Federal Reserve Bank of Minneapolis Quarterly Review
Vol. 25, No. 3, Summer 2001, pp. 3–12

Dollarization and the Conquest of Hyperinflation in Divided Societies

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Abstract

This study argues that the delegation of monetary policy control by one country to another can reduce inflation in the delegating country. Hyperinflation is common in a divided society, one in which special interest groups can pressure a weak central government to issue money to finance their own demands while neglecting the country's overall welfare. A commitment device like dollarization or a currency board, which gives control of the divided country's money supply to another country, can eliminate this inflation bias. This is illustrated by Argentina's experience with inflation and a currency board which, in effect, gave control of Argentina's money supply to the United States. This argument is made precise using a two-country overlapping generations model to study the effects of delegation. The study also finds that a dollarization treaty between the two countries can be welfare-improving for both.

The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

This article studies the effects of political institutions on inflation. In our view, *hyperinflation* is the manifestation of a tragedy of commons in a divided society with a weak central monetary authority. Economies with fiat money are inherently inflation-prone: the collection of seigniorage through the inflation tax is less conspicuous than other taxes, and the printing of money is essentially costless. In many countries, the control of the money supply is de facto or de jure decentralized. Sets of agents (in various regions or interest groups) can effectively pressure the central government to finance their expenditures. As these interest groups pursue their self-interest, they neglect the welfare effects of the inflation tax on individuals in other groups. These elements combine to imply that countries which rely on the inflation tax to meet the resource demands of competing interest groups will typically experience inefficiently (due to negative spillovers) high inflation.

After developing this view of inflation, we consider institutional designs that can reduce inflation. We argue that the delegation of monetary policy, through either a currency board or dollarization, can serve as a commitment device and thus eliminate the inflation bias created by decentralized monetary policy. We construct a treaty between the dollarized country and the United States so that dollarization is welfare-improving for both parties.

Our research is motivated by recent events in Argentina, Brazil, Ecuador, Russia, and other countries that have considered the delegation of monetary authority to reduce inflation. In various ways, these countries have experienced episodes of inflation which can be traced to the decentralization of monetary policy.

Argentina provides a leading example. Over the past 40 years, its average annual rate of inflation has been relatively high (compared to, say, the U.S. rate). Argentina's annual inflation rate averaged 30.3 percent over the 1963–73 period, rose to 200 percent during 1973–78, and then increased once again to an annual average rate of 380 percent during 1983–87 (Edwards and Tabellini 1990, Table 1). Inflation reached 3,066.3 percent by 1989. We argue that this high inflation experience is connected with the decentralization of monetary policy. World Bank (1990), Aizenman (1998), and Saiegh and Tommasi (1999) provide a detailed discussion of the interactions between Argentina's provinces and central government. Argentina has a decentralized system with 23 semi-sovereign provinces with budgets that are funded, in part, by the central fiscal and monetary authorities. Combined with a reliance on the inflation tax, the resource demands of the provinces provide a basis for inflation.

Our thesis that the delegation of monetary control can reduce inflation is brought out by the experience of Argentina. Since 1995, inflation in Argentina has plummeted to an annual rate of less than 5 percent. In 1999, Argentina experienced deflation as prices fell by −2.2 percent.[1]

What lies behind this rather abrupt reduction in the rate of inflation in Argentina over the last decade? In 1991, Argentine law created a currency board, which, in effect, relinquished control of Argentina's money supply to the United States. Under this institutional setting, Argentina's provincial governments could no longer pressure the central monetary authority for transfers financed by seigniorage.[2]

Recently, Argentina began consideration of *dollarization*, a monetary system in which a country substitutes U.S. dollars for its own currency and essentially relinquishes control of its monetary policy to the United States.[3] Thus, the delegation of monetary policy has been used as a tool to reduce the rate of inflation.

Argentina is by no means the only example of the link between inflation and the decentralization of monetary policy. A similar experience arose in the infancy of the Community of Independent States in the early 1990s, when local expenditures were financed by the Russian Central Bank. Aizenman (1998) discusses the experience of Brazil from this perspective. For other countries, such as Ecuador, we think of various interest groups able to pressure a weak central government to issue money for financing their own demands. Ecuador adopted a dollarization regime in 2000.

To formally explore the effects of institutions on inflation, we construct a model with two key features: reliance on the inflation tax and specification of multiple regions with sufficient power to influence the behavior of the central monetary authority. We think of this as an abstract model of a particular commitment problem that stems from the inflation pressures exerted by interest groups in a country, such as Argentina.[4]

In equilibrium, inflation is inefficiently excessive. Acting in the interests of their own citizens, these regional governments use their influence over the central government to redistribute resources in their favor. For simplicity, we think of these as transfers to a region. If a region's transfer is financed by an increase in the supply of money, then there is inflation. The inflation tax is costly because it reduces the real return to work, and thus both employment and output fall as inflation rises. In equilibrium, the inflation is excessive due to *negative spillovers:* the inflation tax is borne by all agents in the economy. The high inflation rate reflects the inability of the central government to commit to not responding to the demands of the regional governments for a share of seigniorage.

In addition to illustrating inflation from this type of commitment problem, we identify conditions such that the delegation of monetary policy, say, through dollarization, can reduce inflation and increase the welfare of agents in Argentina. Essentially, the delegation allows the central government to resist the demands of the regional governments for seigniorage-financed transfers. Further, using our general equilibrium model, we are also able to discuss the implications of dollarization for the United States. In doing so, we characterize an optimal treaty that would eliminate any incentive for the United States to inflate once Argentina dollarizes.

Multiple Interest Groups and a Weak Central Government

Drawing on Cooper and Kempf 2001, we analyze inflation in an overlapping-generations model of the world economy. We assume there are two countries, say, Argentina and the United States for concreteness.[5] Here we study the allocations that arise when each country has its own currency. We turn to other institutions in the next section.

The first country (Argentina) is composed of two regions. Each region acts noncooperatively and is able to force the central monetary authority to print money that is transferred directly to that region.[6] These regions thus have independent power over the central monetary authority, and this creates the basis for the inflation. Each region, in

effect, chooses to print money for its own purpose. Our specification of the multiple regions, that is, a *divided society,* is intended to capture the fact that in some economies, the conduct of policy may not be as centrally coordinated as it is in the United States.

This specification can be viewed as a *commitment problem* of the monetary authority. The regions move first, effectively setting transfer to their citizens. The central government moves second and finances these transfers by printing money. The central government is weak in this sense, and thus a commitment problem exists.

The second country (United States) is an integrated federation with a single monetary authority which acts in the interests of the representative agent. By construction, there are no interest groups or regional governments that can pressure the central monetary authority to inflate in the United States.

We first consider the optimization problems of representative young agents in each of the two countries. We then discuss the equilibrium for given government policies. Finally, we characterize optimal government policies.

Individual Optimization

Individual agents in the model are assumed to work in youth and consume in old age. Because the single consumption good is produced in both Argentina and the United States, consumption goods can be purchased in either country. However, we impose a cash-in-advance constraint, implying that local currency must be used for purchasing goods.[7]

□ *Argentina*

In Argentina (home), there are two regions. The governments in these regions make money transfers to agents when they are old. Here we assume that all transfers are financed by printing money. Thus, the model is simplified to focus on seigniorage.[8] Again, this is the essence of the commitment problem within Argentina: the central government is unable to resist the demands of the regional governments.

The optimization problem for a representative young agent of generation t in region k of Argentina is given by the following:

$$(1) \qquad \max_{n_t^k, m_t^{kh}, m_t^{kf}} u(c_{t+1}^k) - g(n_t^k)$$

subject to

$$(2) \qquad c_{t+1}^k = c_{t+1}^{kh} + c_{t+1}^{kf}$$

$$(3) \qquad p_{t+1}^h c_{t+1}^{kh} = m_t^{kh} + \tau_{t+1}^k$$

$$(4) \qquad p_{t+1}^f c_{t+1}^{kf} = m_t^{kf}$$

and

$$(5) \qquad p_t^h n_t^k = m_t^{kh} + m_t^{kf} e_t.$$

Constraint (2) implies that total consumption (c_{t+1}^k) is the sum of home goods (superscript h) and foreign goods (superscript f). We have simplified matters by assuming that these goods are perfect substitutes. Constraints (3) and (4) are the cash-in-advance constraints, requiring that local currency be used to finance purchases. Constraint (3) includes a transfer (τ_{t+1}^k) from the home government to the agent. This transfer is not present in constraint (4) because the home agent does not receive transfers from the foreign government. In constraint (5), the agent's earnings (in home currency) are used to create a portfolio of home (m_t^{kh}) and foreign (m_t^{kf}) currency, where e_t is the home currency price of foreign currency in period t. Here we assume that the agent's output is proportional to labor input.

There are two first-order conditions for an interior solution in which both home and foreign currencies are held:

$$(6) \qquad p_{t+1}^h = p_{t+1}^f e_t$$

and

$$(7) \qquad (p_t^h / p_{t+1}^h) u'(c_{t+1}^k) = g'(n_t^k).$$

Condition (6) is an arbitrage condition: if money holdings are interior, then the agent must be indifferent with regard to his or her portfolio composition. This condition is similar to the law of one price, but there is a lag involved, reflecting the cash-in-advance constraint.[9] Condition (7) reflects the optimal choice of employment. The right side is the marginal utility loss of working, while the left side represents the marginal gain from selling output in the home market at a price p_t^h and then buying goods in the next period at a price p_{t+1}^h. So the real return (real wage) is effectively p_t^h / p_{t+1}^h. Since the money transfer is lump-sum, it does not factor into the marginal return on work, though it does influence employment through a wealth effect.

□ *United States*

The optimization problem for a representative young U.S. agent of generation t parallels that of an agent in Argentina and is given by the following:

$$(8) \qquad \max_{n_t^*, m_t^{*h}, m_t^{*f}} u(c_{t+1}^*) - g(n_t^*)$$

subject to

$$(9) \qquad c_{t+1}^* = c_{t+1}^{*h} + c_{t+1}^{*f}$$

$$(10) \qquad p_{t+1}^f c_{t+1}^{*f} = m_t^{*f} + \tau_{t+1}^*$$

$$(11) \qquad p_{t+1}^h c_{t+1}^{*h} = m_t^{*h}$$

and

$$(12) \qquad p_t^f n_t^* = m_t^{*f} + m_t^{*h} / e_t.$$

The constraints are essentially the same as those for Argentina. There are two first-order conditions for an interior solution: (6) and the parallel to (7):

$$(13) \qquad (p_t^f / p_{t+1}^f) u'(c_{t+1}^*) - g'(n_t^*).$$

Market-Clearing Conditions Given Money Creation Rates

We now characterize the conditions for market-clearing. Throughout the analysis, we focus on steady states where money supplies grow at constant rates and employment, output, and consumption levels are constant over time (though they may vary across countries and across regions within a country).[10] Accordingly, we assume that governments have selected constant growth rates: σ^* is the growth rate of the U.S. money supply and σ^k is the growth rate in region k in Argentina. Given these growth rates, the transfers are given by

(14) $\tau^{*}_{t+1} I^{*} = \sigma^{*} M^{*}_{t}$

and

(15) $\tau^{k}_{t+1} I^{k} = \sigma^{k} M_{t}$.

Because there are two currencies, we have two conditions for money market-clearing in each period t, given by

(16) $p^{h}_{t} Y_{t} = M_{t}$

for Argentina and

(17) $p^{f}_{t} I^{*} n^{*}_{t} = M^{*}_{t}$

for the United States. In these expressions, I^{k} is the number of agents in region k in Argentina, $Y_{t} = (\sum_{k} I^{k} n^{k}_{t})$ is total real output in Argentina, I^{*} is the U.S. population, M_{t} is the money supply in Argentina, and M^{*}_{t} is the money supply in the United States.

The consumption level for an agent in region k in Argentina is

(18) $c^{k} = (n^{k} + \sigma^{k} Y/I^{k})/(1+\sigma)$.

This expression comes from substituting the market-clearing conditions into the agent's budget constraint. Here σ is the growth rate of the aggregate stock of money in Argentina: $\sigma = \sum_{k} \sigma^{k}$. Because $p^{h}_{t}/p^{h}_{t+1} = 1/(1+\sigma)$, the steady-state levels of employment are given by

(19) $[1/(1+\sigma)] u'([n^{k} + \sigma^{k} Y/I^{k}]/(1+\sigma)) = g'(n^{k})$.

The equilibrium employment levels in Argentina depend on the rates of money creation in each of the two regions (σ^{1},σ^{2}). It is important to realize that, in general, equation (19) implies that employment in region k will depend on each of these money creation rates and not just their sum.

These two expressions make clear the nature of the interaction across regions in determining the rate of money creation in Argentina. Given σ, the consumption level of agents in region k is increasing in the rate of money creation in that region, σ_{k}. This effect captures the idea that by inflating, a region can capture a larger fraction of total output. But inflation is costly since, from (19), output falls as the rate of inflation in Argentina rises.[11] The equilibrium level of inflation will balance these forces. Further, as σ increases given σ^{k}, welfare falls: this is the negative spillover alluded to earlier.

Using the market-clearing conditions and the assumption of a single region in the United States, we have that the consumption by a representative, generation t U.S. agent is n^{*}.[12] Using this as well as the rate of return in terms of home currency, we have that the first-order condition for a generation t U.S. agent is

(20) $[1/(1+\sigma^{*})] u'(n^{*}) = g'(n^{*})$.

In fact, this expression is identical to one in a closed economy model where the sequence of employment levels depends only on the home rate of inflation. The rate of money creation in Argentina has no effect on the employment or consumption of U.S. agents: the U.S. economy is insulated from the money creation process in Argentina.[13]

Given these expressions, we can more formally define a steady-state equilibrium. For this economy, a *steady-state equilibrium* is a pair of employment levels (n^{1},n^{2}) that satisfies (19) for the regions of Argentina and the employment level n^{*} for the United States that solves equation (20). Equilibrium prices are determined so that markets clear for each of the currencies at these equilibrium quantities. The exchange rate is then determined from the arbitrage condition (6). From this condition, the rate of depreciation of the exchange rate will equal the difference in the rates of money growth in the United States and Argentina.

Equilibrium Money Creation

Here we use two configurations of regional power in our model to determine the equilibrium level of money creation.

Clearly, regional governments will attempt to use their influence over the printing press to increase the consumption of their citizens. Who pays the inflation tax that each of these regional governments levies? In our environment, we find that the inflation tax is paid by citizens in the other region of Argentina. Inflation is excessive. U.S. citizens are insulated from the inflation tax by the cash-in-advance constraint: from (20), the allocation in the United States is independent of the inflation rate in Argentina.

To highlight the commitment problem created by the inability of the central monetary authority in Argentina to refrain from financing regional transfers, we assume that the regions set their respective money growth rates at the start of time. Given these growth rates, the steady-state equilibrium is characterized by the solutions to (19) for k = 1, 2 and condition (20). The regions have no incentive to deviate from these inflation paths as long as the rate of inflation is chosen before agents make their labor supply decisions.

For the U.S. government, the choice of money creation is simple. Given the insulation property of the model, only U.S. citizens would bear the inflation tax. Because this tax is distortionary, the optimal setting is $\sigma^{*} = 0$. From (20), zero money growth and thus zero inflation imply that the equilibrium level of employment is efficient because n^{*} solves the planner's problem:

(21) $\max_{n}(u(n) - g(n))$.

The same argument would apply to Argentina if monetary policy were centralized and beyond the influence of the regional governments: the socially efficient level of inflation is zero. But Argentina is composed of multiple regions that can independently influence the rate of money creation. Hence, the equilibrium level of inflation, created by the outcome of the interaction between the regions, may not be efficient.

We study two configurations of regional power in Argentina. In the *symmetric* case, we assume that both regions are equally able to pressure the central monetary authority to inflate. In the *asymmetric* case, we assume that a unique region within Argentina is able to exert pressure on the central monetary authority and benefit from seigniorage, whereas the other region is exposed to the inflation tax. We motivate and study these in turn.

In either case, without further restrictions on utility, the interaction of income and substitution effects induced by region-specific transfers can be complex. To simplify matters and thus to be more specific about equilibrium allo-

cations as we study the choice of money creation rates, we assume that the utility function of a representative agent in either country is given by

$$(22) \quad u(c) - g(n) = c - [n^{1+\gamma}/(1+\gamma)]$$

where $\gamma > 0$. With these preferences, the equilibrium employment rule for an agent in any region in Argentina is simply

$$(23) \quad 1 = (1+\sigma)n^{\gamma}$$

so that income effects induced by money creation have no effect on labor supply and only the sum of the inflation rates matters.[14] Here the elasticity of the labor supply with respect to the real return on work, $1/(1+\sigma)$, equals $1/\gamma$. Likewise, for the U.S. representative agent, employment satisfies

$$(24) \quad 1 = (1+\sigma^{*})n^{*\gamma}.$$

The Symmetric Case

Within Argentina, there is an incentive for each region to inflate since the tax imposed by the government in region k is paid in part by agents in the other region. The government of region k chooses σ^k to maximize the welfare of a representative agent in that region, equation (22), where c^k is given by equation (18) and n^k solves equation (23). The government takes as given the money creation rate of the other government. But each government recognizes its effect on the overall rate of inflation in Argentina and thus internalizes the response of all workers in both regions through (23).[15] Optimization by each of the regional governments leads to a pair of first-order conditions:

$$(25) \quad (1+\sigma)(Y/I^k)[1 + (\sigma^k/Y)\partial Y/\partial\sigma^k] = n + \sigma^k Y/I^k$$

for $k = 1, 2$.

These two conditions represent the best-response functions for the interaction between the two governments. We focus on a symmetric Nash equilibrium in which both governments optimally choose the same rate of inflation. Assume that $I^1 = I^2 = I$ so that the regions are of equal size. In a symmetric Nash equilibrium within Argentina, $\sigma^1 = \sigma^2 = \tilde{\sigma}$, so that the economywide rate of money creation (σ) is $2\tilde{\sigma}$. Let $\tilde{n}$ denote the steady-state employment level. Hence, total output in Argentina is $2I\tilde{n}$ in a symmetric Nash equilibrium.

PROPOSITION 1. *When both regions can print money, the rate of inflation is positive in a symmetric Nash equilibrium.*

Proof. When the conditions for a symmetric Nash equilibrium are imposed and $Y = 2I\tilde{n}$, $\tilde{\sigma}$ must satisfy

$$(26) \quad (1+2\tilde{\sigma})2\tilde{n}(1+\phi) = (1+2\tilde{\sigma})\tilde{n}$$

where ϕ is the elasticity of total output in Argentina with respect to the inflation rate of one region:

$$(27) \quad \phi(\tilde{\sigma}) \equiv (\tilde{\sigma}/\tilde{n})(\partial n/\partial\sigma^k).$$

Here the partial derivative is evaluated at $\tilde{\sigma}$, though the change in employment is the one induced by a variation in the regional level of inflation. When equation (26) is simplified, the symmetric Nash equilibrium level of money creation solves

$$(28) \quad \phi(\tilde{\sigma}) = -1/2.$$

Using the preferences given in (22), we can solve for $\phi(\tilde{\sigma})$:

$$(29) \quad \phi(\tilde{\sigma}) = -[\tilde{\sigma}/\gamma(1+2\tilde{\sigma})].$$

Thus, the equilibrium rate of inflation must satisfy

$$(30) \quad \tilde{\sigma} = \gamma/2(1-\gamma). \qquad \text{Q.E.D.}$$

Let V^d, where the *d* denotes *decentralized*, represent the lifetime utility of a representative agent in Argentina in this equilibrium. This value is calculated using the preferences given in (22) with the labor input determined by (23) evaluated at the equilibrium rate of inflation, equation (30). In the symmetric equilibrium, each region gets an equal share of total output. However, because total output is falling in the rate of inflation, the higher the inflation, the lower the welfare in Argentina.

To interpret this equilibrium, note that if each region inflates at a rate of 50 percent, the economywide growth rate of the money stock will be 100 percent. This will be the equilibrium output if $\gamma = 0.5$. The equilibrium rate of inflation is an increasing function of γ for $\gamma \in [0,1)$. At $\gamma = 1$, the rate of inflation is infinite.[16]

In this economy, where both regions can pressure the central monetary authority to print money, there is an inflation bias. Here both regions would benefit if the rate of inflation were forced to zero, which, as argued above, is the efficient rate of inflation. Thus, the structure in the symmetric case is that of a prisoner's dilemma, where the equilibrium entails positive inflation, yet zero inflation produces a Pareto preferred outcome.

The Asymmetric Case

If just a single region (say, $k = 1$) is inflating, then the government of region 1 chooses σ^1 to maximize the welfare of a representative agent in that region, (22), where c^1 is given by (18) and n^1 solves (23), where $\sigma = \sigma^1$ because only one region is inflating. The first-order condition to this problem parallels equation (25):

$$(31) \quad (1+\sigma)[Y/I^1 + (\sigma/I^1)\partial Y/\partial\sigma] = n^1 + \sigma Y/I^1.$$

PROPOSITION 2. *When only region* 1 *can print money, the rate of money creation is given by*

$$(32) \quad \sigma = (\lambda-1)\gamma/\lambda$$

where λ *is defined as the inverse of the share of the total population in region* 1:

$$(33) \quad \lambda = (I^1+I^2)/I^1.$$

Proof. When the definition of total output and (22) are used, (30) can be written as

$$(34) \quad (1+\sigma)\lambda[1 - \sigma/\gamma(1+\sigma)] = (1+\sigma\lambda).$$

Simple algebra reduces this condition to

(35) $\sigma = (\lambda-1)\gamma/\lambda$. Q.E.D.

Clearly, if only a single region inflates, it will use its power to tax agents in the other region. The inflation rate will increase as the size of the other region increases relative to the region that controls the printing press. This makes sense: as the tax base increases, so will the inflation rate. It is important to be specific about the measure of this tax base. We can show that if the two regions differ in terms of productivity, then λ will be the inverse of region 1's share of total gross domestic product (GDP) in the country.[17]

Also, the rate of inflation will be lower if the response of output ($1/\gamma$) to inflation is higher. Essentially, the region 1 government recognizes that its inflation will reduce total output at a rate parameterized by ($1/\gamma$).

Relative to the symmetric case in which both regions can inflate, the rate of inflation is lower in the asymmetric case. We can see this by comparing equation (32) to equation (30) with $\lambda = 2$. Intuitively, when both regions can inflate, their attempts to grab a large share of the economic pie magnify the gain to the inflation tax by a single region.

As in the symmetric case, the United States has no incentive to inflate. It is unable to tax Argentine citizens and does not wish to incur the distortion of the inflation tax.

Part of the inflation tax in Argentina is paid by citizens of region 2, which lacks any ability to tax citizens in region 1. Consequently, the game in the asymmetric case does not correspond to a prisoner's dilemma as it did in the symmetric case. From a welfare perspective, the citizens in region 1 do not suffer from an inflation problem, though citizens in region 2 think otherwise.

Dollarization

Can dollarization solve the inflation problem? Here we focus on dollarization as a way to delegate monetary policy to an outside authority. Currency boards are another such mechanism, but may be a weaker form of delegation since the monetary authority may retain some degree of freedom in adjusting the money supply.

The equilibrium in Argentina has a positive rate of inflation. If both regions can inflate, we have argued that the outcome is one of excessive inflation and that all agents would benefit from a commitment not to inflate. Even if only a single region is able to influence the policy of the central monetary authority, we see that inflation is a result as well. Here, though, the welfare costs of inflation are not as clear since one region is benefiting from the inflation tax that is borne by another. Using a social welfare function that gives weight to region 2 agents would imply that the rate of inflation given in (32) is too high. Or, given a political process in which the region 2 agents could express their displeasure over the inflation tax, remedial action would be warranted. Thus, we take it as given that there is an inflation problem in Argentina in our model economy.

Equilibrium

Suppose that Argentina dollarizes so that there is a single currency in the two-country economy, and the supply of this currency is controlled by the U.S. central monetary authority. This economy with two countries is isomorphic to the two-region model of Argentina studied earlier. Here the United States is region 1 and Argentina is region 2. Let variables with the superscripts U and A refer to allocations in the United States and Argentina, respectively. The equilibrium employment levels for a given money creation rate (now set by the U.S. monetary authority) are given by equation (23), and the consumption levels are given by

$$(36) \quad c^U = (n^U + \sigma Y^W/I^U)/(1+\sigma)$$

and

$$(37) \quad C^A = n^A/(1+\sigma)$$

where Y^W is the steady-state real world output given by $I^U n^U + I^A n^A$. As in the earlier analysis, this system of two equations determines the employment levels in each of the two countries.

If the United States maintains a zero rate of money creation, then the utility of U.S. agents will be the same as in the economy with multiple currencies. But this is not necessarily an equilibrium. Instead, the United States will choose the rate of money creation to maximize the utility of the representative U.S. agent. The result of Proposition 2 holds: the United States will have an incentive to inflate.

Let $V^\$$ be the lifetime utility of an agent in Argentina under a dollarization scheme with the United States. Will Argentina necessarily gain from dollarization? That is, under what conditions is $V^\$ > V^d$? We see one condition from Proposition 2: the magnitude of U.S. inflation will depend on the relative sizes of the two countries. The gains for the United States from inflation rise with the size of the Argentine population relative to the size of the U.S. population. So $V^\$$ will necessarily fall with the relative size of the country that dollarizes with the United States.

The other condition is the degree of decentralization of monetary policy within a country. All else the same, as the decentralization problem worsens (through the creation of more interest groups), V^d will necessarily fall. This provides a larger gain from dollarization for those countries.

Thus, for a small country (relative to the United States) with high inflation due to the decentralization of monetary policy, there are clearly gains to dollarization. The fact that the country is small implies that the United States will not have much of an incentive to inflate, and thus the small country will clearly gain from dollarization. However, for a large country, the incentive for the United States to inflate may be significant. Further, if the large country does not suffer much from an inflation bias, then dollarization may not reduce inflation. In this case, the large country is better off using its own currency.

We can take this argument further to imagine a setting in which there are $N + 1$ identical countries, with N of them simultaneously choosing whether or not to dollarize and the remaining country being the United States. Each of the N countries may perceive a gain to dollarization as a means of reducing inefficiently high inflation. Yet, from Proposition 2, the costs of joining the group of dollarized countries will depend on the relative size of the dollarized bloc relative to the size of the United States.

This setting suggests that there exists an equilibrium number of countries using a given currency. Suppose that if only one country dollarizes, then $V^\$$ exceeds V^d. As the number of countries increases, $V^\$$ decreases and V^d stays the same. Thus, an N^* clearly exists such that an international arrangement with only N^* countries dollarizing is an

equilibrium in that none of the countries wishes to leave the dollarized bloc and no other countries would choose to join.[18]

Sharing Seigniorage

The resulting U.S. inflation represents a cost to Argentina since its citizens pay part of the inflation tax. Thus, they have an incentive to try to limit U.S. inflation.[19]

In fact, Senator Connie Mack introduced the International Monetary Stability Act in the U.S. Senate with a provision to share seigniorage under such settings. While this act may partly reflect a desire to compensate Argentina for the seigniorage it would lose by giving up its own currency, such an act, or treaty, could serve another purpose. We can use our model to solve for the terms of a treaty that would eliminate the incentive for the United States to inflate.

Let ρ denote the share of newly printed money that is transferred to U.S. agents. Then in the dollarization regime, the consumption levels of U.S. and Argentine agents would be given by

$$(38) \quad c^U = [n^U(1+\sigma\rho) + \rho\sigma n^A I^A/I^U]/(1+\sigma)$$

and

$$(39) \quad c^A = [n^A(1 + \sigma(1-\rho)) + (1-\rho)\sigma n^U I^U/I^A]/(1+\sigma).$$

For a given value of the sharing parameter, the U.S. government maximizes the welfare of its representative agent by choosing the rate of money creation. In doing so, it takes into account the labor supply response of agents in Argentina to variations in σ through (23). The first-order condition for the U.S. choice of money growth is

$$(40) \quad (1+\sigma)[n^U\rho + n^A I^A\rho/I^U + \rho\sigma(dn^U/d\sigma + dn^A/d\sigma(I^A/I^U))] = c^U.$$

Evaluating this condition at $\sigma = 0$ will determine the value of ρ such that the United States is induced to choose zero money creation. This value for ρ is given by

$$(41) \quad \rho = GDP_{US}/(GDP_{Arg}+GDP_{US})$$

where GDP_x is the nominal value of *GDP* in country *x*. From 1999 World Bank data, $\rho = 0.97$.[20] Thus, if the United States agrees to share 3 percent of seigniorage with Argentina, any incentive for the United States to inflate under a dollarization regime will be thwarted.

A Solution?

Suppose that a treaty is agreed upon which implies that the United States will not inflate. Will dollarization solve the commitment problem in Argentina? The answer depends on the nature of the relationship between the regional governments and the central government in Argentina. In our analysis, we have assumed that the central monetary authority in Argentina lacks commitment power relative to the regional governments. As a consequence, the monetary authority must find a way to commit to not financing the regional fiscal deficits.

What about the fiscal authorities at the federal levels? If the central fiscal authority is strong and thus not susceptible to pressures from the regional governments, then the delegation of monetary control to the United States will solve the internal problems in Argentina. In this case, dollarization along with an optimal treaty will suppose the planner's solution.

However, suppose the fiscal authority is also unable to commit to its policies. Then the same interactions across regions that led to the inflation will appear. That is, each region will have an incentive to run a deficit which will be financed by taxes on other regions and levied by the central fiscal authority. This is a type of *tax shifting*. There will be no inflation, but there will be higher federal taxes and more distortions in the aggregate.

This is more than a theoretical possibility. In November 2000, the Argentine federal government and the provinces (again) negotiated a fiscal pact to fix transfers and to limit spending at the provincial level.

In brief, if the federal government can succeed in reining in the fiscal pressure imposed by the provinces, then the need for dollarization will be dramatically reduced. If not and the pressure continues, then dollarization would only succeed in redirecting the pressure away from the central bank. The core of the monetary problem is fiscal irresponsibility, not the choice of the currency.

Concluding Thoughts and Extensions

We have argued that there may indeed be gains to dollarization for Argentina because the delegation of monetary policy can solve an internal commitment problem. As long as Argentina is able to constrain the tax-shifting of its regions, dollarization will enable it to strengthen its central monetary authority and thus escape from socially costly inflation. In this case, the outcome with dollarization (fortified by a treaty with the United States) will yield a higher level of welfare than a flexible exchange rate system.

Our argument for some form of delegation relies on a commitment problem within Argentina. Interestingly, the commitment problem is quite different from the more traditional one between the government and private agents highlighted by Kydland and Prescott (1977). Still, our model solves a "puzzle" suggested by the more traditional framework. Within that framework, the vast difference in the U.S. and Argentine inflation experiences can be explained if the government in Argentina suffers less of a loss from inflation.[21] But why should the loss from inflation be so different across these countries? These differences in political tastes presumably stem from institutional differences in these countries. Our model provides an explanation through the decentralization of monetary policy.

There are undoubtedly many other pertinent dimensions of dollarization to consider. Though including them in our abstract model is beyond the scope of this study, it is nonetheless useful to informally discuss some of the leading points.

- Dollarization versus a currency board. Argentina currently has a currency board and has been contemplating dollarization. Our model is silent about the differences between these institutions since, in effect, they both delegate monetary policy to the United States. There is speculation that dollarization is a stronger form of commitment, though this is an open issue.
- Stabilization policy. To the extent that active monetary policy has value as a tool of stabilization, the delegation of monetary policy may have a cost. Relinquishing control over the money supply is a key

component in the analysis of Mundell (1961), though formalizing these costs is more difficult.[22]

- Exchange rate crises. One of the supposed benefits of dollarization stems from the reduction of uncertainty over nominal exchange rates. Because there were no exchange rate crises in our model economy with multiple currencies, evaluating this argument is not possible.
- Financial fragility. A final but important concern arises from other potential costs of delegation. As is well understood, monetary policy has elements beyond attempts to influence prices and the level of economic activity. In particular, the central bank has a valuable role as a lender of last resort. Dollarization means that Argentina will not have the ability to provide liquidity to its banks and will be unable to finance deposit insurance through the printing press.[23]
- Trade and integration. A rationale for dollarization is clearly linked to the desire to foster economic integration through trade or even political bonds. It is certainly what motivated Panama to adopt the dollar in the early 20th century (1907).

These important extensions are left for future analysis.

*The authors gratefully acknowledge financial support from the NSF and the CNRS as well as helpful conversations with Patrick Kehoe, Tim Kehoe, Narayana Kocherlakota, and Art Rolnick on this topic. The authors are grateful to Carlos Zarazaga for supplying some data, to Aleh Tsyvinski for research assistance, and to seminar participants at the Federal Reserve Bank of Kansas City for comments.

[1]These figures are from the World Bank Group, available at http://devdata.worldbank.org.

[2]See Ghosh, Gulde, and Wolf 2000 for discussions of this law and its consequences. Under a constitutional provision, the Argentine central bank was required to sell dollars for pesos at an exchange rate of one-for-one and was required to maintain reserves, consisting of gold, foreign currency, or bonds convertible in gold and foreign currency, at a level at least equal to the monetary base.

[3]We focus on official dollarization, where a country adopts a foreign currency as legal tender. Of course, there is also unofficial dollarization, where agents within a country choose to use the dollar as a medium of exchange and a store of value. Bogetić (2000) discusses this distinction and country-specific experiences.

[4]For related presentations of this theme, see Aizenman 1992 and Zarazaga 1999. For a survey of dollarization in Argentina, see Velde and Veracierto 2000.

[5]While we use Argentina as an example throughout the article, we think that the trade-offs illuminated in our model apply more broadly.

[6]In Cooper and Kempf 2001, we provide a more detailed model of the fiscal and monetary relationships between these regions and the central government.

[7]Restrictions of this form are commonly used in these models to generate determinant currency demands. A rationale for these restrictions is put forth in Cooper and Kempf 1998.

[8]Cooper and Kempf (2001) broaden this structure to include fiscal policy. See a discussion by Chari and Kehoe (1997) as well.

[9]In fact, with the cash-in-advance constraint, the law of one price, stated as $p^h_{t+1} = p^f_{t+1}e_{t+1}$, will not hold. Thus, models that both assume this condition and impose cash-in-advance constraints are not properly specified.

[10]We define the steady state more formally below. We focus on steady states for tractability. Of course, there is a continuum of nonstationary equilibria for the overlapping-generations model.

[11]This assumes that substitution effects dominate income effects in the agent's response to a variation in the real return to work.

[12]Here we use the fact that in equilibrium the currency portfolio of an agent is not determined. So we assume that agents hold only their own currencies.

[13]As discussed in Cooper and Kempf 2001, this insulation property reflects the imposition of cash-in-advance constraints and thus may provide another argument in favor of these constraints. If, following the structure of Kareken and Wallace 1981, there were no legal restrictions, then in equilibrium the United States would bear some of the inflation tax imposed by the regions in Argentina.

[14]With the absence of income effects, there is no reason to identify employment by region so that n represents the labor input per capita in Argentina.

[15]Analytically, it is easy to characterize the equilibrium in terms of labor inputs using (18) and (23). Of course, by influencing equilibrium quantities, the governments also influence prices.

[16]For $\gamma > 1$, the inflation rate appears to be negative, but this is not an equilibrium. In the two-region model, as γ goes to one so that the elasticity of labor supply falls, the rate of inflation goes to infinity. This reflects the fact that with large γ, the distortionary effect of inflation on the labor supply within the region falls. Also note that in the optimization problems of the regions, there are no bounds on the rate of money creation so that the choice set is not compact. For γ sufficiently close to (but less than) one, the bound will bind. For γ in excess of one, the bound will bind as well.

[17]Formally, we assume that the two regions are of equal size, and we let output per capita in region k be given by $y^k = A^k n^k$, where A^k is a region-specific productivity parameter. Then retracing the steps used in Proposition 2, we see that the rate of money creation in region 1 is given by $\sigma = (1-s^1)\gamma$, where s^1 is region 1's share of total (Argentine) GDP. We will use GDP to measure size in our discussion of dollarization.

[18]Of course, in a more complete model, these other countries may then join another currency bloc.

[19]Although doing so is clearly welfare-reducing for the United States.

[20]The data come from http://www.worldbank.org/data/countrydata/countrydata.html. Here we are again measuring country size by GDP weights. Using 1999 data, we are calculating GDP in Argentina during the currency board regime.

[21]The traditional model relates inflation to two parameters: the elasticity of aggregate supply and the policymakers' preferences over inflation and the output gap. Using the estimates in Lucas 1973, we see that the Argentine economy is not very responsive to nominal shocks, reflecting the large variability of nominal shocks in that country. Thus, explaining the observed differences in the inflation experience of the two countries requires different weights on inflation and the output gaps. Recent versions of these models study the importance of reputation effects. From that perspective, the differences in inflation experiences might correspond to various equilibria of the repeated game.

[22]Cooper and Kempf (2000) provide a model of a monetary union in which domestic monetary policy is one of the tools used to finance unemployment insurance. In that environment, the delegation of monetary policy to a central bank may lead to less effective insurance for unemployed agents.

[23]Of course, this was true during the currency board regime and led to some problems in responding to banking difficulties in the mid-1990s, as discussed by Carrizosa, Leipziger, and Shah (1996).

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