other hand, welfare costs are related to the possibility of inflation being used as an instrument to increase public spending in the absence of shock.

One of the advantages of the Cole-Kehoe methodology is to carry out a welfare analysis. We use their approach to evaluate the expected welfare of a union member country. The parameters used in the model represent, in a stylized way, the Brazilian economy during the 1998-2001 period. We compare the results from common currency and local-currency regimes to dollarization in order to appraise why Brazil and Argentina adopted different monetary arrangements between 1998 and 2001. The need to restore confidence in local currency induced both the governments to use a stabilization plan that pegged their local currency to the dollar in the early 90s. However, each country was under different monetary arrangements at the end of the decade. Argentina maintained the currency-board regime, which is similar to dollarization, while Brazil has adopted a floating exchange rate regime since January 1999, which resembles our local currency model. This fact led to a moderate inflation in Brazil as of 1999 and caused deflation in Argentina. The possibility of the Argentine government to obtain revenue with the devaluation of its currency would have been a valuable instrument to the financing of the international liquidity restriction caused by the Russian moratorium occurred in August 1998. Note in Figure 1 that along with a restriction to the international credit, the current account deficit had to be reduced in both countries, but only in Brazil inflation was used to smooth the impact of the adjustment. The analysis that the absence of inflation may have worsened the Argentine crisis is aligned with Sims ([11]) who emphasized the advantages associated with an unexpected inflation as a means to smooth tax tightening events.

Our main result is that for a country with a highly credible currency, the local-currency regime is the best choice. Under local-currency, autonomy to inflate produces higher welfare than under common-currency, since the union's decision may be contrary to the member country choice. However, for a low credible currency, local currency is not the best choice anymore. The country will prefer dollarization or common currency depending on the correlation of external shocks.

This result refers to a common currency created by emerging market economies. According to our model, the country decision of adopting the euro is more likely to the decision of adopting the dollar-currency regime. Note that the European Central Bank is uniquely independent and even if several member countries face similar debt problems, it may be unwilling to create the required inflation. In the union considered here, the ability of imposing an inflation tax does give its members an additional degree of freedom in dealing with a run on its external debt. Although it may be hard to engineer some controlled inflation tax in a country with a fairly recent history of high inflation, zero-inflation may not be desired. The recent bad experience of emerging economies with pegged exchange rate regimes has led them to search for alternative institutional framework in order to achieve currency credibility, as an inflation target regime. We argue that monetary union can be another option to enhance this credibility by changing the decision process for inflation.

On a more methodological ground, the possibility that default can be welfare enhancing is in accordance with the current bankruptcy literature, which says that it is optimal to have some bankruptcy in equilibrium, contrary to conventional wisdom (see Geanakoplos, Dubey and Shubik [6], for penalties on the utility function, and Araujo, Páscoa and Torres-Martínez [1], for infinite horizon economies) although the risk of default should be kept under control. Accordingly, the introduction of common currency can give rise to the possibility of a better bankruptcy technology through inflation than just the repudiation of external debt, which can be quite costly.

2 The model with local currency

Cole and Kehoe developed a dynamic stochastic general equilibrium model in which they consider the possibility of a self-fulfilling crisis of the public debt held by international bankers occur. We modify the original model in order to assess the welfare of an economy with two currencies and two periods. Besides the dollar currency, the local currency is added with the subterfuge that the government carries public debt in local money. The inflation tax is extracted from consumers when the government decides on the maturity date to reduce the real return of local currency bonds. This partial moratorium on local currency debt can be employed to avoid a default on the denominated dollar debt or to create inflation tax for political purposes in the absence of an external crisis. Next, we will describe a local currency economy.

2.1 Economic agents

The economy comprises three sectors: government, international bankers and consumers. There are infinite periods and a single good that can be consumed or saved in form of capital. Production utilizes capital and, implicitly, inelastically supplied labor.

The population of consumers is continuous and normalized to unit. Each consumer lives for infinite periods, pays a fraction ($\theta \in (0,1)$) of his income on taxes and allocates $(1-\theta)$ between consumption, government bonds denominated in local currency and investment so as to maximize his preferences subject to his budget constraint:

$$\max_{\{c_t,k_{t+1},b_{t+1}\}_t} E\left[\sum_{t=0}^{\infty}\beta^t(c_t+v(g_t))\right]$$

$$s.t.: c_t + k_{t+1} - k_t + q_t b_{t+1} \leq$$

$$[a_t.f(k_t) - \delta k_t](1-\theta) + b_t - b_t(1-\vartheta_t)\,;\ \forall\, t$$

c_t is private consumption and g_t is public expenditure. $v(.)$ is a continuous function, differentiable, strictly concave and increasing[1]. k_t is the capital stock. b_t is the government debt denominated in local currency, consisting of zero-cupon bonds maturing in one period and acquired in $(t-1)$. ϑ_t is the government's decision variable on whether or not to inflate. When purchasing a local-currency bond, an investor pays q_t in t to receive 1 or ϕ units of good in $(t+1)$, depending on whether the government exercises inflation or not. If the government decides to inflate, then $\vartheta = \phi$; otherwise, $\vartheta = 1$. Inflation rate is given by $\left(\frac{1-\vartheta}{\vartheta}\right)$, $b_t\,(1-\vartheta_t)$ is the revenue that government raises by lowering the real value of its common currency debt, a_t is the productivity measure that is depreciated, if the government produces inflation or if it does not pay its dollar denominated debt. It takes one of the following values[2], depending on the occurrence of default or inflation previously, or in the current period:

$$
\begin{aligned}
(a_t|\text{inflation}) &= \alpha^{\phi} \\
(a_t|\text{default}) &= \alpha \\
a_t &= 1, \text{ otherwise,} \\
where &: 0 < \alpha < \alpha^{\phi} < 1
\end{aligned}
$$

At last, $f(.)$ is the production function of the economy: continuous, concave, differentiable and strictly increasing[3]. Each consumer is endowed with k_o units of capital and with b_o units of bonds in the initial period.

The population of bankers is also continuous and normalized to unit. Each banker is risk neutral and has an endowment $\overline{x}$ of consumer goods in each period to be allocated between consumption x_t and government bonds denominated in dollars b^*_{t+1}. When bankers purchase a dollar-bond, he pays q^*_t units of the consumption good in t to receive 1 or 0 units of that good in $t+1$, whether the government exercises default or not. Banker's decision to purchase government bonds is made based

[1] $v\prime(0) = \infty$

[2] This is due to empirical data. See Simonsen and Cysne ([12]) and Cole and Kehoe ([3]).

[3] $f(0) = 0;\ f\prime(0) = \infty;\ f\prime(\infty) = 0$

on his preferences as well as on his budget constraint:

$$\max_{\{b^*_{t+1}\}_t} E\sum_{t=0}^{\infty}\beta^t x_t$$
$$s.t. \ : \ x_t + q^*_t b^*_{t+1} \leq \overline{x} + z_t b^*_t;\ \forall t$$

where z_t is the government's decision variable on whether or not to exercise default. International bankers are endowed with b^*_o units of bonds in the initial period. $\overline{x}$ is greater enough so that the supply of credit from all international bankers meets the demand for loans.

The government is benevolent and maximizes consumers' preferences. At each period it chooses public expenditures g_t and debts of the coming periods, B^*_{t+1} and B_{t+1}. It also chooses whether it would exercise default or inflation (z, ϑ) according to the following budget constraint:

$$\begin{aligned} g_t + z_t B^*_t + \vartheta_t B_t &\leq q^*_t B^*_{t+1} + q_t B_{t+1} + \theta.\left[a_t.f(K_t) - \delta K_t\right] \\ z_t &\in \{0,1\};\vartheta_t \in \{\phi, 1\} \text{ and } \phi \in (0,1) \\ g_t &\geq 0 \\ (z_t + \vartheta_t) &\geq 1 \end{aligned}$$

The last restriction shows that it is not possible to default and to inflate at the same time.

A dollarized economy is regarded as a specific case of the economy with local currency described above. We consider that to dollarize an economy means to follow passively the monetary policy implemented by a country with a sound currency[4]. Then, to dollarize means to equalize to one the exchange rates and to zero future inflation rates.

Next we will make some simplifications so that the economy may be represented in two periods: the first one where the monetary regime is selected, the public debt is renewed and the investments decisions take place and the second, when uncertainty is solved.

[4]There is no possibility of inflation.

2.1.1 Economy in Two Periods

In the initial period, $t = 0$, the economy has public debt denominated in dollars, B_o^*, public debt denominated in local currency, B_o, and its productivity, a_o, is equal to one. Furthermore, there has been no shock and the public debt is renewed at the same level. The rollover cost per unit of debt, $(1 - q_o^*, 1 - q_o)$, and the investment level k_1, depend on the monetary regime previously selected.

In the next period, $t = 1$, the economy is subject to two shocks: political inflation and speculative attacks on its external debt. When uncertainty is disclosed the government chooses ϑ, a new level for its debts, decides on whether or not to exercise default and consumers choose the new level of investments. Uncertainty refers to the possibility of bankers not being willing to purchase new dollar debt from the government and the possibility of political inflation occurs. Assuming that the government maintains its debt levels constant, chosen when uncertainty is solved, and that z_t and ϑ_t remain unchanged as from $t = 1$, the economy with infinite periods can be described by only two periods, in which the second one is a perpetuity with public debt represented by a flow of interest rate over this amount.

2.2 Uncertainty under local currency

In the model presented here, as in the Cole-Kehoe model, the adverse shock is a restriction to foreign credit caused by a self-fulfilling debt crisis associated with a speculative attack on external public debt. The occurrence of an attack depends on a sunspot variable ζ, that is supposed distributed with uniform $[0, 1]$ and describes the bankers' confidence that local government will not default on its external debt. This variable can be viewed as a fundamental that drives confidence and defines the equilibrium in the crisis zone: all speculators refuse to purchase new dollar bonds and default is the optimal decision or they purchase the new external debt and there is no default[5]. Next, we will introduce two additional shocks to the original model.

[5]The attack may be triggered without warning in response to change in the economic fundamentals that are not explicitly described in the model, such as: change in the price of commodities that intensively take part in exports, change in the government preferences (election), reduction in international liquidity, among others.

First, it is not realistic to assume that each speculator knows in equilibrium exactly what other speculators will do. So we consider two critical values for confidence instead of one. A low value, π^d, and a high value, π^{up}. If $\zeta < \pi^d$, then the price of new dollar debt is zero, since the speculator's confidence is quite low. All of them refuse to renew their loans. Because of this, default is the optimal decision for the government whose debt is in the crisis zone. If $\zeta \geq \pi^{up}$ then all speculators are willing to purchase new external debt at a positive price and default is not optimal. But if $\pi^{up} > \zeta \geq \pi^d$ then a partial rollover takes place. In the occurrence of this moderate attack, few bankers are willing to purchase new external debt at a positive price, and so the government can renew only a fraction, φ, of its external debt. We set φ less than one but sufficiently large so that government prefers to inflate rather than default during a moderate attack. Although we are not interested in modeling the information structure, one can think that international bankers are divided into two groups. The first and better informed one can identify three states of nature: no attack, intense attack and moderate attack. The second one can identify only two states: attack and no attack.

The second type of shock occurs when public debt is inflated away for political reasons in the absence of attacks. Political means that inflation is not an optimal decision. The probability that this shock occurs, given that there is no attack, is denoted by ψ. Therefore a political inflation shock occurs with unconditional probability equal to $\psi(1 - \pi^{up})$.

The model provides that under certain debt levels the intensity of default is proportional to the external debt crisis, that is, moderate and intense speculative attacks are respectively responded with inflation and default. Moreover, in the absence of attacks, it is optimal for the government to respect debt contracts. These critical debt levels are defined as the crisis zone in Section 4. Hereinafter we suppose that public debt is in the crisis zone.

In order to avoid creating another sunspot variable, we assume that ζ also drives consumer's actions. Accordingly, if $\zeta < \pi^d$, then consumers are sure that the government whose debt is in the crisis zone will not inflate. If $\pi^{up} > \zeta \geq \pi^d$, then they know that the government will inflate. If

$\zeta \geq \pi^{up}$ neither default nor inflation is optimal and they are aware that there may be political inflation with probability ψ. Defining $\pi^{up\psi}$ as $\pi^{up} + \psi(1 - \pi^{up})$, we conclude that political shock occurs if $\pi^{up} \leq \zeta < \pi^{up\psi}$. There are no shocks with probability $\left(1 - \pi^{up\psi}\right)$.

Therefore, the candidate country that elects the local-currency regime instead of the dollarization may be in one of the four possible states, s, described in Table 2.

In the beginning of period $t = 1$ uncertainty is solved with the drawing of the sunspot variable. The state s occurs if $\zeta \in \Pi_s$, where $\Pi_d \equiv [0, \pi^d)$; $\Pi_i \equiv [\pi^d, \pi^{up})$; $\Pi_p \equiv [\pi^{up}, \pi^{^{up\psi}})$; and $\Pi_c \equiv [\pi^{^{up\psi}}, 1]$. Defining $\pi^i \equiv \pi^{up} - \pi^d$, $\pi^p \equiv \pi^{up\psi} - \pi^{up}$, and $\pi^c \equiv 1 - \pi^{up\psi}$, the probability of occurrence of state s is given by π^s. All the economy sectors know the critical values and the distribution of ζ.

3 The model with common currency

Now, we consider a third alternative for monetary regime: a monetary union. We define a monetary union as an association of n countries plus the union's central bank. We denote each member country as member j, where $j \in \{1, 2, ..., n\}$. When they decide to create the union, their debt denominated in local currency is replaced by debt denominated in common currency. We consider that each one of them has some influence over the union's central bank, the decision-making body for inflation. The decision variable ϑ for the union will be denoted by ϑ^u, and the decision variable ϑ for each member will be denoted by ϑ^j and indicates if the member j is voting for inflation or not. Then, to join a monetary union means to share with other countries the control over inflation. We also redefine the Banker's budget constraint in order to consider the debt level from all member countries:

$$x_t + \sum_{j=1}^{n} q_t^{j*} b_{t+1}^{j*} \leq \overline{x} + \sum_{j=1}^{n} z_t^j b_t^{j*}; \forall t$$

Now, in order to estimate the welfare of country j under common currency, we must define its influence over the union's central bank. Next, we describe two different possibilities for the decision process at the union's central bank.

In the first case, we assume that every member of the union has the right of veto over the union's decision to inflate. Then, inflation over common currency takes place only if each member votes for it. If any member prefers to default rather than to inflate, it votes for not to inflate. Considering the right of veto, when a country joins a monetary union, its decision to default is not changed in comparison to the local-currency regime. However, its decision to inflate may not take place if the union's decision is against it. In this case, a country has to choose between default or respect debt contracts. Note that, a dollarized economy can be regarded as a specific case of a union between an emerging market economy and a country which hypothetically always vetoes inflation.

Instead of the right of veto, we also consider an alternative voting system where each member j has some political influence on the union's central bank. In this case, when members do not agree with the decision to inflate, we assume that each member j will succeed in implementing its decision with probability pw^j. The variable pw^j is the political weight of j in the union, and the greater the value of pw^j, the greater the influence that it has on the union's central bank. Note that in this case, when a country joins a monetary union, its decision to default may be changed in comparison to the local-currency regime. If any member decides for default but the union decides for inflation, then inflation takes place. As we ruled out from the model the possibility of default and inflation at the same time, the member cannot default. Just in this case, if the public expenditure becomes negative because default is avoided, we consider that the member country can default and inflate at the same time. For such situation, the productivity measure a_t becomes $\left(\alpha \cdot \alpha^{\phi}\right)$.

Therefore, it is taken into account that, given a monetary union of n emerging market economies available, each economy might adopt one of the following monetary regimes: local currency, dollarization, and common currency. Under local currency, the economy does not share its currency with any country and its inflation decision is always possible to implement. Under dollarization, inflation is ruled out. Under common currency, the inflation decision is shared.

3.1 Uncertainty under common currency

We have already described uncertainty under local currency. Now, consider a country that elected the common-currency regime instead of the local-currency one. We assume that ζ^j has the same distribution and critical values for each member j and that all members know the correlation between events related to sunspots $\left\{\zeta_1^1, ..., \zeta_1^n\right\}$ realization. We consider the following structure of correlation between events related to speculative attacks: the probability of occurrence of an intense attack in one country j $\left(Prob(\zeta^j \leq \pi^d)\right)$ does not depend on events occurred in other members $j\prime \neq j$. If there is no occurrence of intense attack at the union, the events with symmetry of attacks between members are positively correlated by ρ. Thus, if ρ value is minus one and there is no occurrence of intense attack, then there is no symmetrical attacks, like "moderate attack in all members". If its value is zero the attacks occur independently and if its value is one there is no asymmetrical attacks.

Thus, if candidate countries choose to create a monetary union with the right of veto for each one of them, they will be subject to five possible states, instead of four. This happens because the voting system adds a further uncertainty to the economy. The additional state u is defined as the one where the country suffered a moderate attack but cannot practice the desired inflation since at least one country voted against that. If country j votes for inflation in the absence of attack but another member vetoes its choice, then j visits state c and moves out from state p. Country j actually visits state p when decision for political inflation is aligned with the other members' vote. The probability of state d is not altered by the voting system when veto is allowed.

Table 3 sums up the five relevant events (from 16) for a member of a monetary union formed by two identical countries $(A$ and $B)$, as well as the probabilities of occurrence. Column s_u^A informs the state of the country A, conditional to its being part of the monetary union. The calculation of these probabilities is detailed in the Appendix, that also presents the relevant events for a member country when the union involves three identical members and 64 possible events.

Now, if candidate countries choose to create a monetary union without the right of veto and believe that each one of them has political influence pw^j over the union's central bank, then each member j will be subject to six possible states, instead of five. This happens because the new voting system adds a further uncertainty to the economy. The new state denoted by w is defined as the one where the country suffered an intense attack, but cannot practice the desired default since the union's central bank had decided for inflation. In this case, if the total tax (including inflation) is not enough to pay the external debt, we assume that this country practice default and inflation. Table 4 sums up the six relevant events (from 16) for a member of monetary union of this type and formed by two identical countries (A and B), as well as the probabilities of occurrence. The last column of Table 4 shows the probabilities of occurrence of each state, if country A prefers to maintain local currency instead of common one.

In both types of monetary union, with right of veto or without, the possibility of inflation to avoid an external default is reduced, but not ruled out as in dollarization. Inflation to avoid default is prevented by the union when s^j changes from i to u. On the other hand, political inflation in country j is also prevented when s^j changes from p to c.

3.2 Sequence of events

In the period $t = 0$, taking n as given, each government j chooses its monetary regime, m, among local currency,common currency and dollarization[6]. Moreover, public debts are rolled over and consumers from each member choose c_0^j, b_1^j and k_1^j.

In the period $t = 1$, the events have the following order:

1. Variable ζ^j is realized, the aggregate state of economy j is $S^j = (K_1^j, B_o^{j*}, B_o^j, a_o^j = 1, \zeta^j)$ and the aggregate state of the union of n members is S, $S = \{S^1, ...S^n\}$.

2. Government j chooses $\vartheta^j \in \{\phi, 1\}$, taking S as given.

3. Government j, taking S, ϑ^u, and the price q_1^{j*} as given, chooses the new dollar debt $\{B_{1+\tau}^{j*}\}_{\tau>0}$.

[6] In the first case, j chooses $\vartheta^u \equiv \vartheta^j \in (\phi, 1)$ and n turn to be one. In the last case, j chooses $\vartheta^u = \vartheta^j = 1$.

4. International bankers, taking S, ϑ^u, and q_1^{j*} as given, choose whether to purchase $\left\{b_{1+\tau}^{j*}\right\}_{\tau>0}$ for each j.

5. Government j, taking S, ϑ^u and the price q_1^j as given, chooses the new common-currency debt $\left\{B_{1+\tau}^j\right\}_{\tau>0}$.

6. Investors from country j, considering S, q_1^j, q_1^{j*} and ϑ^u as given, choose whether to purchase common-currency bonds issued by their own country $\left\{b_{1+\tau}^j\right\}_{\tau>0}$.

7. Knowing ϑ^u, B^j,and B^{j*}, government j chooses z_1^j.

8. Consumers from country j, taking a_1^j as given, choose c_1^j and $\left\{k_{1+\tau}^j\right\}_{\tau>0}$.

3.3 An Equilibrium

Following Cole-Kehoe we define an equilibrium where market participants choose their actions sequentially, starting with consumers who choose last. Consumers from each country j take as given the aggregate state S, the union's decision ϑ^u, their government's decisions $G^j \equiv (m^j, \vartheta^j, z^j, g^j, B^j, B^{j*})$, and their own decisions regarding capital k^j, and debt level b^j. In equilibrium, their choices $C^j \equiv (c^j, k^j, b^j)$ coincides with the aggregate capital and debt level $(., K^j, B^j)$. The consumer maximizes his utility function and chooses k_{t+1}^j that solves:

$$\frac{1}{\beta} = (1-\theta^j)\left[f\prime(k_{t+1}^j)E_t[a_{t+1}^j] - \delta\right] + 1$$

Furthermore, consumers act competitively and are risk neutral, so they purchase public debt denominated in common currency whenever its price is equal to the expected return $1/\beta$:

$$1/\beta = E_t[\vartheta_{t+1}^u]/q_t^j$$

International bankers take as given the aggregate state S, the offer of new debt (B^j, B^{j*}), and the debt (b^j, b^{j*}) to be received in such period. As bankers act competitively and are risk neutral too, they purchase public debt denominated in dollar from country j whenever its price is equal to the expected return at $1/\beta$:

$$1/\beta = E_t[z^j_{t+1}]/q^{j*}_t$$

Government chooses at two different times: in $t = 0$, it decides on the monetary regime m; and in $t = 1$, after uncertainty is solved, it makes decisions at three different moments. First, in the beginning of the period, knowing the aggregate state S, it announces its vote for inflation, ϑ^j_s. After knowing the union's decision, ϑ^u_s, it chooses new public debt (B^j_s, B^{j*}_s). At last, it chooses z^j_s and g^j_s. At the beginning of the period, the government is capable of anticipating capital accumulation as productivity expectation and the price that makes bankers and investors indifferent to purchasing public debt. Its optimization problem is

$$\max_{G^j_{t,s}} E \sum_{t=0}^{\infty} \beta^t \left[c^j_{t,s} + v(g^j_{t,s})\right]$$

$$\begin{aligned} s.t.\ \vartheta^j_s &\in \{\phi, 1\}\ ; \forall s \in S \\ g^j_{t,s} &\leq \theta\left[a^j_{t,s} f(K^j_{t,s}) - \delta K^j_{t,s}\right] - B^{j*}_{t,s}(z^j_{t,s} - q^{j*}_{t,s}) - B^j_{t,s}(\vartheta^u_{t,s} - q^j_{t,s}); \forall s, t \\ z^j_s &\in \{0, 1\}, z^j_s + \vartheta^u_s \geq 1\ ; \forall s, j \end{aligned}$$

Then, for each country j, an equilibrium can be defined as a list of choices $G^j_{t,s}$, $C^j_{t,s}$, $b^{j*}_{t+1,s}$, , an equation of accumulation of aggregate capital $K^j_{t+1,s}$ and prices $q^{j*}_{t,s}, q^j_{t,s}$ so that, for every t, s and j:

(i) Given $S, G^j_{t,s}, q^{j*}_{t,s}, q^j_{t,s} : C^j_{t,s}$ solve the consumer's problem.

(ii) Given $S, C^j_{t,s}, q^{j*}_{t,s}, q^j_{t,s} : G^j_{t,s}$ solve the government problem.

(iii) $q^{j*}_{t,s}$ and $q^j_{t,s}$ solve: $1/\beta = E_t[\vartheta^u_{t+1,s}]/q^j_{t,s} = E_t[z^j_{t+1,s}]/q^{j*}_{t,s}$.

(iv) Given S, $B^j_{t+1,s} = b^j_{t+1,s}$.

(v) Given S, $B^{*j}_{t+1,s} = b^{j*}_{t+1,s}$.

(vi) Given S, $K^{j}_{t+1,s} = k^{j}_{t+1,s}$.

4 Debt Crisis Zone

The payoff for government j conditional to decisions z^j and ϑ^u is denoted by $U(z^j, \vartheta^u)$. The debt crisis zone is defined as the local-currency and dollar debt levels for which it is optimal for the government to respond with inflation to a moderate attack, to respond with default to an intense attack and to honor contracts in the absence of an attack. Moreover, if government debts are in the crisis zone and inflation cannot be implemented during a moderate attack, then default will be the second best option. Thus, (B_o, B_o^*) will be in the debt crisis zone if the following conditions are satisfied:

$$\begin{aligned}
\zeta^j &\in \Pi_d \Rightarrow U(0,1) \geq \max\{U(1,\phi), U(1,1)\} \\
\zeta^j &\in \Pi_i \Rightarrow U(1,\phi) \geq U(0,1) \geq U(1,1) \\
\zeta^j &\in \Pi_c \cup \Pi_p \Rightarrow U(1,1) \geq \max\{U(0,1), U(1,\phi)\}
\end{aligned}$$

To construct this equilibrium, we consider the local currency debt fixed at level B_o^j for all t. The choice of parameters ϕ and φ is somewhat arbitrary but essential to obtain the crisis zone. Given φ, we can choose ϕ so that inflation is the best response only against a moderate attack. Note that for a different moderate attack (different value of φ), the government may set a different value of ϕ in order to avoid an external default. In the numerical exercise we consider only one type of moderate attack, and thus only one value for φ.

Government's preferences also affect the crisis zone. If the government is sufficiently concerned with current public expenditures, then it would rather respond to attacks with default. Conversely, a government sufficiently concerned with private consumption would rather fully pay its debts in all states. We construct this equilibrium to obtain an intermediate and more realistic case for government preferences, where both incentives to default and to inflate are present in this crisis zone.

5 Numerical Exercises

In this section, we present numerical exercises where we attempt to outline under which conditions emerging economies would be better off, in terms of welfare, by joining their currencies than being on their own. We consider a monetary union between two and three countries, where each one of them can veto the union's decision to inflate. Different political influences that members have on the union's central bank are also taken into account.

The parameters used in the simulations have been chosen to portray the Brazilian economy during July 1998 to August 2001. The definition of period length is based on the Brazilian government debt whose average length varied as indicated in Table 5. The government discount factor, β, is approximated by the yearly yield on government bond issued by the US, whose values fluctuated between 4.8 and 5 percent[7]. Based on these figures, we interpret a period length as being one year and a yearly yield on risk free bonds, r, as being 0.05, which implies a discount factor β of $0.95 (= (1+r)^{-1})$. The tax rate, θ, varied between 0.30 and 0.35 in the period and we set it equal to 0.30. The choice of the functional form was the same used by Cole and Kehoe [3], that is, $v(g) = \ln(g)$, which implies a coefficient of relative risk aversion of one. The results are very sensitive to this parameter which, besides determining the coefficient of risk aversion, defines the relative importance of public expenditure. The production function, $f(k)$, is given by $(k)^{\lambda}$, where capital share λ is established at 0.4. The yearly depreciation rate, δ, is equal to 0.05. The parameter α equals 0.95, assuming that default causes a permanent drop in productivity of 0.05, as in the Cole-Kehoe model. This drop is equivalent to a net present loss relative to GDP of 1.05[8]. We set φ as 0.62 and ϕ as 0.85. The correspondent inflation rate, $(1-\phi)/\phi$, is equal to 0.18. The permanent welfare cost of inflation, α^{ϕ}, is estimated to be 0.998. This drop is equivalent to a net present loss relative to GDP of 0.03[9].

[7]Considering U.S. government bond yield. Using the U.S. discount rate reported by IMF (International Financial Statistics), the yield varies between 4.5 and 6 percent.

[8]Considering $k_{s,t} = k_o, \forall t, s$. Considering the optimal investment level the drop is equivalent to 1.7.

[9]In estimation of welfare cost of inflation we use Bailey's approximation and the money demand specified as kr^{-a}, where r is the logarithmic annual inflation (see Simonsen and Cysne [12]). We consider k and a equals to 0.04 and 0.6, respectively.

The probability of default, π^d, and the probability of inflation, $\pi^i + \pi^p$, under the crisis zone and the local-currency regime is calculated on the basis of risk premium practiced in the financial market according to the following expression:

$$\frac{1}{\beta} = \left(1 + r_D^{BR}\right)\left(1 - \pi^d\right) = \left(1 + r_{LC}^{BR}\right)\left(1 - \left(\pi^i + \pi^p\right)(1 - \phi)\right)$$

where r_D^{BR} and r_{LC}^{BR} are yearly yields on Brazilian public debt denominated, respectively, in dollar and in local currency (discounting expected inflation of Brazilian currency).

Data for r_D^{BR} is available for the whole period of analysis, while r_{LC}^{BR} only since January 2002, when its value was about 0.12[10]. Therefore, values for π^d varied between 0.04 and 0.11 and for $(\pi^i + \pi^p)$ is evaluated at 0.42. In the simulation, π^d and π^i were fixed at 0.04, and π^p varied from 0 to 0.9. Analogous to π^p, the correlation ρ is somewhat arbitrary and varied between -0.3 and 1 in the simulation.

Second column of Table 6 sums up debt levels, investment, private consumption and public expenditure used in numerical exercises. The last column also indicates the range of the actual economic variables observed in Brazil during the 1998-2001 period.

5.1 Results

5.1.1 Debt Crisis Zone

Following Cole and Kehoe approach, we present in Figure 2 the debt crisis zone as a function of the maturity structure of the debt for a dollarized economy subject to speculative attack (only intense, that is, $\pi^{up} = \pi^d$). Henceforth, lengthening the maturity structure means converting an initial quantity B of one-period (one year) bonds into equal quantities B_n of bonds of maturity 1,2,. . . ,N. Then, the government redeems B_n^* bonds every period and sells B_n^* n-period bonds, where B_n^* is given by $B_n^*(1 - \beta^n) = B^*(1 - \beta)$. Results presented in Figure 2 consider the stationary participating constraint, which gives the highest debt level under which not to default is better than to default when there is no speculative attack. The no-lending condition gives the highest debt level under which not

[10] Yearly yield on LTN minus inflation.

to default is better than to default when the government cannot renew its old debt. For a sufficient long maturity, no-lending condition and no-stationary participation constraint coincide[11]. In our exercise we consider the external debt as 0.45 of GDP. As the maturity gets longer, the debt required for the economy being in the crisis zone is greater. If maturity were longer than three years, for debt levels considered here, the economy would be out of the crisis zone.

5.1.2 Monetary Arrangements Between Two Countries with Right of Veto

According to the model, the possibility to inflate depreciates the economy welfare in two ways. At first, the government may inflate even if it is not optimal to do so. Secondly, it reduces national investors' confidence in advance and, consequently, interest rate on local-currency debt rises and investment is reduced.

Our results establish conditions under which to reduce monetary autonomy is better than to maintain local-currency regime. The preferred regime depends on the risk of political inflation and on the correlation of external shocks that members are subject to. This correlation determines the likelihood of suboptimal states u, w and p occurring.

Considering a two-identical-country union, Figure 3 shows that, by changing the external shocks correlation, we obtain the optimal monetary regime for each level of the risk of political inflation, which is represented by the probability π^p. When the correlation is low and there is no risk of political inflation; investors have full confidence that the government will not inflate for political reasons $(\pi^p = 0)$; then it is better not to give up monetary autonomy. Conversely, when the risk is very high $(\pi^p = 0.9)$, the economy is dollarized and monetary policy decision is transferred to the US Federal Reserve Bank. In the last case, the result is independent of correlation. Note that for high levels of political inflation the union is not desirable because it loses its inflation-inhibiting function. In such cases it is likely that both governments would vote for inflation even in the absence of attacks. For mid-risk levels, the correlation is important to define the most appropriate currency-regime. The

[11] As from 45 years in our simulation.

higher the correlation, the greater the interval of risk of political inflation for which a common currency would be selected. At last, the results show how the common currency area changes in relation to the presence of an arbitrary cost associated with the creation of the union. We do this exercise by fixing cost at one percent of GDP, only to show the sensitivity of the common currency option. In the presence of this cost, more correlation is necessary for the government to choose common currency instead of local currency.

5.1.3 Alternative Monetary Arrangements

Figure 4 present results for a three-identical-country union and compares the results with a two-identical-country union. The addition of a new member with right of veto makes inflation less likely in the monetary union. Thus, the area of preference for a common-currency regime moves towards higher values of external shocks correlation. This conclusion is based only on financial aspects of monetary unions and should not be taken as an optimum currency area approach since issues as international trade and factor movements are not considered in the model.

The hypothesis of identical members is convenient since it enables the conclusion that if there is an incentive to one country to join the monetary union (greater expected welfare under common-currency) there is an incentive to all, and thus the union is feasible. Relaxing such hypothesis, in the next exercises, we analyze incentives for country A to join an already established monetary union, which is defined as country B. At first, the risk of political inflation of B, π^{pB}, is fixed, while the risk of political inflation of A varies as in the previous exercises. Secondly, we consider that members have different influences over the union's decision to inflate, instead of the right of veto.

Figure 5 reports results for two different values for the risk of political inflation of country B. They are fixed at $\pi^{pB} = 0.7$ and $\pi^{pB} = 0$. As expected, with the reduction of risk of political inflation in B, inflation in the union becomes less likely, and the region's preference for common currency over dollarization is increased while the region's preference for common currency over local currency is decreased. With no risk of political inflation in B, this country will vote for inflation only when it suffers a moderate attack. Therefore, country A will have less chance to inflate and common currency is less attractive for low levels of risk of political inflation. As the risk of political inflation in A and correlation rises, country A chooses common currency to improve monetary discipline.

Figure 6 shows the results when we consider that country A has some political influence over the union's central bank, instead of the right of veto. With this hypothesis, there may be inflation on common currency even if any member does not vote for it. The variable pw indicates the possibility that country A will succeed in changing the union's decision. The greater pw is, the stronger is its influence on the union's central bank. Results in Figure 6 consider π^{pB} fixed at 0.7 and pw^A as being 0, 0.4 and 0.8.

Note that over the line that separates the common-currency and the local-currency regions, welfare level is the same for both regimes. Its locus does not depend on the value of pw. Thus, if the government is indifferent to both regimes it will be indifferent to pw value.

Moreover, Figure 6 shows again that at high levels of risk of political inflation, $\pi^{PA} > 0.7$, country A looks for monetary discipline. For correlation below to 0.55, dollarization is the best monetary arrangement, because correlation is not high enough for common-currency regime to be chosen. Increasing the correlation a little (around 0.1), country A joins the monetary union as pw decreases. This way, it attains the desired monetary discipline without having to dollarize and to discharge inflation.

In figure 7, we compare monetary regimes for member A when it can join a union where each member has the right of veto and when it can join a union where it has no political influence over the decision for inflation. The value of π^{PB} is fixed at 0, thus in both unions there is no inflation for political reasons. In the former case, the union's central bank will inflate when both member vote for it, and in the last case when B votes. The decision of the union's central bank will depend on the decision process only when B votes for inflation but A does not[12]. There are only two possibilities for

[12]Under local currency country A is subject to four possible states (c, p, i, d) and country B to three possible states

this event: or $(z^A, \vartheta^A, z^B, \vartheta^B)$ is equal to $(1, 1, 1, \phi)$ or to $(0, 1, 1, \phi)$. Country B suffer a moderate speculative attack in both cases, an event with low probability of occurrence. In the first case, country A does not suffer any shock, an event with low probability of occurrence when its risk of political inflation is high. For a low level of risk of political inflation, but high level of correlation this event is rare again, due to asymmetry with the event in country B. In the second case country A suffers an intense attack, another rare event. Concluding, these two events, drawn from twelve possibilities are very rare if we consider the region where common currency is the best option. This is the reason for, in figure 7, both pictures seem to be equal for $pw^A = 0$. In fact, if common currency is the best choice for A when veto is not allowed, then it is also the best choice when member A has the right of veto over the inflation decision.

Although these results refer to a zero-political-influence for country A, if its influence gets bigger, then the above conclusion would still be the same[13]. Monetary union with right of veto is preferable to an union with political influence decision process, because in the last one it is possible that a member decides not to inflate but the union prefers to inflate. When the union's decision prevails the forced inflation decreases the welfare or in the worst state (default with inflation), or in the best state, inflation under no-shock. Thus, according to this model, forced inflation decreases the value of common currency under political influence decision process relative to the value of common currency under the union where members have the right of veto.

Both types of union, with members having the right of veto and some political influence over the inflation decision, could be described at once, with the following structure. When the union member country votes for inflation, its decision is accepted by the union with probability p. When the union member country votes for no inflation, its decision is accepted by the union with probability q. If $q = 1$, we have the first type union. If $q = p < 1$ we have the second type union. We separate types of descriptions for two reasons. First, for didactical purposes since in the second type, additional

(c, i, d). Under common currency, country A will be subject to twelve possible states.

[13]Note that if we change pw^A from 0 to 0.9, the common currency area shrinks. It is also true if we increase π^{pB}.

uncertainty is considered. Second, to argue that having the right of veto (or not) is not a decisive factor to decide if common currency is adopted or not, as shown in Figure 7.

5.1.4 Brazil and Argentina: different monetary arrangements

The results obtained with the numerical exercise are aligned with the preference for dollarization by both countries in the early 90s, when to reduce inflation was the main target for monetary policy. It is also possible to appraise why different monetary regimes were adopted in Brazil and Argentina between 1998 and 2001. Brazil did not adopt a monetary arrangement similar to dollarization[14], while Argentina did and suffered a default. A trivial explanation is that Argentine government erroneously thought that the adoption of foreign currency would bring economic stability, an idea largely debated in Latin America. Next, we discuss two other possible reasons for the difference in monetary arrangements: differences in risk of political inflation and differences in relative coefficient of risk aversion.

One reason for the different choice might be that the risk of political inflation of Argentina was higher than the Brazilian one. According to the results of Figure 3, the Argentinian choice would be located in the dollar region, which is characterized by higher levels of risk of political inflation relative to the local-currency one, which was the Brazilian monetary choice[15]. A higher risk of political inflation can be explained by the difficulty in controlling public expenditure in Argentina where each province would have incentive to maximize the local expenditure with no commitment to sustainability of the aggregate expenditure. In Brazil, on the other hand, the institutional environment favored a little more the public expenditure control. The fiscal responsibility law completed in May 2000 is an example of political efforts towards ensuring the public finance sustainability.

Another reason concerns government preferences which are captured by the utility function $v(g)$. In the following exercise, we investigate different specifications for this function (for Argentina) in

[14] In the sense of the dollar-currency regime described here.

[15] In a very preliminary version of Araujo and Leon ([2]), written before the 2001 Argentinian crisis, the debate about local-currency regime versus dollarization was brought about. They argue that the local currency improves default technology and welfare is higher relative to dollarization as long as political pressure over the central bank is not too strong.

order to conclude how the relative coefficient of risk aversion affects the preferences for monetary arrangements. With a few exceptions, the parameters used in the simulation for the Argentine economy were the same as for Brazil. The following parameters were changed: $\theta = 0.25$, $v(g) = g^{0.01}$, $\frac{B}{GDP} = 0.5$[16]. According to the new specification for $v(g)$ the coefficient of relative risk aversion is 0.99 instead of one. With these new parameters, the government is indifferent between the local currency regime and dollarization. If the coefficient of relative risk aversion were less than 0.99, then dollarization would be preferred. If it were greater than 0.99, then local currency would be preferred. Thus, for such parameters, the region where dollarization is preferable grows along with the reduction in the risk aversion.

5.1.5 Latin American Common Markets

By comparing welfare under common and local currency we appraise if each member country would be disposed to unify their currencies considering the following common markets: Southern Common Market, Andean Community of Nations and Central American Common Market.

Table 7 presents the parameters used in the simulations[17] and results for different assumptions about external correlation and decision process for common currency devaluation (inflation). To compute such results we consider that currency devaluation improves trade balance and helps country in smoothing external shocks as detailed in the appendix B. This way, countries like Peru may opt to inflate even without having public debt denominated in local currency.

To understand the role for correlation[18] remember that, considering local currency, there are only 4 possible states for each country and three optimal decisions. Under such common currencies, with five countries, each member is subject to 1024 states since other members decisions for inflation

[16]The local currency debt was about five percent of GDP between 1998 and 2001. We consider a greater value for debt level to increase local-currency regime payoff. We also fixed the risk of political inflation at 0.53 and changed the parameter ϕ from 0.85 to 0.5. With such changes, the government is indifferent between the local currency regime and dollarization.

[17]Variables that are not presented in Table 7 are the same for all countries including Brazil, as detailed in the beginning of the section 5. Parameters have been chosen to resemble economies in the end of 2000-year and to ensure that their debts are in the crisis zone as defined in section 4.

[18]Here, we consider correlation both for intense and moderate attacks. If $\rho = 0$, attacks are independent between countries. If $\rho = 1$, states like no-attack, moderate-attack or intense attack are the same for all countries.

affect the probability of implementing the optimal decision. As correlation becomes higher, countries tend to agree about optimal inflation decision and common currency can prevent political motivated inflation without avoiding "good" inflation (associated with moderate attacks).

These 1024 states can be reduced to 6 states as in Table 4. Accordingly, if there is no correlation ($\rho = 0$), suboptimal states becomes more likely and so local currency for the most of countries is the best option. Considering perfect correlation ($\rho = 1$), common currency is the best option for the most of countries. In this case, decision process for inflation that inhibits states with inflation, like the one based on veto right, is better than process based on majority rules.

Finally, even looking just for financial aspects, we guess that for high correlation levels common currency should be a good idea for those common markets. When most of members agree that common currency is a good deal, it can be implemented with some negotiation. For example, each country that prefers common currency may share its gain with other members when setting trade agreements.

6 Conclusions

The paper brings into discussion the financial aspect about monetary regimes for countries heavily dependent on international lending and subject to political inflation. This task is accomplished by means of a macroeconomic model that incorporates microfundamentals, rational expectations and credit risk of local and foreign currency-denominated debts.

The results obtained with the numerical exercise are aligned with the preference for dollarization by economies under very high risk of political inflation. It also argued that when the risk of political inflation is moderate and external shocks correlation are high between countries, a monetary union can be an effective arrangement to increase confidence in the currency, without losing inflation as an additional instrument to smooth external shocks.

Traditionally, research on monetary union arrangements do not address the political inflation or default risk as variables of decision on adopting common currency. Such issues do not have appeal to developed economies that have strong currencies and minor risk of default. However, they are extremely relevant to emerging economies.

Finally, we would like to emphasize that even though reasonable results were obtained in the numerical exercises, many aspects related to the theme were not considered, such as international trade and different types of goods.

References

[1] Araujo, A.; Páscoa, M. R.; Torres-Martínez, J.P.(2002):“Collateral Avoids Ponzi Schemes in Incomplete Markets”, Econometrica, v.70(4), 1613-1638.

[2] Araujo, A. and Leon, M. (2000): “Speculative Attacks on Debts and Dollarization”, Anais do XXII Encontro Brasileiro de Econometria, December.

[3] Cole, H.L.; Kehoe, T.J. (1996): “A Self-Fulfilling Model of Mexico’s 1994-1995 Debt Crisis”, Journal of International Economics, 41:309-330.

[4] Cole, H.L.; Kehoe, T.J. (1998): “Self-Fulfilling Debt Crises”, Research Department Staff Report 211, Federal Reserve Bank of Minneapolis.

[5] Cole, H.L.; Kehoe, T.J. (2000): “Self-fulfilling Debt Crises”, Review of Economic Studies, London: Blackwell, v. 67, n. 1, p. 91-116

[6] Dubey, P.; Geanakoplos, J.; and Shubik, M. (2005): “Default and Punishment in General Equilibrium” Econometrica, 73(1).

[7] Kenen, P.A. (1969):“The Optimum Currency Area: An Eclectic View”, R.A. Mundell and A. K. Swoboda (eds.), Monetary Problems of the International Economy. Chicago: University of Chicago Press.

[8] McKinnon, R. A. (1963):“Optimum Currency Areas”,American Economic Review, v.53, n.4, p.717-725, September.

[9] Mundell, R.A. (1961): “A Theory of Optimum Currency Areas”, American Economic Review, v.51, n.4, p. 657-665, Nov. 1961

[10] Reinhart, C.M. ; Savastano, M.A. ; Rogoff, C.S. (2003):“Debt Intolerance”; NBER Working Paper No.9908. August.

[11] Sims, C. (1999):"Fiscal Consequences for Mexico of Adopting the Dollar", available in <http://www.princeton.edu/~sims/#Papers>.

[12] Simonsen, M.H.; Cysne, R.P. (1994): "Welfare Cost of Inflation: The Case for Interest-Bearing Money and Empirical Estimates for Brazil", Ensaios Econômicos, EPGE, Fundação Getulio Vargas, n.245,April.

7 Appendix A

Next table presents the events at monetary union between two identical countries $(A+B)$, given no occurrence of intense shock.

Event	A - Vote	Decision	State	Symmetry	Probability
(s^A, s^B)	ϑ^A	ϑ^u	$s^{A,u}$	Attacks	$Prob((s^A, s^B))$
(c,i)	1	1	c	n	$\pi_A^c \pi_B^i (1-\rho)\mu$
(c,p)	1	1	c	y	$\pi_A^c \pi_B^p (1+\rho)\mu$
(c,c)	1	1	c	y	$\pi_A^c \pi_B^c (1+\rho)\mu$
(p,c)	ϕ	1	c	y	$\pi_A^p \pi_B^c (1+\rho)\mu$
(i,c)	ϕ	1	u	n	$\pi_A^i \pi_B^c (1-\rho)\mu$
(i,p)	ϕ	ϕ	i	n	$\pi_A^i \pi_B^p (1-\rho)\mu$
(i,i)	ϕ	ϕ	i	y	$\pi_A^i \pi_B^i (1+\rho)\mu$
(p,p)	ϕ	ϕ	p	y	$\pi_A^p \pi_B^p (1+\rho)\mu$
(p,i)	ϕ	ϕ	p	n	$\pi_A^p \pi_B^i (1-\rho)\mu$

Where

$\binom{P_{NS}}{P_S} \equiv \binom{\pi_A^c\pi_B^i+\pi_A^i\pi_B^c+\pi_A^i\pi_B^p+\pi_A^p\pi_B^i}{\pi_A^c\pi_B^p+\pi_A^c\pi_B^c+\pi_A^i\pi_B^i+\pi_A^p\pi_B^p+\pi_A^p\pi_B^c}$, $and\ \mu \equiv \frac{P_{NS}+P_S}{P_{NS}+P_S+\rho(P_S-P_{NS})}$.

$if\ \rho \in [-1,1] \Rightarrow P_{NS}+P_S+\rho(P_S-P_{NS}) \geq 0 \Rightarrow \mu \geq 0.$

$$P_{NS}+P_S = P_{NS}(1-\rho)\mu + P_S(1+\rho)\mu$$

$$P_{NS}+P_S = \pi_A^c(\pi_B^i+\pi_B^c+\pi_B^p) + \pi_A^i(\pi_B^c+\pi_B^i+\pi_B^p) + \pi_A^p(\pi_B^i+\pi_B^p+\pi_B^c)$$

$$P_{NS}+P_S = (\pi_B^i+\pi_B^c+\pi_B^p)(\pi_A^c+\pi_A^i+\pi_A^p)$$

$$P_{NS}+P_S = \left(1-\pi^d\right)\left(1-\pi^d\right) = \left(1-\pi^d\right)^2$$

$$P_S - P_{NS} = P_{NS}+P_S-2P_{NS} = \left(1-\pi^d\right)^2 - 2P_{NS}$$

$$P_S - P_{NS} = \left(1-\pi^d\right)^2 - 2\pi_B^i(\pi_A^c+\pi_A^p) - 2\pi_A^i(\pi_B^c+\pi_B^p)$$

$$P_S - P_{NS} = \left(1-\pi^d\right)^2 - 2\pi_B^i\left(1-\pi^d-\pi_A^i\right) - 2\pi_A^i\left(1-\pi^d-\pi_B^i\right)$$

$$\pi_A^i = \pi_B^i = \pi^i \Rightarrow P_S - P_{NS} = \left(1-\pi^d\right)^2 - 4\pi^i\left(1-\pi^d\right) + (2\pi^i)^2$$

$$P_S - P_{NS} = \left[\left(1-\pi^d\right) - 2\pi^i\right]^2 > 0$$

$$\mu = \frac{\left(1-\pi^d\right)^2}{\left(1-\pi^d\right)^2+\rho\left[\left(1-\pi^d\right)-2\pi^i\right]^2}.$$

If ρ value is -1 and there is no occurrence of intense attack then there is no occurrence of symmetrical attack. If its value is 0 the shocks occur independently and if its value is 1 there is no occurrence of asymmetrical moderate attack. Table 3 sums up the five relevant events (from 16) for a member A and $n=2$. If $n=3$ we have:

s_u^A	Probability
d	π^d
c	$\pi^c\left(\pi^d\right)^2+2\pi^c\pi^d\pi^i+4\pi^c\pi^p\pi^d+2\pi^d\left(\pi^c\right)^2+2\pi^d\left(\pi^p\right)^2+2\pi^p\pi^d\pi^i+\pi^p\left(\pi^d\right)^2+...$
	$...(1-\rho)\mu\left[\pi^c\left(\pi^i\right)^2+2\pi^i\left(\pi^c\right)^2+4\pi^c\pi^p\pi^i\right]+(1+\rho)\mu\left[3\pi^c\left(\pi^p\right)^2+3\pi^p\left(\pi^c\right)^2+\left(\pi^c\right)^3\right]$
u	$2\pi^c\pi^d\pi^i+\pi^i\left(\pi^d\right)^2+2\pi^p\pi^d\pi^i+2\pi^d\left(\pi^i\right)^2+(1-\rho)\mu\left[2\pi^c\left(\pi^i\right)^2+\pi^i\left(\pi^c\right)^2+2\pi^c\pi^p\pi^i\right]$
i	$(1-\rho)\mu\left[2\pi^p\left(\pi^i\right)^2+\pi^i\left(\pi^p\right)^2\right]+(1+\rho)\mu\left(\pi^i\right)^3$
p	$(1-\rho)\mu\left[\pi^p\left(\pi^i\right)^2+2\pi^i\left(\pi^p\right)^2\right]+(1+\rho)\mu\left(\pi^p\right)^3$

Where, $\binom{P_{NS}}{P_S}=\binom{3\pi^c\left(\pi^i\right)^2+6\pi^c\pi^p\pi^i+3\pi^i(\pi^c)^2+3\pi^p\left(\pi^i\right)^2+3\pi^i(\pi^p)^2}{(\pi^p)^3+(\pi^c)^3+(\pi^i)^3+3\pi^c(\pi^p)^2+3\pi^p(\pi^c)^2}$.

8 Appendix B

In order to obtain the real exchange rate as a function of the government inflation decision (z), we define the real exchange rate devaluation as a function of nominal exchange devaluation (E), foreign currency inflation $(\varkappa^*)$ and local currency inflation $(\varkappa)$:

$$\frac{\Delta R}{R}=\frac{\Delta E}{E}+(\varkappa^*)-(\varkappa)$$

Assuming that the foreign price level P^* is constant, we obtain the local-inflation rate $\varkappa$:

$$\varkappa=\frac{\tau}{1-\tau}\frac{\Delta R}{R}=\frac{1-\phi}{\phi}$$

with the pass-through from nominal exchange rate change to local prices, τ, being equal to $(\varkappa)/\left(\frac{\Delta E}{E}\right)$. The value of z, which corresponds to the units of domestic goods that a local-currency bond actual pays at maturity, is defined as

$$z(\phi)=\frac{1}{1+\varkappa}$$

Accordingly, we arrive at an expression that relates z to the change in the real exchange rate:

$$z=\left(1+(R-1)\frac{\tau}{(1-\tau)}\right)^{-1}$$

where the devaluation rate is given by $(R-1)$, assuming $R_1=1$. Now, defining Exp as exports measured in domestic output units, Imp as imports denominated in units of tradable, R_1 as the initial real exchange rate, and R_2 as its new level after devaluation, we can compute the trade balance change $D(.)$ as:

$$
\begin{aligned}
TB(R) &= Exp(R) - Imp(R)R \\
\frac{\Delta TB}{\Delta R} &= \frac{\Delta Exp}{\Delta R} - \frac{\Delta Imp}{\Delta R} R_2 - Imp\left(R_1\right) \\
\frac{\Delta TB}{\Delta R} &= \frac{\Delta Exp}{\Delta R}\frac{R_1}{Exp\left(R_1\right)}\frac{Exp\left(R_1\right)}{R_1} - \frac{\Delta Imp}{\Delta R}\frac{R_1}{Imp\left(R_1\right)} R_2 \frac{Imp\left(R_1\right)}{R_1} - Imp\left(R_1\right) \\
\frac{\Delta TB}{\Delta R} &= \left[\eta\left(\frac{Exp\left(R_1\right)}{R_1 \cdot Imp\left(R_1\right)}\right) + \eta^* \frac{R_2}{R_1} - 1\right] Imp\left(R_1\right)
\end{aligned}
$$

Where $\eta = \frac{\Delta Exp}{\Delta R}\frac{R_1}{Exp(R_1)}$ and $\eta^* = -\frac{\Delta Imp}{\Delta R}\frac{R_1}{Imp(R_1)}$. Defining σ as the exports-imports ratio, $R_1 \equiv 1$, and $R_2 \equiv R$, we obtain

$$D(R) = (R-1)\left[\eta\sigma + \eta^* R - 1\right] Imp(1)$$

We set $\{\tau, \eta, \eta^*\}$ equal to $\{.5, .6, .6\}$ for all countries. Considering that all international transactions are done trough the government, we compute the new following government restriction:

$$g^j_{t,s} \leq \theta\left[a^j_{t,s} f(K^j_{t,s}) - \delta K^j_{t,s}\right] - B^{j*}_{t,s}(z^j_{t,s} - q^{j*}_{t,s}) - B^j_{t,s}(\vartheta^u_{t,s} - q^j_{t,s}) + D(z); \forall s, t$$

Where new term $D(z)$ is zero for $z = 1$, and positive for $z = \phi$ and $(\eta\sigma + \eta^* R > 1)$. Then, we compute the trade balance effect from currency devaluation.

Tables and Figures

Table 1: Monetary Regimes Trade-offs

Regime	Flexibility	Credibility
Local Currency	total	low
Common Currency	partial	medium
Dollarization	null	high

Table 2: States Under Local Currency in the Crisis Zone

States	Shocks	Actions
c	none	respect contracts
p	political inflation	inflation
i	moderate attack	inflation
d	intense attack	default

Table 3: Monetary Union Between Members With Right of Veto (n=2)

s_u^A	Probability
d	π^d
c	$\pi^d(\pi^c+\pi^p)+\pi^c(1+\rho)\mu[2\pi^p+\pi^c]+(1-\rho)\mu[\pi^c\pi^i]$
u	$\pi^i\left(\pi^d+\pi^c(1-\rho)\mu\right)$
i	$\pi^i\mu(\pi^p(1-\rho)+\pi^i(1+\rho))$
p	$\pi^p\mu(\pi^p(1+\rho)+\pi^i(1-\rho))$
where $\mu\equiv\frac{(1-\pi^d)^2}{(1-\pi^d)^2+\rho(1-\pi^d-2\pi^i)^2}$.	

Table 4: Monetary Union Between Members With Political Influence

s^A	Probability Under Common Currency (n=2)	(n=1)
d	$pw^A\cdot\pi^d+(1-pw^A)\cdot[\pi^d\pi^d+\pi^d\pi^c]$	π^d
c	$pw^A\cdot\pi^c+(1-pw^A)\cdot\{\pi^d(\pi^c+\pi^p)+\pi^c(1+\rho)\mu[\pi^p+\pi^c]\}$	π^c
u	$pw^A\cdot 0+(1-pw^A)\cdot[\pi^i(\pi^d+\pi^c(1-\rho)\mu)]$	0
w	$pw^A\cdot 0+(1-pw^A)\cdot[\pi^i\pi^d+\pi^p\pi^d]$	0
i	$pw^A\cdot\pi^i+(1-pw^A)\cdot[\pi^i\mu(\pi^p(1-\rho)+\pi^i(1+\rho))]$	π^i
p	$pw^A\cdot\pi^p+(1-pw^A)\cdot[\mu([\pi^p\pi^p+\pi^c\pi^p](1+\rho)+(1-\rho)[\pi^p\pi^i+\pi^c\pi^i])]$	π^p

Table 5: Brazilian Public Debt Length (Years)

Length	Model	Brazil (98-01)
Average Maturity	1	[0.4 , 2.2]
Average Duration	1	[0.2 , 0.9]

Table 6: Economy in the Crisis Zone

Variables relative to GDP	Model ($t = 0$)	Brazil (98-01)
External debt	$\frac{(B^*)}{f(K)} = 45$	[31 , 45]
External public debt	$\frac{(B^*)}{f(K)} = 45$	[9 , 24]
Local currency public debt	$\frac{(B)}{f(K)} = 30$	[27 , 31]
Capital outflow	$\frac{B^*(1-q^*)}{f(K)} = 4$	-
Investment	$\frac{\delta K}{f(K)} = 16$	[20 , 22]
Private consumption	$\frac{c}{f(K)} = 60$	[61 , 62]
Public expenditure	$\frac{g}{f(K)} = 20$	[19 , 19]

Table 7: Latin America Common Markets

Market	Country	Tax/GDP	B*/GDP	B/GDP	EXP/GDP	IMP/GDP	Moder. Attack	π^d	π^p	π^i	Prodct. Shock infl.	Prodct. Shock def.	What is the better regime, common-currency or local-currency? ro=0,rule 1	ro=1,rule 1	ro=0,rule 2	ro=1,rule 2	ro=0,rule 3	ro=1,rule 3
Southern Common Market	Arg	21%	42%	11%	11%	17%	66%	7%	10%	2%	99,8%	93%	lc	cc	lc	lc	lc	lc
	Bra	30%	24%	31%	11%	16%	7%	7%	55%	10%	99,7%	96%	lc	cc	lc	cc	lc	cc
	Par	16%	32%	2%	37%	46%	65%	10%	23%	4%	99,0%	93%	lc	cc	lc	cc	lc	lc
	Uru	26%	38%	3%	18%	25%	52%	30%	42%	7%	99,7%	94%	lc	cc	lc	cc	lc	cc
	Ven	14%	26%	4%	29%	21%	72%	8%	10%	2%	98,4%	95%	lc	cc	lc	lc	lc	lc
Andean Community of Nations*	Bol	17%	46%	5%	18%	29%	76%	4%	6%	1%	99,7%	95%	lc	cc	lc	lc	lc	lc
	Col	17%	28%	9%	19%	21%	58%	7%	24%	4%	99,4%	94%	lc	cc	lc	cc	lc	cc
	Ecu	15%	75%	6%	38%	41%	88%	12%	35%	6%	99,0%	95%	lc	cc	lc	cc	lc	cc
	Per	17%	45%	0%	16%	22%	75%	6%	39%	7%	99,7%	95%	lc	cc	lc	cc	lc	cc
	Ven	14%	26%	4%	29%	21%	62%	8%	10%	2%	98,4%	95%	cc	cc	cc	cc	lc	lc
Central American Common Market*	Cos R.	12%	26%	9%	49%	46%	68%	19%	55%	10%	97,7%	94%	lc	cc	lc	cc	lc	cc
	El Sal.	12%	34%	10%	27%	42%	76%	1%	24%	4%	99,5%	94%	lc	cc	lc	lc	lc	lc
	Gua	10%	19%	0%	20%	29%	63%	3%	52%	9%	99,4%	94%	lc	cc	lc	cc	lc	cc
	Hon	18%	84%	0%	41%	55%	86%	8%	53%	9%	99,3%	94%	lc	cc	lc	cc	lc	cc
	Nic	14%	110%	63%	24%	51%	95%	2%	37%	6%	99,8%	92%	lc	cc	lc	lc	lc	lc

rule 1: Each member can veto inflation. rule 2: Majority-Rule, (3) votes are required for inflation be implemented. rule 3: Majority-GDP-Rule, the "vote-power" is proportional to GDP, but at least two votes is required for inflation be implemented. We set π^p/π^i equal to (.85)/(.15). * We consider beta equal to 0.98.

Sources: IMF , World Bank and Central Banks.

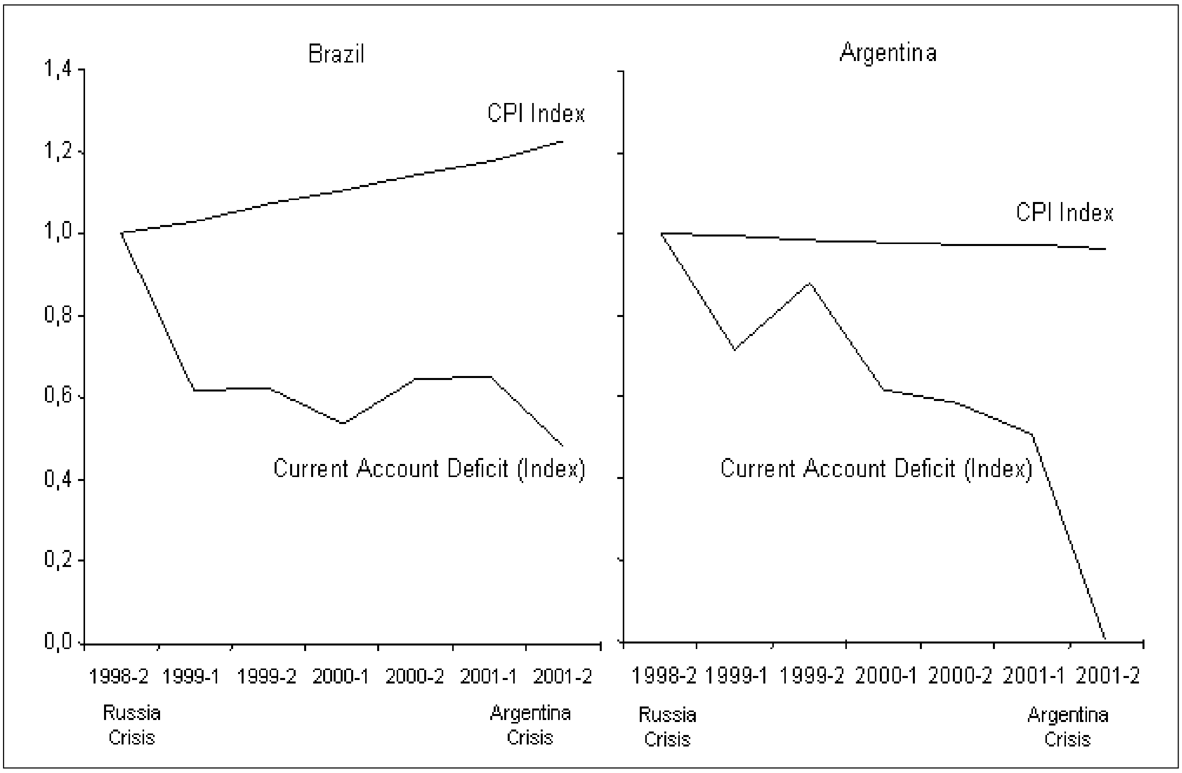

Figure 1: Inflation versus Current Account Adjustment

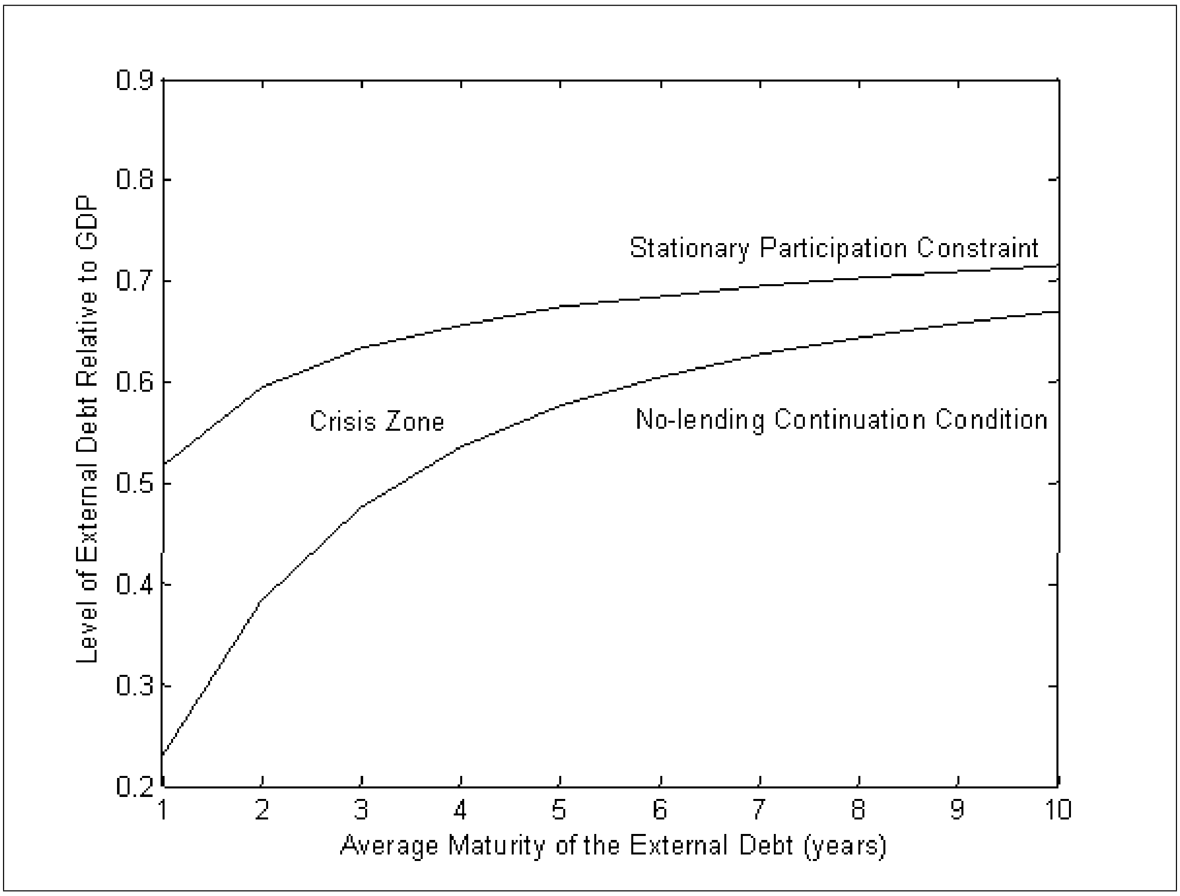

Figure 2: Debt Crisis Zone and Average Maturity of the External Debt

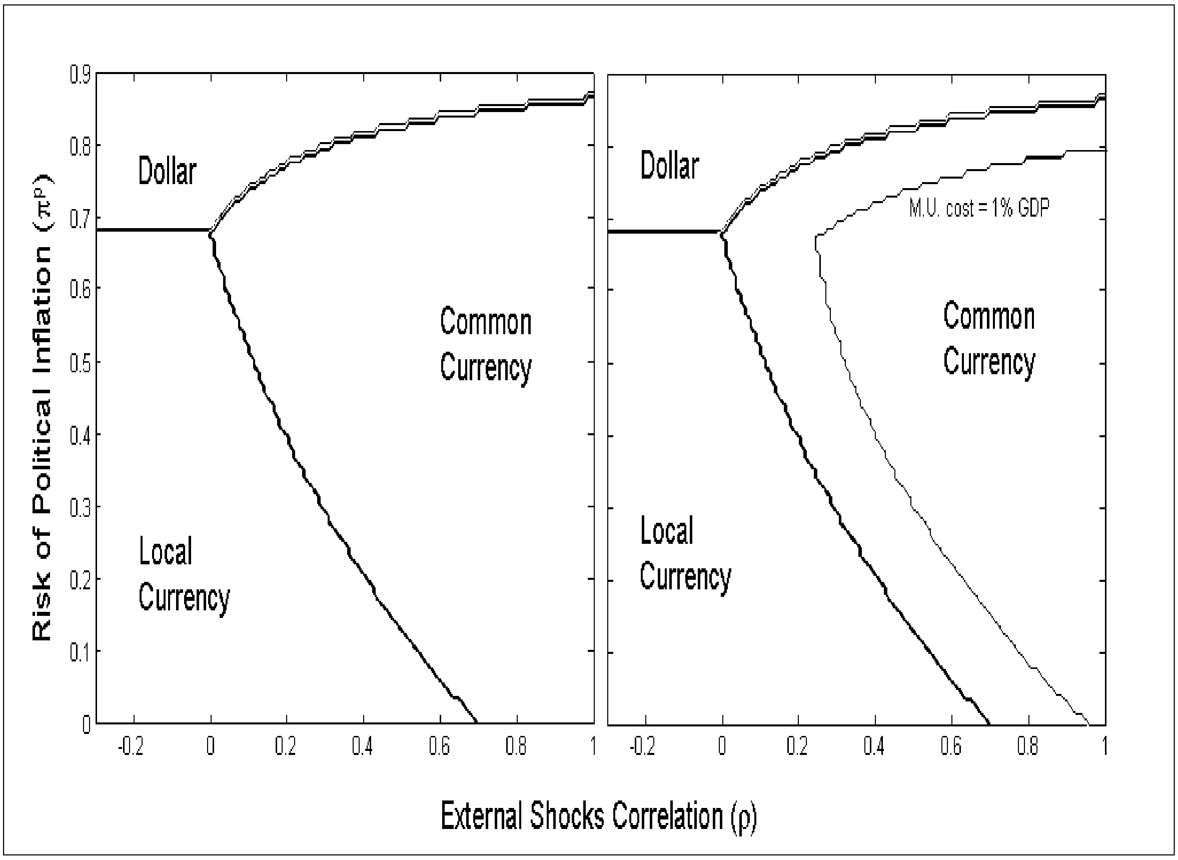

Figure 3: Optimal Monetary Regime (veto allowed, n=2)

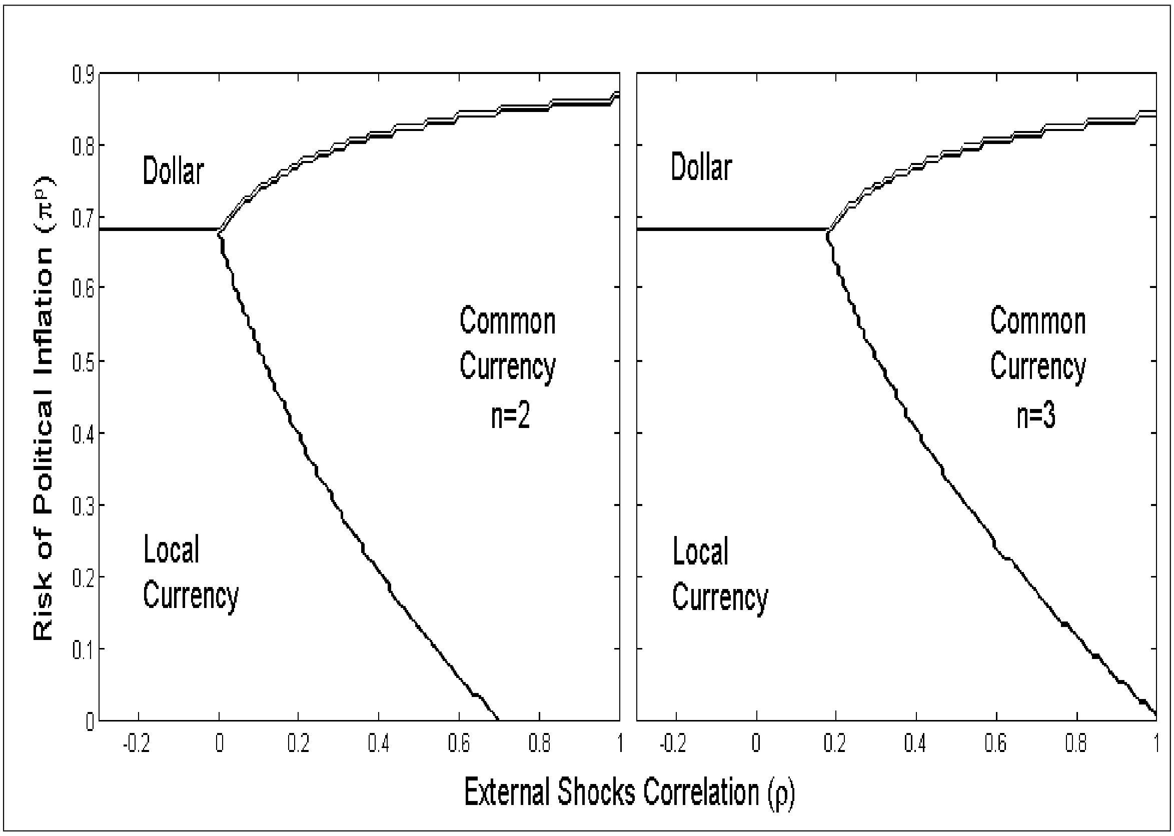

Figure 4: Optimal Monetary Regime (veto allowed, n=2 and n=3)

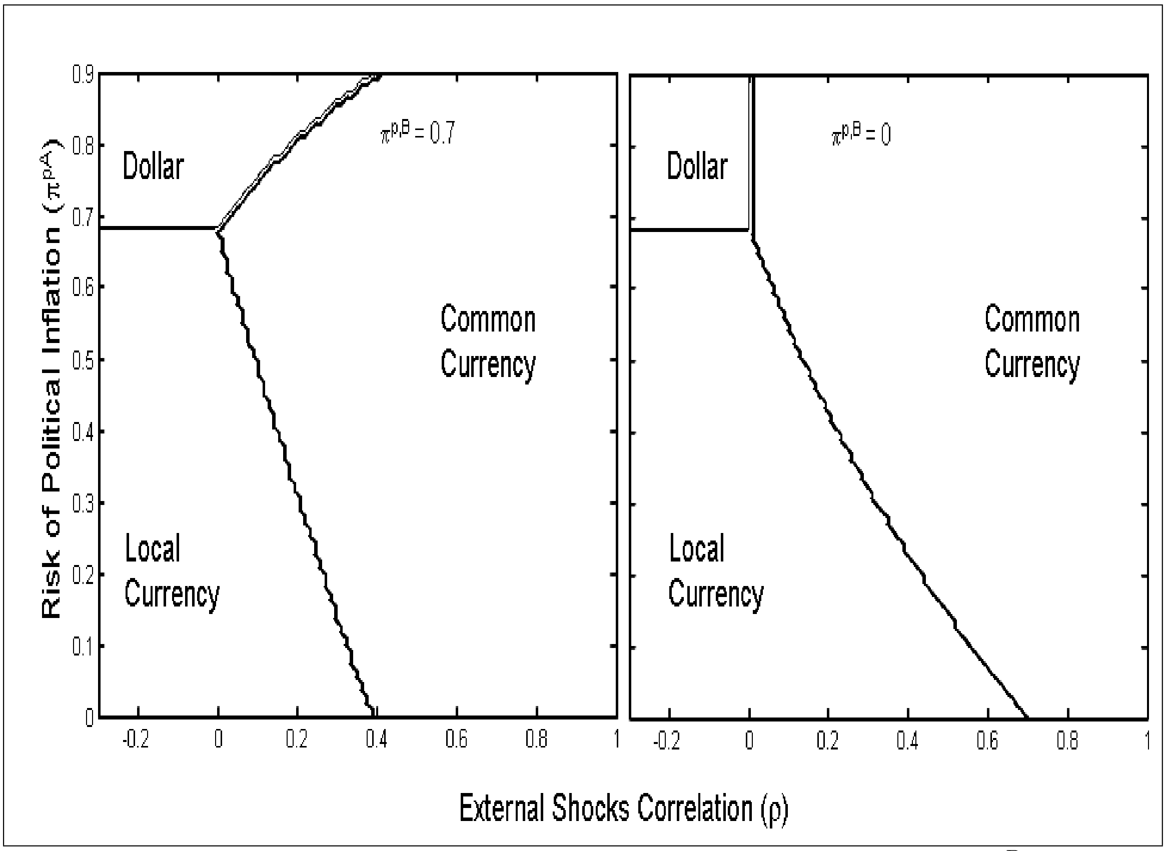

Figure 5: Optimal Monetary Regime (n=2, veto allowed, Different π^{pB})

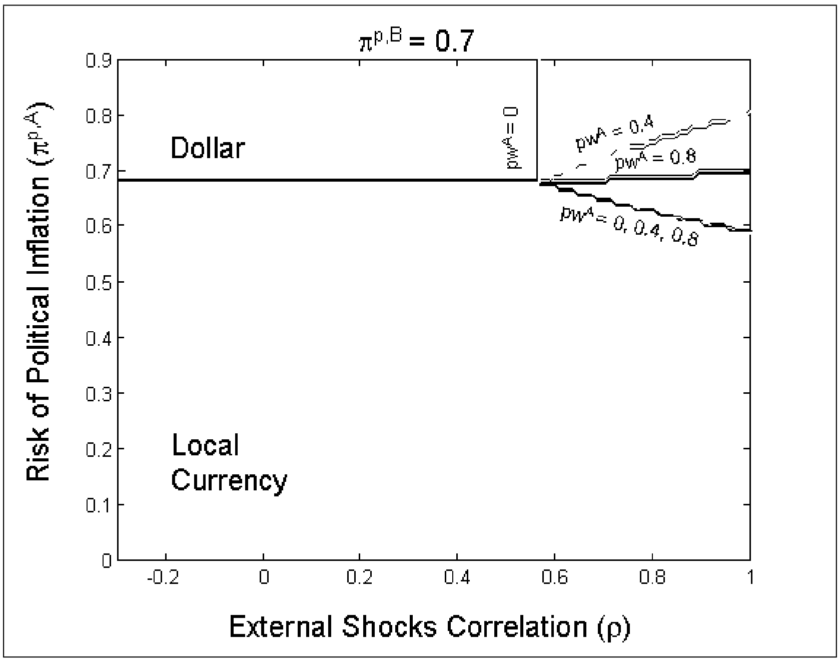

Figure 6: Monetary Union of Members With Different pw

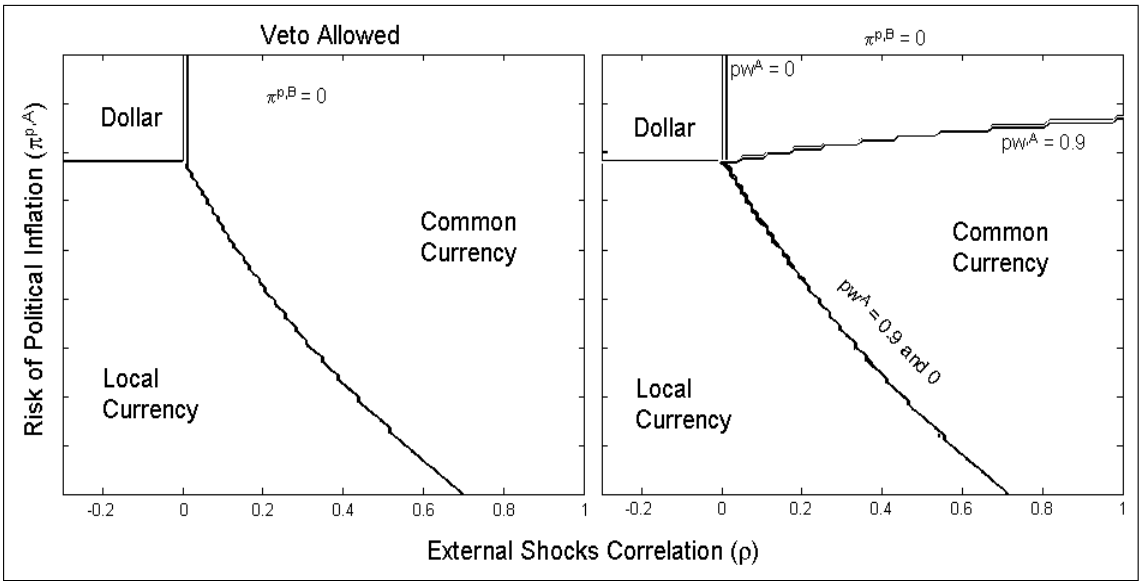

Figure 7: Right of Veto versus Political Influence