

RECURRENT HIGH INFLATION AND STABILIZATION
A DYNAMIC GAME

by

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ABSTRACT

We present a game theoretic model in which fluctuations between low and high inflation are endogenously generated as the outcome of an income distribution struggle. We use the model to interpret two facts that are salient in high inflation Latin America. First, inflation is perceived as the costly outcome of the mechanics of the politico-economic system. Second, governments repeatedly engage in transitory stabilization programs that are accepted by society.

The game has features of conflict over relative income and features of coordination over inflation. The relative importance of the conflict-cooperation elements depends on the state of the economy. When inflation is low, attempting to increase relative income is a dominant strategy. However, past struggles riddle the present with an accelerating inflation rate. When inflation becomes too high, cooperation and a truce in income redistribution can be supported and so governments launch stabilization programs. But, when low inflation is accomplished, the incentives to violate the truce dominate again and the stabilization effort is abandoned.

We analyze the conditions on the financial technology and on the costs of inflation that will determine whether an economy will be subject or not to the type of cycle described above. It turns out that high inflations will always have a cyclical nature.

INTRODUCTION

A large fraction of Latin American countries suffer from high inflation rates. Indeed, for some of them, the average inflation during the last two decades is in the three digits. However, what makes Latin American inflation rates even more puzzling is its variability. To a great extent, this variability is associated with the frequent introduction of stabilization programs that succeed in bringing inflation down rapidly but are gradually abandoned. Figure 1 shows the behavior of the inflation rate for two countries. There, we observe that average inflation is very high. But inflation rates periodically drop suddenly and substantially. These episodes are always associated with stabilization efforts on the part of the government. Most of these efforts, are supported by the population at their inception but that support eventually dwindles away. In this paper, we provide a model of why this (individually rational but, as it turns out, socially sub-optimal) behavior develops and is sustained through time.

This aspect of macroeconomic behavior seems to contradict prevailing inflation theories. If one were to explain inflation from a fiscal perspective as in Sargent (1983) quick permanent disinflation would only result if the policies credibly solved the long run fiscal problems. In this case, while stabilization would be "painless" (but for the difficult fiscal deficit reduction) it would tend to be permanent; something not observed in the data. Furthermore, models based on reputational considerations à la Barro-Gordon (1983) have a difficult time explaining the repetition of the inflation/stabilization episodes. What is then the explanation?

The prevailing explanation for this behavior among non-academics is

based on what Akerlof (1991) labels myopia or saliency. Governments (societies) have a number of goals that are not consistent among them. For instance, there may be redistribution demands on the government that can only be met by printing money. At low inflation, those goals become salient and policies are implemented that sooner or later lead to high inflation. At that stage, the inflation problem becomes salient and stabilization takes place. Such analysis relies on a number of arguments which are not immediately consistent with a rational choice framework. Why are private actions (time) inconsistent? Why does the government behave in such a myopic manner? How do social demands result in accelerating inflation? In this paper, we take a political economy approach to the question of inflation, trying to explain the observed patterns within an individually optimizing setting.

We imagine an economy consisting of two pressure groups and a government. The government does not undertake any strategic actions and merely accommodates the demands for subsidies from the pressure groups. Each pressure group is representative of a very large number of agents, the sum of which describes the economy. While a pressure group may benefit from the subsidies, its members also pay part of the inflation tax necessary to finance it. Hence, we assume each group internalizes those costs. We do not explicitly model government behavior.¹ This is a rather simple application of the Bentley hypothesis that governments are, to some extent, endogenous to underlying conflict of interest. To borrow political science jargon, we assume the government is a *perfect agent* for both groups. This type of accommodating behavior can be justified by a variety of political

¹We share this shortcoming with the other "distributional conflict" explanations of inflation and stabilization, i.e., the work following the contribution of Alesina and Drazen (1991).

microfoundations, i.e., maximization of survival chances, or minimization of a loss function whenever pressure groups have enough power to hurt the government. Alternatively, this behavior can be motivated by the action of political entrepreneurs in the context of a somewhat decentralized decision making process, as those described in Tabellini (1986), Aizenman (1992) and Heymann *et al.* (1991).

The interaction between groups results in a dynamic prisoner's dilemma. The dynamics arise from the optimal financial response of the atomistic agents. We assume individuals must conduct transactions either with domestic currency or with a number of other financial alternatives that hedge consumers against inflation exposure. These may be indexed checking accounts, non-fiat money, barter, black-market operations, "dollarization" (operating in foreign currency), etc. We refer to these channels as *financial adaptation* (Sturzenegger, 1992). Financial adaptation is costly in a way to be made explicit in the paper. Operationally, financial adaptation is relatively more resource expensive than domestic currency. Agents hold money depending on the current level of the inflation tax, the anticipated future levy, the degree of past monetization, and the cost of financial adaptation. These are, in turn, the determinants of the current inflation tax base.

One of the equilibria the model generates is of the following form. Suppose the economy starts from low inflation and low financial adaptation (a.k.a. high financial deepening, monetization, low monetary velocity). Each interest group has to weigh the advantages it can derive if it demands a subsidy from the government, with the costs it understands will follow. These include the inflation and financial adaptations costs forced upon its members in the current and future periods. Under some conditions, demanding the subsidy is privately optimal and leads to high inflation. In the next period,

as higher inflation and widespread financial adaptation represent the state of the system, the groups must perform their (intertemporal) calculations anew. But now, the resulting inflation would be very high since demanding a subsidy with low monetization would lead to an accelerated inflation. The privately optimal outcome is to accept a stabilization program that cuts subsidies. The equilibrium we just described, seems to explain the three stylized facts we discussed above: high average inflation, variability over time of the inflation rate and periodic stabilization attempts that are "successful" only for a short time.

Interestingly, the behavior delivered by the model is similar to the predictions from a "myopia" model. Only that here myopia is derived endogenously from fully rational forward looking behavior. Individuals are rational, but their collective behavior is not due to the non-cooperative nature of the game being played. The results are due to the presence of elements of both conflict and commonality of interests. The equilibrium strategy, being state dependent, induces cooperation at high inflation and conflict at low inflation. Clearly, the equilibrium the economy has settled in is sub-optimal. If one could achieve social consensus to modify the rules of the game, a welfare increasing permanent stabilization could be achieved. But even if permanent stabilizations are not possible, our model predicts that the periodic disinflations will be welfare enhancing. Some cursory empirical evidence supportive of this description is found in the effects of inflation on government popularity, and the informal evidence of popular attitudes towards inflation. See Fischer and Huizinga (1982), Schneider (1984) and the evidence in Paldam (1985) where he shows that few Latin American political administrations survive a spell of hyperinflation.

Every time a stabilization plan falls apart -after some initial success-

analysts argue that the necessary long-run adjustments were not made. What those long run adjustments are, is also a prediction of this model. In order to settle "distributional conflicts" in a permanent manner, structural reforms must take place either to change the payoffs of the game or to somehow induce more cooperative play. Recent successful stabilization programs in Latin America and Israel have been accompanied of "institutional" reforms. The changes usually call for a permanent truce in the union-management wage dispute (the Mexican "Pacto") an aggressive disindexation-cum-wage moderation scheme (Israel) or simply a radical change in the government rules of engagement in the private sector disputes (Pinochet in Chile or the public sector reforms in Bolivia). See Dornbusch and Fischer (1991), Bruno (1989) and Morales and Sachs (1987). The model developed here predicts that certain institutional reforms that increased the costs of inflation (disindexation), allowed for unrestricted use of financial adaptation, or changes that rendered more difficult a transitory redistribution of income could turn low inflation into a permanent equilibrium.

We also show that high inflation necessarily implies variable inflation rates over time, hence providing an alternative explanation for the correlation between inflation level and variability (Ball 1988 and references there).

The model in this paper closely relates with other political economy approaches to delayed action. In particular, Fernandez and Rodrik (1991) show the possibility of policy inaction in the context of trade liberalization. They show how a positive sum game may not take place if interest groups do not, ex-ante, know the distribution of gains and losses. Alesina and Drazen (1991) show the possibility of policy delay in the context of inflation

stabilizations when parties, unaware of the other's tolerance for pain, debate over the costs of the program. Guidotti and Vegh (1992) show the possibility of policy reversals: how a stabilization program that has successfully brought down the inflation rate may collapse. The idea is that stabilization programs can be achieved easily by fixing the exchange rate. However, supporting the new fixed rate requires reducing a budget deficit. Here two groups struggle over paying the costs of the tax package and race against a balance of payments attack. All the papers alluded to above are based on a crucial assumption: there is uncertainty over the pay-offs or the preferences of the other party. Once the relevant information is revealed, the struggles are resolved immediately and permanently. We regard this as a shortcoming, since, as shown in Figure 1, stabilization programs are repeatedly undertaken and abandoned. This paper not only is able to avoid this assumption but incorporates in a single framework the possibility of inaction, delays and policy reversals. Under some conditions our model will generate inaction. Under others it will induce delayed stabilizations. Finally under an alternative set of conditions it will generate a path of repeated inflation-stabilization cycles. Therefore, one may think of the model in this paper as a generalization which encompasses all of those above.

Another important feature of our model is that inflation results in a "public bad". It is the interaction of privately optimizing groups leading to suboptimal aggregate outcomes that create inflation. While inflation results from taxing money balances, inflation does not result from a Ramsey optimizing government as in Phelps (1973), Lucas and Stokey (1983), and others. It is the decision to demand subsidies that leads the accommodating government to print enough money to finance them. Inflation is the logical result of that action and everybody understands its costs.

The rest of the paper is organized as follows. Section 1 will introduce the technology, preferences and rules of engagement for the economy. Section 2 describes the conditions necessary for the existence of stable and oscillating inflation equilibria. Section 3 analyzes the robustness of our results to changes in the structure of the economy. Section 4 discusses possible policy implications, extensions and interpretations of the model.

1. DESCRIPTION OF THE ECONOMY

The economy is inhabited by a continuum of infinitely lived agents. These agents are identical in every respect but for a characteristic that we index by $i \in [0,1]$ (call it "location") that characterizes them from a "collective action" point of view. They will organize into two politically active groups, $A=[0,1/2]$ and $B=[1/2,1]$. The groups may represent capital-labor, agriculture-industry, Federal-State governments, workers-retirees, exporters-wage earners, state enterprises -private firms, or any other of several possible dimensions.

Each period, agents receive an endowment e , and they may additionally obtain a government transfer s_t . The game is worded in terms of demands for transfers, but it is isomorphic to the setting of prices with important distributive consequences (such as the exchange rate), to tax exemptions or any other policy interventions with distributional consequences and deadweight losses. Each agent in A receives the same subsidy, which depends on the action chosen by group A (similarly for B).

We assume that the government faces a constant stream of expenditures in goods and services that are financed via regular taxation (debt financing is

not available). Any additional expenses, like subsidies, must be financed via inflation taxes. We restrict the source of government finance to highlight the importance of inflation taxes as a short term instrument, assuming that regular taxation is not very flexible in the short run. Cheap credit, monetary accommodation of price and wage increases and devaluations can all be thought of as group subsidies that result in higher inflation rates.

The budget constraint for the government (or equilibrium in the money market) is given by

$$(1) \quad g_t = \pi_t(e - F_t)$$

where g is real government spending (subsidies to private sector) measured in units of commodities. The unitary measure of agents implies that the aggregate endowment equals individual endowment, e , which is constant over time. F_t represents the degree of aggregate financial adaptation in the economy and π_t the (inflation) tax rate at time t . In the presence of cash in advance constraints, inflation represents a uniform commodity tax on all goods purchased with domestic currency. Inflation however generates other costly distortions in the economy beyond Bailey's money demand triangles.² The welfare losses associated with inflation $\phi(\pi)$ are monotonically increasing and $\phi(0)=0$. We also assume that as $x \rightarrow 0$, $\phi(y/x) - \phi(y/2x) > y/2$; i.e., even at high inflation, a doubling of the inflation rate still has a non-trivial impact on welfare. We impose no other restriction on the function. This is appealing since the perceived costs of inflation will be a crucial determinant of the type of equilibria we will observe.

²To state it shortly, inflation damages the efficiency of transactions technology in several ways not captured in the estimates of money demand used to construct Bailey triangles. On the welfare costs of inflation see Laidler (1977), Tommasi (1991), Heymann and Leijonhufvud (forthcoming), Fischer (1986), Driffill et al (1990) and Casella and Feinstein (1990).

At each moment in time an agent can trade a certain amount f_t of his endowment outside the domestic currency circuit in which case these transactions are exempt from taxation.³ This is exactly the intuition behind the use of alternative means of payments in high inflation economies. Financial adaptation is costly. In particular, we assume that each period the agent can freely increase the size of f by a pre-specified amount J . The costs of exceeding J are assumed infinite. The cost of adjustment technology, represented in Figure 2, exhibits a spike at value J . Downward adjustments in the level of financial adaptation are free. As explained in Section 3, a symmetric cost of adjustment function gives the same results. The assumption that full dollarization is not immediately feasible is a key one for most of our results. It tries to capture the inertia present in money demand adjustments as discussed in the money demand literature and which may be the result of learning, time to build constraints, information lags, etc.⁴ Our assumed cost function is an extreme version of adjustment costs which are increasing and convex on the real line. Section 3 shows that the results are robust to more general specifications, with the usual trade-off between generality and analytical tractability. In our framework, the space of possible values for the degree of financial adaptation is: $f \in (0, J, 2J, \dots, nJ, e)$. Once $f=e$ the whole endowment is shielded against inflation taxation. Finally, we assume that operating in the inflation shielded system is costly. This assumption induces a real valued money

³Notice that we use F to denote the aggregate degree of financial adaptation and f for the individual's. In equilibrium they will be identical.

⁴Goldfeld and Sichel (1990) claim that: "...the partial adjustment model has been widely used for this purpose [estimation of money demand]... Partial adjustment is typically motivated by cost-minimizing behavior wherein the costs of disequilibrium are balanced against adjustment costs. (p 325)."

demand. If operating under a fully indexed or "real" currency was feasible and costless, there would be no demand for nominal money in equilibrium.

The timing of events in each period is the following. First, subsidies are requested and announced. Second, individuals act upon that information and decide on the optimal adjustment of their level of financial adaptation f_t based on their expectations of inflation. Finally inflation results from (1).

1.1. INDIVIDUAL OPTIMIZATION

Each agent has stage utility function that depends linearly on consumption, $U(c)=c$.⁵ Her budget constraint is given by an exogenously fixed endowment, the subsidies that her group negotiates, and a number of taxes and transaction costs. In particular, we assume a transaction (cash in advance) technology that requires that enough domestic or foreign currency must be held to purchase goods. If the consumer chooses to hold foreign currency, then she must bear a transaction cost equal to

$$T_t = \begin{cases} \tau f_t & \text{for } f_t < e \\ \tau f_t + K & \text{for } f_t = e. \end{cases}$$

These costs may arise due to a variety of reasons (inconvenience of dealing in foreign currency due to the costs of exchanging currencies, gathering information on exchange rates, etc.)⁶. If the level of financial adaptation

⁵The assumption of risk neutrality, while adding tractability, is in no way essential to our results.

⁶It may be argued that many of these costs are fixed or at least concave

equals the endowment then it is assumed that the costs are higher. This, in turn, may be the consequence of the additional costs of shielding assets totally against inflation when some agents (most notably the government) continues to deal with domestic currency even at extreme rates of inflation. Because we assume that agents are completely liquidity constrained (no debt is allowed) the agents will always hold their entire endowment in cash or foreign currency. The budget constraint can then be written as,

$$(2) \quad c_t = e + s_t - \pi_t(e - f_t) - T_t - \phi(\pi_t)$$

The first three terms capture disposable income, with s_t being the transfers obtained from the government. We then subtract the proportional cost of operating in the indexed or foreign currency, T_t , and the costs of inflation.

The individual choice variable is the degree of financial adaptation. The subsidy request s_t will be strategically chosen at the group level. The individual chooses sequences $\{f_t\}_{t=0}^{\infty}$ to maximize

$$(3) \quad \sum_{t=0}^{\infty} \delta^t U_t$$

for given sequences $\{\pi_t\}_{t=0}^{\infty}$, subject to the budget constraint (2) and the law of motion for f_t :

$$(4) \quad f_{t+1} \in (0, J, 2J, \dots, f_t, f_t + J) \quad ; \quad f_{t+1} \leq e$$

This law of motion represents the cost of adjustment technology where it is

in the value of transactions. This in no way jeopardizes the results. A declining average cost for the use of financial adaptation may be used to justify why the low inflation equilibria is stable in many countries. In these cases financial adaptation may be very costly as the extent to which it is used is small.

costless to reduce your stock of f but where increases are performed in one discrete (J -size) change.

1.2. GROUP OPTIMIZATION

A group policy that requires from members a given degree of financial adaptation (money demand) would be non-enforceable, given the structure and timing of events. On the other hand, we assume that the political structure is such that individuals do not have direct access to government subsidies. They can only be obtained through group pressure. Group decisions can be reached by any voting mechanism since we will always have unanimity. From here on we refer to the groups as choosing the request of subsidies from the government.

Each group's action set is $\{S, 0\}$ in every period;⁷ that is, they either request (and get) a transfer S from the government to each of its members, or refrain from doing so. Let s_t^A and s_t^B denote the actions of groups A and B at time t . They choose strategies in order to maximize discounted utility (3) of their representative members. Notice that since all other expenditures are financed via lump sum taxes, government expenditures in equation (1) result in $g = s_t^A + s_t^B$.

The game between sectors is a dynamic game i.e., stage pay-offs are dependent upon past actions through financial adaptation and hence inflation. Introducing general strategy profiles in such games turns out to be rather complicated. For that reason, we restrict the equilibrium concept to be used to Markov Perfection (Fudenberg and Tirole 1991, Chapter 13). A Markov

⁷The assumption of a discrete action space is also generalized in section 3.

Perfect Equilibrium (MPE) is a profile of Markov strategies that yields a Nash equilibrium in every proper subgame. "Markov" or "state-space" are strategies where the past influences current play only through its effect on a state vector which summarizes the direct effect of past (payoff-relevant) information on the current environment.⁸ In our game, the proper state variable is the degree of financial adaptation F . We will refer to the inflation rate π as our state variable in order to aid the intuition of the results in terms of a publicly known and easily observable variable.

2. EQUILIBRIUM

An equilibrium to our economy is a set of sequences $(\pi_t, s_t^A, s_t^B, F_t)_{t=0}^{\infty}$ such that:

(i) Given a $(\pi_t)_{t=0}^{\infty}$ sequence, $(f_t)_{t=0}^{\infty} = (F_t)_{t=0}^{\infty}$ maximizes the individual's problem (3)-(4).

(ii) The sequences $(s_t^A, s_t^B)_{t=0}^{\infty}$ constitute a MPE. I.e. each group chooses s_t^i to maximize $U(s_t^i, \pi_t) + \delta V(\pi_t)$ subject to:

(a) π_{t-1} given.

(b) The dynamic equation for the level of aggregate financial adaptation (4) and the budget constraint of the government (1) are satisfied.

(c) Player $-i$ follows strategy s_t^{-i} .

We provide a taxonomic description of all Strong Symmetric Markov Perfect Equilibria to our game. Section 3 discusses weak symmetric MPE, non

⁸Notice that the individual choice of financial adaptation is not restricted to be Markovian.

symmetric MPE and other types of equilibrium. The first two theorems characterize conditions under which constant (or steady) inflation equilibria exist. They show whether inflation will be zero or positive, and they explain why high constant inflation is not possible. Theorems 3 and 4 provide a similar analysis for the case of inflation cycles. In this section we work out the case in which $e \in (2J, 3J)$, so that the financial technology reduces to $f \in (0, J, 2J, e)$. As we will see, this restricts the cycles to be two-period phased. This restriction is in no way essential for the results and it is generalized in section 3.

Given the timing of the game and the equilibrium concept, we solve for the equilibrium strategies as follows. Initially we postulate a sequence of subsidy demands. Individual agents are informed of this path and hence decide on their demand for money $\{f_t\}$. To do this, they must form expectations over the future path of inflation, which also requires forming expectations on the aggregate level of financial adaptation (F), as both subsidies and money base determine the inflation rate through equation (1). We then look for a "monetary equilibrium" for which $F_t = f_t$ (representativeness condition). Once we have found such a monetary equilibrium we check that the path of subsidies postulated initially is optimal for both groups conditional on the monetary equilibrium chosen. I.e. we look for a MPE such that no deviations are profitable. In computing the profitability of deviations we must verify monetary equilibrium ($F'_t = f'_t$) along deviations from the equilibrium path. Notice that as groups maximize the utility of a representative agent, they internalize the inflation tax paid by its members but not the costs imposed on the other group.

Let us introduce some additional notational conventions. We call $W^*(\pi_{t-1})$ the value function for an individual member of a group in an economy

that has experienced an inflation rate equal to π_{t-1} last period. We define $V^*(\pi_{t-1})$ as:

$$V^*(\pi_{t-1}) = W^*(\pi_{t-1}) - \frac{e}{1-\delta}$$

where $e/(1-\delta)$ is the present discounted value of the endowment and $V^*(\cdot)$ the value function for the difference between the equilibrium path and the constant zero inflation/no financial adaptation path. To simplify notation and w.l.g. we work with the V function.

In any SSMPE, the two groups will choose the same action at any point in time (although actions will not be constant over time in some of the equilibria). That being the case, equation (1) can only produce the following set of inflation rates: 0, S/e , $S/(e-J)$, and $S/(e-2J)$. Notice that as $F \rightarrow e$, $\pi \rightarrow \infty$, and that the conditions on the cost of inflation function will prevent the economy from ever reaching that point; the threat of hyperinflation is enough to induce unilateral restraint in the demand for subsidies.

Table 1 summarizes the four possible steady-state inflation configurations that we find:

- 1) Steady positive inflation: $\pi=S/e$ for all t . This is likely to result if the costs of transacting in alternative currencies are high (which will induce no financial adaptation) and the welfare costs of inflation are low (which will lead groups to demand transfers).
- 2) Zero inflation regime: $\pi=0$ for all t . Intuitively, this occurs when the costs of inflation are high. In that case, groups do not find profitable to induce inflation through subsidy demands. This is the first best for the economy, with the equilibrium level of financial adaptation equal to zero.
- 3) Low inflation cycles: $\pi=0, S/(e-J)$. These will take place when the costs of inflation are low and the costs of financial adaptation are moderate. The low

cost of inflation induces groups to demand subsidies. The moderate cost of financial adaptation induces an intermediate pattern of financial adaptation which translates into low inflation cycles.

4) High inflation cycles: $\pi=0, S/(e-2J)$. These also requires low costs of inflation. These equilibria are possible for a wider range of financial adaptation costs than that for the low inflation cycles. Small costs induce large levels of financial adaptation generating high inflation, but large costs can also sustain widespread financial adaptation as equilibrium inflation rates are high.

As we show in the corollary to theorem 1, high and steady inflation cannot occur as an equilibrium in our model. For high inflation to result we need a de-monetized economy. This can only be true if the costs of operation under financial adaptation are low. But then, individuals would totally substitute away from domestic currency and hyperinflation would result. The associated welfare costs are enough to induce groups to unilaterally stop requesting government transfers.

We now proceed to analyze the existence of equilibria of the four types mentioned. The first two theorems analyze the case of constant steady state inflation.

2.1. STEADY INFLATION

Theorem 1: *Steady positive inflation will be an equilibrium iff:*

i) $\tau > S/e$ and

ii) $S/2 > \phi\left(\frac{S}{e}\right) - \phi\left(-\frac{S}{2e}\right)$

Proof: If the inflation rate is positive, then in a SSMPE both groups demand subsidies, and inflation must be greater or equal to S/e from equation (1).

Hence, if $\tau < S/e$, the savings in inflation tax are always larger than the costs of transactions in the dollarized economy so that it is always optimal to financially adapt. In steady state they will operate at $F=f=e$. On the other hand, if $\tau > S/e$, the value for individuals which we denote by v is: $v(f) = -\tau f + \pi f$. If $F=0$ then monetary equilibrium requires $\tau > S/e$, otherwise financial adaptation would be optimal at the individual level. Notice, that this is the least restrictive structure under which this monetary equilibrium could exist and where inflation is constant and positive. Monetary equilibrium will either take place at $F=f=e$ if $\tau < S/e$ or at $F=f=0$ if $\tau > S/e$.

The value of the optimal strategy on the equilibrium path is

$$V^*(\pi) = -\tau F - \phi\left(\frac{S}{e-F}\right) + \delta V^*(\pi),$$

where notice that the subsidies cancel with the inflation tax. The value to a group of not requesting subsidies for one period and then going back to the postulated equilibrium is,

$$V^0(\pi) = -S/2 - \tau F - \phi\left(\frac{S/2}{e-F}\right) + \delta V^*(\pi)$$

so that,

$$V^*(\pi) - V^0(\pi) = \frac{S}{2} + \left[\phi\left(\frac{S/2}{e-F}\right) - \phi\left(\frac{S}{e-F}\right)\right]$$

Since the inflation rate that results when both parties demand subsidies is always twice as high than when only one does, the term in square brackets is always negative and decreasing in the degree of financial adaptation. Hence it is optimal to deviate from a constant and high inflation rate whenever $V^*(\pi) - V^0(\pi) < 0$, or

$$\frac{S}{2} < \phi\left(\frac{S}{e-F}\right) - \phi\left(\frac{S/2}{e-F}\right)$$

When $F=0$ there may exist equilibria with constant low inflation rates ($\pi=S/e$) as the second condition of the theorem demands. For $F \rightarrow e$ an alternative monetary equilibrium without monetization could exist. Nevertheless, from the assumption that the costs of inflation are not "too concave" at very high rates, deviations from the strategy will be profitable at high inflation rates. This correspond to our intuition that the "risk of a hyperinflation" is what eventually leads agents to demand lower subsidies. Q.E.D.

Corollary: *High steady inflation cannot occur in equilibrium.*

Theorem 2: Steady zero inflation is an equilibrium iff:

$$i) \tau < \left(\frac{S/2}{e-J}\right) \quad \text{and} \quad ii) \frac{S}{2} < \tau J + \phi\left(\frac{S/2}{e-J}\right)$$

or

$$i') \tau > \left(\frac{S/2}{e-J}\right) \quad \text{and} \quad ii') \frac{S}{2} < \phi\left(\frac{S}{2e}\right)$$

Proof: A no-inflation equilibrium requires subsidy demands to be zero all the time. On the equilibrium, clearly $f=F=0$, to avoid unnecessary costs of operating in foreign exchange. In order to evaluate the profitability of deviating to $s_i=S$, we have to specify off-equilibrium monetary behavior. For $\tau < S/2e$, the only consistent monetary behavior is $f=F=J$. For $\tau > \frac{S/2}{e-J}$, the only consistent monetary behavior is $f=F=0$. For intermediate values, both monetary equilibria are self-fulfilling.⁹ In that case, we consider $f=F=J$. We proceed now to verify the conditions for profitable deviations for the two cases of τ smaller and greater than $\frac{S/2}{e-J}$.

(a) When $\tau < \frac{S/2}{e-J}$, an aggregate level of financial adaptation of $F=J$ induces $f=F=J$, since $\tau < \pi = \frac{S/2}{e-J}$, the cost of operating in foreign currency is smaller than the inflation tax. The value function of a deviation given that inflation was zero in last period and will be zero again next period is,

$$V^S(0) = S - \pi(e-J) - \tau J - \phi(\pi) + \delta V^*(0)$$

The terms include the gains from the subsidy S minus the inflation tax, the transaction cost due to some financial adaptation, and the costs of inflation. Finally, the last term represents the discounted value of continuing along the optimal zero inflation strategy. This last term is clearly equal to zero.

From (1) we have that $\pi = \frac{S/2}{e-J}$ so that the above equation reduces to,

⁹ We always require representativeness ($f=F$) even along deviations. As it turns out, there is a range $[\frac{S}{2e}, \frac{S/2}{e-J}]$ for the value of τ , where multiple off-equilibrium behaviors are representative, namely 0 and J. Since we are interested in describing the possibility of existence, we concentrate on the off-equilibrium monetary behavior that supports existence for the largest possible set of parameter values. For that reason, and also because it simplifies the exposition and the statement of the theorem, we consider $f=F=J$ as monetary behavior, in the range of indeterminacy.

$$V^S(0) = \frac{S}{2} - \tau J - \phi\left(\frac{S/2}{e-J}\right)$$

hence for a deviation to be profitable we require $V^S(0) > 0$ which results in

$$-\frac{S}{2} > \tau J + \phi\left(\frac{S/2}{e-J}\right)$$

So that zero-inflation will be an equilibrium (when τ is low) iff condition (ii) is satisfied, as claimed.

(b) When $\tau > \frac{S/2}{e-J}$, then $f=F=0$. In that case, the gains from deviating from the postulated equilibrium are $V^S(0) = \frac{S}{2} - \phi(S/2e)$. Given that $V^*(0)=0$, a deviation is unprofitable when τ is high as long as (ii') is satisfied. Q.E.D.

The two theorems established conditions under which stable inflation rates can exist. These conditions provide some powerful intuitions. First, if financial adaptation is cheap relative to inflation, positive constant inflation rates are not sustainable. In these cases financial adaptation takes place increasing inflation unboundedly. But as inflation accelerates costs mount up and sooner or later a stabilization follows. A clear corollary is that only low constant inflations can be verified. This will result if the cost of operating in a financially adapted economy are high and the costs of inflation are low (otherwise the groups would refrain from demanding subsidies and zero constant inflation would result.)

Second, zero inflation is likely to be the outcome if the costs of inflation are high.

Third and most interesting, if the costs of inflation do not increase very fast and the cost of operating in foreign currency are low, there is no constant inflation equilibria. Since it is cheap to financially adapt, the savings from the inflation tax almost always dominate the operational costs.

The relatively low marginal cost of inflation makes groups willing to tolerate inflation (initially, but eventually the threat of hyperinflation induces adjustment). The result is that no constant inflation program will survive in this economy.

Figure 3 illustrates the possible combinations of τ and ϕ that generate the different type of equilibrium discussed above. For the purposes of illustration we assume in the Figure that $\phi(\pi)=\alpha\pi$.¹⁰ We have divided the space with the boundaries derived in theorems 1 and 2. Constant positive inflation results in the southeast region. Constant zero inflation will occur for high inflation costs¹¹. Finally, in the southwest region no constant inflation equilibria exists. The condition that rules out stable inflation rates requires relatively small costs of operating in foreign currencies and of inflation. The first restriction eliminates the possibility of sustainable positive inflation. The second, induces groups to deviate from low inflation. Both conditions plausibly apply to the highly indexed and dollarized Latin American economies.

We next turn to an analysis of the potential existence of inflation cycles. This is, as claimed in the introduction, a feature of Latin American countries.

2.2. INFLATION CYCLES

¹⁰If $\phi(\cdot)$ were strictly concave or convex we could have a region of multiple steady inflation equilibria or with no equilibria at all.

¹¹For low τ , financial adaptation will take place upon deviations and the groups will internalize both costs (τ and ϕ) when evaluating a deviation, inducing a downward sloping condition. For high τ , no financial adaptation will occur, and hence only the costs of inflation prevent groups from deviating (horizontal segment to the right of $S/2(e-J)$.)

Theorems 3 and 4 present the conditions under which low- and high- (average) inflation cycles can occur. Together with our previous results, we show that high inflation necessarily implies variable inflation, and that the conditions for high inflation are a relatively low cost of operating in alternative means of payments and low cost of inflation at relatively high inflation.

We define a low inflation cycle as an oscillation from $\pi=0$ to $\pi=\frac{S}{e-J}$, and a high inflation cycle as oscillation from $\pi=0$ to $\pi=\frac{S}{e-2J}$. To observe cycles, it must be the case that the MP strategy is of the form:

$$(5) s_t^i = \begin{cases} 0 & \text{for } \pi > \bar{\pi} \\ S & \text{for } \pi \leq \bar{\pi} \end{cases}$$

for $i=A,B$, where $\bar{\pi} = 0$ in the case with two-period cycles. In the more general case explored in section 3, inflation will escalate before a stabilization takes place, so that $\bar{\pi} > 0$.

Theorem 3: *Low inflation cycles constitute an equilibrium iff:*

$$i) \tau > \frac{S/2}{e-J} \quad i') \tau < \frac{S}{e-J}$$

$$ii) \frac{S}{2} > \tau J + [\phi(\frac{S}{e-J}) - \phi(\frac{S}{2e})] \text{ and}$$

$$iii) \frac{S}{2} < 2\tau J + \phi(\frac{S/2}{e-2J}) - \frac{\delta(1-\delta)}{1-\delta^2} [\tau J + \phi(\frac{S}{e-J})]$$

Proof: See Appendix.

Theorem 3 shows that cycles with low average inflation can exist under certain conditions. The conditions (i) and (i') bound the path of financial adaptation in order to obtain representativeness; i.e. that individual agents

optimal f corresponds to the aggregate F . The cost of transactions in foreign currency has to be low enough to induce a positive amount of financial adaptation in the inflation state. This in turn will incorporate the threat of further financial adaptation which induces the groups to decline subsidy demands in the following period. At the same time τ has to be high enough to induce agents to reduce their holdings of foreign assets in the low inflation period. The restriction is important because if the cost was low, individuals would always financially adapt in anticipation of saving part of the inflation tax. Then, monetary equilibria would imply a de-monetized economy and any demand for subsidies would lead to high inflation.

There are also two additional restrictions on the inflation cost function. Inflation costs can not increase too fast because otherwise it would be optimal for groups to unilaterally "deviate" and not demand subsidies when the equilibrium strategy indicates positive demands. At the same time, at high inflation rates, the costs of inflation must be increasing rapidly (when properly weighted by the discount rate) so that groups do not find it optimal to demand subsidies, accelerate inflation and postpone stabilization in the periods of moderate inflation.

While it is certainly feasible that a country may turn out to satisfy these restrictions, we regard them as narrow. For this reason, we analyze next the case when cycles of high average inflation constitute the equilibrium of the system.

Theorem 4: *An equilibrium with high inflation cycles exists iff:*

$$\begin{aligned}
 & i) \tau < -\frac{S/2}{e-2J} \quad , \quad i') \tau > \frac{S-K}{e-J} \\
 & ii) \frac{S}{2} > \phi\left(-\frac{S}{e-2J}\right) - \phi\left(\frac{S/2}{e-2J}\right)
 \end{aligned}$$

Proof: See Appendix.

Theorem 4 shows that high average inflation cycles are feasible for low transaction cost parameter (condition (i') may not bind at all for K sufficiently large) and low costs of inflation. High transaction costs (τ) would imply that operating in highly dollarized economies is not individually optimal. Monetary equilibrium would then result in lower average inflation rates, than those of Theorem 3. Hence, a low τ is necessary for this type of equilibrium. Condition (ii) requires that the costs of inflation do not increase too much at high inflation rates as this provides the incentives to demand subsidies even when knowing this will result in high inflation. But, at the same time, there are strong incentives to refrain from demanding subsidies, independently of the other group's action, when inflation has been high, as this will lead the economy into hyperinflation. Indeed, it is the threat of hyperinflation and the costs it entails that ensure groups will find it individually optimal to accept a stabilization plan. However, because the marginal costs of inflation are sufficiently low, once stabilization has been achieved it is optimal for the groups to re-start the income distribution struggle. Oscillating high average inflation equilibria therefore develops.

Figure 4 characterizes the inflation cycles equilibria that we developed in theorems 3 and 4. The graph has been traced, as before, for the case where the cost of inflation function is linear. The conditions established in theorem 4 specified that high average cyclical inflation can only result for relatively low costs of inflation and costs of operation in a financially adapted economy. The area is represented by a rectangle in the south-west of

the diagram.¹² Low average inflation required more restrictions on the cost functions. Low average inflation requires high costs of transactions in foreign currencies. But, for deviations not to be profitable, the costs cannot be too high. If the costs of inflation or of financial transactions were high, it would be optimal for groups to deviate and avoid asking for subsidies in periods of stability. Notice that the regions for cyclical inflation overlap to a great extent. Multiplicity of equilibria is possible. What one should learn from the figure is that oscillating high average inflation can be supported in a large region of the parameter space and that such a region would all be in the southwest corner of figure 3, the area where no constant inflation existed.

Summarizing, in this section we have shown that under some reasonable conditions, a constant inflation rate may not result so that an economy will oscillate between inflation periods and stability. In fact, those periods of stability, will be associated with fiscal restraint and low monetary growth, typical of stabilization programs. But then, the dynamics of the interaction between private groups would lead them to demand subsidies to avoid a redistribution of resources away from them. These periods are the collapse of stabilization programs. Clearly, if stability could be sustained, it would be a positive welfare development. However, the nature of the interaction by the private sector and the rules of engagement for the government are such that permanent stabilizations are not feasible without substantive structural reforms.

In the next section, we analyze the robustness of our results to a number of important modifications to the technology. First, we consider

¹²In the figure we assume K sufficiently large, such that condition (i') imposes no restriction on τ .

endogeneizing the size of the subsidies demanded. Then we consider a more general financial adaptation technology. Third, we look at an economy that exhibits three period cycles. The purpose of such exercise is to show that this framework can generate escalation of inflation prior to stabilization. In this way, we provide an alternative model of *delayed stabilization*. We believe our framework has the advantage of explaining in a unified manner delay and the original cause of the problem. Fourth, we look at non-symmetric equilibria. Finally, we investigate the conditions for a delayed *permanent* stabilization à la Alesina-Drazen to occur.

3. EXTENSIONS

The model developed above showed some striking results. Namely, that oscillation of the inflation rate could easily result as an equilibrium. In the process of presenting the results as simply and intuitively as we could, we made several assumptions that can make the reader uncomfortable. In particular, the "discreetness" of the problem may be responsible for the type of behavior found. For instance, it could be that because we assign an all or nothing nature to the demand for subsidies equilibrium results in oscillation. If the groups could choose internal solutions for the demand for subsidies, then they could ask for lower subsidies in periods of high financial adaptation. Hence, by convexifying the decision set we may converge to a smooth equilibrium path.

Alternatively, it could be that the strict form of financial adaptation costs provides all the model's power. If one were to assume a more typical

convex cost of adjustment technology, how would individual agents adjust their portfolio ? If they moved faster towards full dollarization then maybe low (or no) inflation would be the only equilibrium. Or, if people adjusted more gradually, then the tax base would remain larger and longer inflationary episodes would result. Furthermore, the model assumed asymmetric adjustment up and down for financial adaptation. Could a more symmetric model result in smoother inflation paths ?

A third extension allows for higher than two phased inflation cycles. We discuss the possibility of three period inflation cycles, but the result easily generalizes to longer periods of inflation escalation.

A fourth extension deals with the possibility of nonsymmetric equilibrium. Where only one group demands subsidies or where groups alternate in their subsidy demands.

Finally we consider a slight modification in the financial adaptation technology which transforms our model of inflation cycles into a model of delayed stabilization.

The five subsections that follow analyze these five problems in turn. In the most tedious cases we will present only heuristic arguments to try to convince the reader of the robustness of our results. Formal proofs are relegated to an appendix. Notice that in the first three cases, what we do is to establish conditions under which equilibria of the type described in Theorem 4 obtain.

3.1. ENDOGENOUS CHOICE OF SUBSIDY, S.

Suppose groups could decide on the size of subsidy they wish. What levels would they choose? I.e. we want to obtain the optimal choice of subsidies if

the action space is $s \in [0, S]$. We show that there exists an equilibrium with discontinuous optimal sequence of subsidy demands of the form: $\{S, \Sigma, S, \Sigma, \dots\}$ with $\Sigma < S$, where the corresponding levels of financial adaptation are $\{2J, J, 2J, J, \dots\}$. Intuitively, Σ replaces 0 in Theorem 4, where Σ is the point at which the value function becomes discontinuous due to the change in F (if $s^A + s^B > \Sigma$, F jumps up).

Proof: We first derive the conditions for existence of a monetary equilibrium. Consider the alternative paths of monetary holdings:

$$v(J, 0) - v(2J, J) = J(\tau - \pi_L) + J(\tau - \pi_H) = 2J\tau - J(\pi_L + \pi_H) < 0 \text{ if } \tau < \frac{\pi_H + \pi_L}{2}.$$

$$v(e, 2J) - v(2J, J) = J(\pi_L - \tau) + (e - 2J)(\pi_H - \tau) < 0 \text{ if } \tau > \frac{S - K_L J \pi}{e - J}$$

Under the conditions derived for τ the equilibrium levels of financial adaptation will be individually optimal. We must now show conditions under which choice $s = S$ takes place, given other player's choice of S , where s denotes the individual group choice variable. We check that each group will also demand S by showing that

$$V^*(\pi_L) - V^S(\pi_L) > 0 \text{ for every } s \in [0, S].$$

The condition is

$$V^*(\pi_L) - V^S(\pi_L) = \frac{S-s}{2} + \phi\left(\frac{S+s}{e-2J}\right) - \phi\left(\frac{S}{e-2J}\right) > 0$$

which has the same interpretation as that of previous theorems.

Now we must find Σ s.t. it is best response and constitutes a Nash equilibrium. We know that inflation rates along the equilibrium path are

$\pi_L = \frac{\Sigma}{e-J}$ and $\pi_H = \frac{S}{e-2J}$. Hence, the second condition for a monetary equilibrium becomes increasingly binding as Σ increases. Indeed, the condition becomes binding when $\Sigma = \frac{(e-J)}{J}[\tau(e-J)-S+K]$. Further increases in demands beyond this point would lead to an increased level of financial adaptation, which in turn would increase inflation and reduce utility. But this is a Nash equilibria since asking for less than Σ leads to losses as the other group asks for it. Obviously, asking for more will only lead to a violation of the monetary equilibrium and to hyperinflation.¹³

Q.E.D.

3.2 ALLOWING FOR DIFFERENT DEGREES OF FINANCIAL ADAPTATION

We now consider a slightly more general cost of financial adaptation function. We allow individuals to choose whether to adapt (from $f=0$) upwards by $f=J$ and pay a cost of βJ or to adapt up by $f=2J$ and pay $2\beta J$. The proportionality of the cost function is rather useful since it stresses the difference with the previous case. Figure 5 shows a graph of the cost function.¹⁴

We postulate the sequence of subsidy demands to be $[S,0,S,0,\dots]$ and the aggregate financial adaptation to be $[2J,0,2J,0,\dots]$. It is tedious but easy to determine conditions under which $f=F$ and monetary equilibrium exists. In general, those conditions imply restrictions on the maximum size of the cost of financial adaptation, β , the cost of operating in a financially adapted

¹³The same argument can be used to show that the restriction of an upper bound on S is not necessary for our results, though it would imply non existence of more than two period inflation cycles.

¹⁴ A more general increasing marginal cost function would not substantially change the results. Hence we operate at little loss of generality.

economy τ and on S and e , the subsidy size and the endowment. We find those conditions to be rather plausible. If a monetary equilibrium exists, we are back to the conditions necessary for theorem 4 to hold (condition ii in particular). Namely, we require that the subsidy must be bigger than the increase in the cost of inflation that will be born out by group A when it does not deviate from equilibrium.

Once again, because individuals find it optimal to financially adapt, inflation will be high in periods of subsidy demands. Restraint will follow next period since otherwise hyperinflation would result. The cost of financial adaptation technology, does not seem to represent a threat to the oscillating equilibria proposed above.¹⁵

3.3. INFLATION ESCALATION

We now look at the effect of lifting the restriction that within three discrete episodes of financial adaptation the economy is completely dollarized. In particular, we consider the case where $3J \leq e < 4J$. Because we keep the rest of the structure of the model, financial adaptation will only take place in discrete steps of size J . The postulated sequence of subsidy demands is $[S, S, 0, S, S, 0, \dots]$ and for financial adaptation $[2J, 3J, J, 2J, 3J, J, \dots]$.

In this case, inflation will accelerate for a while before stabilization takes place. Individual choices will follow the aggregate financial

¹⁵ As for the lack of symmetry between adjustments up or down in financial adaptation costs this really is an innocuous assumption. Since, in thm 4, adjusting by more than J is infinitely costly, people would only move down from $2J$ to J , or a one step adjustment. Hence symmetry does not change the analysis at all.

adaptation for conditions less stringent than those of theorem 4. That is, the cost of operating in a financially adapted technology can now be a bit higher and we still will get the postulated path as an equilibrium. The intuition is simple. Because inflation will be present most of the time (before it was only half the time) the savings from financial adaptation are large. On the other hand, the costs τ must be high enough to justify a reduction in financial adaptation in periods of relatively low inflation.

But given the monetary equilibrium, groups should find it optimal to demand subsidies according to the postulated sequence. Deviations from that sequence ought, as indeed they are, not to be profitable under conditions that are remarkably close to those of theorem 4. When inflation was high in the previous period, groups will wish to stabilize since the threat of hyperinflation makes it costly to ask for subsidies. When last period had price stability, groups will ask for subsidies, gradually abandoning the stabilization effort, if the increased costs of inflation are lower than the gains from the subsidy. Finally, when inflation was intermediate, any group would still find it optimal to keep demanding subsidies if the increasing costs of inflation are still less than the transfer to the other group. The conditions on the cost increase are, in this case, similar to condition ii of theorem 4. The intuition for the equilibrium is again, that since the other group is asking for a subsidy you may as well ask for one. While inflation turns out higher and costlier, at least the subsidy to the other group is avoided.

3.4. NON-SYMMETRIC EQUILIBRIA.

In this sub-section we present a variant to the strong symmetric equilibrium. For the purposes of illustration we will consider a

non-symmetric extension of theorem 1. Similar exercises can be performed for the other inflation configurations. Consider a steady positive inflation equilibrium in which only group A asks for subsidies equal to $2S$, while group B does not demand any subsidies at all. In this extension to theorem 1 the inflation rate will equal S/e and we assume the conditions there so that the optimal level of financial adaptation equals zero.

Proof: For briefness we check if there exist incentives for group B to ask for a subsidy and for group A to resign its subsidy, the other deviations are left to the reader. The value functions equal

$$V^{A*}(0) = S - \phi(S/e) + \delta V^{A*}(\pi)$$

$$V^{B*}(0) = -S - \phi(S/e) + \delta V^{B*}(\pi)$$

Group B's deviation is not profitable as long as

$$V^{B_{2S}}(0) - V^{B*}(0) = -\phi(2S/e) + S + \phi(S/e) < 0.$$

For group A a deviation is not profitable as long as

$$V^{A_0}(0) - V^{A*} = -S + \phi(S/e).$$

In both cases we assume τ large enough for the monetary equilibrium to remain with no financial adaptation.

3.5. DELAYED STABILIZATIONS.

Here we allow the space of possible values for financial adaptation to be

$$f_t \in \{0, J, 2J, \dots, \max\{f_i, i < t\}\}; \quad f_t \leq e.$$

This change is critical as it indicates that the inertia we built in the money demand process happens only once. Once the economy achieves a given level of financial adaptation it can return to that level independently of the current state of f_t . Under this situation we show that a possible equilibrium implies a path of subsidies $\{S, S, S, \dots, S, 0, 0, 0\}$ with an increasing level of financial adaptation and increasing levels of inflation until the stabilization date, i.e. the model becomes a model of *delayed permanent stabilizations*.

Proof: Value functions are now dated as the game becomes non-stationary. We assume there exists a period T in which $V_T^S = -\infty$, so that the equilibrium strategy in that period is to stabilize. We will show no deviations are profitable after T so that $V_T^* = 0$ (as the level of financial adaptation also reverts to zero). For previous periods the value along the equilibrium path equals:¹⁶

$$V^*(\pi_t) = -\tau t J - \phi\left(\frac{S}{e-tJ}\right) + \delta V_{t+1}^*$$

Simple backward substitution shows that the path of equilibrium value functions is declining. The incentive to deviate from the equilibrium path is given by

$$V_t^0 - V_t^* = \phi\left(\frac{S}{e-tJ}\right) - \phi\left(\frac{S/2}{e-tJ}\right) - S/2.$$

¹⁶Notice that the path for s induces $F = \{J, 2J, \dots, TJ, 0, 0, \dots\}$.

For the case of a linear function $\phi = \alpha\pi$, the condition reduces to $\alpha > e - tJ$, so that it is monotonic in t . Stabilization takes place when $t = (e - \alpha)/J$. Finally, we should verify that deviations after the stabilization date are not profitable. But this follows from the fact that the set of feasible f 's is now the same as at the stabilization date. Q.E.D.

There are a number of other extensions not addressed here but that could help enrich the model. Namely, why should pressure groups be symmetric? A first obvious concern is the division of the economy into two equal sized groups. If both groups were of different sizes, the same pattern of equilibria would still follow, though the set of feasible oscillating equilibria would be smaller. In the limit, when only one group exists, the political economy game ceases to be of any interest and stable zero inflation is the only equilibrium.

A second source of symmetry that is important is that because of the assumed linearity of the utility function different endowments and subsidies across individuals make no difference. In a model with concave preferences and uneven income distribution, gains and losses would differ. Additionally, the objectives and policies of the government could be different from the simple notion of this model. If such were the case, the (implicit voting) equilibria would change. Considerations of this nature could be important for the success of economic reforms guided at breaking an oscillating inflationary equilibria.

Finally, we may wish to consider a differential access to financial adaptation. If one group can costlessly access these financial technologies, then the zero inflation equilibrium does not appear feasible, as the group that is perfectly shielded against inflation taxation will always demand the subsidy.

4. CONCLUDING REMARKS

The paper was motivated by a somewhat puzzling empirical observation for a number of developing countries. High inflation is associated with volatile inflation. In particular, inflation seems to accelerate for a while until a stabilization program is put into place. At that point, inflation is dramatically reduced. But the inflation rate does not remain low for a long time. After a brief success, the programs are abandoned and inflation resumes.

We modeled those stylized facts in a simple model of two pressure groups interacting in their demand for subsidies. We show that for an oscillating inflation to result, it must be the case that inflation is not very costly and that the costs of operation in a financially adapted system should also be low. A country that suffers high inflation must necessarily suffer a volatile inflation as well. This entails high welfare losses for society, losses associated with the costs of inflation, its variability and the costs of operating in a financial system that is efficient as an inflation hedge but less so as a resource allocator. Societies like the ones described in this paper will long for a stabilization program. However, when a program that only considers fiscal restraint is assembled and offered to society, it will only be successful for a short while. While the program is welfare enhancing (the costs of inflation are lower) the individual groups will eventually find in their best interest to request transfers again, resulting in an abandonment of the program.

For a stabilization effort to permanently succeed would require substantial structural adjustments. These adjustments may include increasing

the costs of inflation (i.e. de-indexation) or the costs of operation in a substitute to domestic currency (i.e. financial repression). The last case is of particular interest since a large number of countries that suffer from inflation resort to financial repression. While repression is usually associated with a desire for an increased inflation tax base (Mondino and Videla 1991), we could interpret it as a move towards a more stable inflation rate. The move towards increasing the costs of operation could also provide an explanation for the observed difficulty of many economies that stabilize high inflation to completely control it. Many times, high inflation is followed by moderate inflations (Dornbusch and Fischer 1991). That particular feature is explained in our model by an increase in τ but not in ϕ .

As stated in the Introduction, we believe that the key to a "durable" stabilization is a change in the rules of the game.

APPENDIX

Proof of Thm. 3: For a low inflation cycle, we need the path of financial adaptation to oscillate from 0 to J. As usual, we require monetary consistency, i.e., $f=F$. If F oscillates from 0 to J, f will follow 0-J as long as:

$$v(0,J)-v(0,0)= J(S/(e-J)-\tau)>0$$

$$v(0,J)-v(J,2J)=+\tau J+J(\tau J-S/(e-J))>0$$

or equivalently as long as: $\tau < \frac{S}{e-J}$ and $\tau > \frac{S/2}{e-J}$ which are condition (i) and (i'). To check the optimality of the required strategy (5) (which implies a sequence of subsidies [0,S,0,S,...]), we would need to check deviations from zero and from positive inflation. Note that

$$V^*(0) = -\tau J - \phi\left(\frac{S}{e-J}\right) + \delta V^*(\pi)$$

and

$$V^*(\pi) = \delta V^*(0)$$

where $V^*(0)$ is the value function along the equilibrium path when last

period's inflation was zero, $V^*(\pi)$ is the value along the equilibrium path when last period inflation was positive. Let $V^S(\pi)$ be the value function off the equilibrium path when the group asks for a subsidy when it should have not. It indicates that inflation will continue to be positive for one more period. Finally, let $V^0(0)$ be the value off the equilibrium path when no subsidies are demanded when they "should". The resulting inflation will then still be positive. Following a one period deviation the agents revert to playing equilibrium strategies. We evaluate first $V^0(0)$. As always we start by considering the atomistic agent monetary equilibrium. Since the economy verified zero inflation last period and was moving along the equilibrium path, financial adaptation was zero. This means we can restrict our attention to the case where $F=0$ or J . However, one can easily verify that if the conditions on τ stated by the theorem are satisfied, then $F=J$ is not a monetary equilibrium.¹⁷ If $F=0$ then the condition for monetary equilibrium is $v(f=0) > v(f=J) \Rightarrow \tau > S/2e$, which is satisfied from (A1). The resulting lower inflation from the deviation, does not justify the costs of financial response. Hence,

$$V^0(0) = -S/2 - \phi\left(\frac{S}{2e}\right) + \delta V^*(\pi)$$

The loss from deviating equals

$$V^*(0) - V^0(0) = -\tau J - \phi\left(\frac{S}{e-J}\right) + \frac{S}{2} + \phi\left(\frac{S}{2e}\right)$$

which is always positive according to condition (ii) of the theorem.

Next consider demanding subsidies when restraint should be shown. Since last period showed positive inflation ($f=J$), private agents can now choose $f \in (0, J, 2J)$. We must then check the monetary equilibrium conditions. If $F=2J$, and $\tau < \frac{S/2}{e-2J}$ then $2J$ is an equilibrium. No monetary equilibria exists for $F=J$ (but for an uninteresting knife edge case). Finally, if the costs of financial adaptation are sufficiently high, $F=0$ could also result in an equilibrium. Our task is simplified, since if this was the case, then a fluctuating inflation equilibria would not exist.¹⁸ For this reason, we

¹⁷ If $F=J$, and f can only assume the values 0 or J , then the condition for it to be a monetary equilibrium is $\tau < \frac{S/2}{e-J}$, which violates (A1).

¹⁸ It can be verified that when no financial adaptation follows a deviation that increases the inflation rate, the groups would always find it

concentrate our attention on the $F=f=2J$ equilibrium.

The value function in case of a deviation is,

$$V^S(\pi) = \frac{S}{2} - \tau 2J - \phi\left(\frac{S/2}{e-2J}\right) + \delta V^*(\pi)$$

Notice that since inflation is positive in this period, the game restarts along the equilibrium path next period but moves to a no inflation stage $V^*(\pi)$. For the deviation not to be profitable we verify condition (iii) Q.E.D.

Proof of Thm. 4: To observe a high-inflation cycle, the following paths are necessary for the demand for subsidies and for financial adaptation respectively: $S^A = [0, S, 0, S, \dots]$ and $F = [J, 2J, J, 2J, \dots]$. First, we verify the conditions for the path for F constituting a monetary equilibrium.

Consider the following individual gains from financial adaptation:

$$v(0, J) = -\tau J + J \frac{S}{e-2J}$$

$$v(J, 2J) = -\tau J - \tau 2J + 2J \frac{S}{e-2J}$$

$$v(2J, e) = -\tau 2J - \tau e - K + e \frac{S}{e-2J}$$

In order for $v(J, 2J)$ to be an individually dominating strategy, we need $\tau < \frac{S/2}{e-2J}$ and $\tau > \frac{S-K}{e-J}$ which are condition (i) and (i'). Once monetary equilibrium is achieved, we move to check the group equilibrium. The value functions for the equilibrium path are:

$$V^*(0) = -\tau 2J - \phi\left(\frac{S}{e-2J}\right) + \delta V^*(\pi)$$

and

$$V^*(\pi) = -\tau J + \delta V^*(0)$$

We now consider deviations from strategy (5), starting with the case when no subsidies are demanded by one group when they should have. Since by condition (i) the transaction cost of financial adaptation is low it is easily verified that monetary equilibrium along this deviation implies $F=f=2J$. The deviating group value function is,

optimal to deviate. The difference in the value functions is,

$$V^*(\pi) - V^S(\pi) = [-\tau J - \phi\left(\frac{S}{e-J}\right) - \frac{S}{2} + \phi\left(\frac{S}{2e}\right)] \frac{\delta(1-\delta)}{1-\delta^2} < 0$$

hence deviations are optimal.

$$V^0(0) = -\frac{S}{2} - \tau 2J - \phi\left(\frac{S/2}{e-2J}\right) + \delta V^*(\pi)$$

for the deviation to be unprofitable we require

$$\frac{S}{2} > \phi\left(\frac{S}{e-2J}\right) - \phi\left(\frac{S/2}{e-2J}\right)$$

which is satisfied by condition (ii) of the theorem.

The alternative deviation is to demand subsidies during a stabilization program. Notice that once again, because the transaction cost is so low, individuals will remain financially adapted. Here however, since last period financial adaptation was at $2J$, it is possible for them to move to $F=e$. But in this case, the demands for subsidies lead to hyperinflation. The condition on the inflation cost function under hyperinflation insure this will be a dominated strategy for the group. Hence, the deviation will never be verified. Q.E.D.

Proof of Extension 3.2. We assume a cost function of the form $c(\Delta F) = \beta \Delta F$ or βJ and $\beta 2J$. Once again the postulated equilibrium sequence is $[S, 0, S, 0, \dots]$ and $[2J, 0, 2J, 0, \dots]$. We check the multiple possible deviations from monetary equilibria:

- 1) $v(2J, J) - v(2J, 0) = c(2J) - c(J) - \tau J < 0$ if $\tau > \beta$
- 2) $v(J, 0) - v(2J, 0) = \beta + \tau J - J\pi < 0$ if $\tau < \pi - \beta/J = \frac{S}{e-2J} - \beta/J$
- 3) $v(e, J) - v(2J, 0) = -\tau J + S - K - (e-2J)\tau < 0$ if $\tau > \frac{S-K}{e-J}$
- 4) $v(e, 2J) - v(2J, 0) = -\tau 2J + \beta J + S - K - (e-2J)\tau < 0$ if $\tau > \frac{\beta J + S - K}{2}$

If all 4 conditions are met, then we must check the group payoffs along the equilibrium and off-equilibrium paths.

$$V^*(0) = -\tau 2J - \phi\left(\frac{S}{e-2J}\right) - \beta 2J + \delta V^*(\pi)$$

$$V^*(\pi) = \delta V^*(0)$$

The conditions for local deviations to be unprofitable are

$$V^*(0) - V^0(0) = \frac{S}{2} - [\phi\left(\frac{S}{e-2J}\right) - \phi\left(\frac{S/2}{e-2J}\right)] > 0 \text{ and}$$

$$\tau < \frac{S/2}{e-2J} - \beta/J \text{ for monetary equilibrium under this deviation.}$$

The second deviation is trivially satisfied as,

$$V^*(\pi) - V^S(\pi) = -\frac{S}{2} + \tau 2J + \phi(\infty) - \phi(\cdot) + \delta V^*(0) - \delta V^*(\pi) > 0 \text{ for sure. Q.E.D.}$$

Proof of Extension 3.3: There exists an oscillating equilibrium of phase 3 with the following sequences of demand for subsidies and aggregate financial adaptation [S,S,0,S,S,0,...] and [2J,3J,J,2J,3J,J,...]. The resulting inflation rates are $\pi = (0, \frac{S}{e-2J}, \frac{S}{e-3J})$ where we call π the middle inflation and Π the high inflation. Monetary equilibria, $F=f$: As always we check the value of deviations:

$$i) \quad v(2J,3J,J) - v(J,2J,0) = -\tau 2J + \frac{JS}{e-2J} + \frac{JS}{e-3J} > 0 \text{ iff } \tau < \frac{1}{2} \left[\frac{S}{e-2J} + \frac{S}{e-3J} \right].$$

$$ii) \quad v(2J,3J,J) - v(3J,e,2J) = \tau J + (e-2J)\tau + K - J \frac{S}{e-2J} - S > 0 \text{ iff } \tau > \frac{S}{e-2J} - K/(e-2J).$$

If these restrictions are satisfied, all other deviations are non-profitable too. The value functions for group behavior along the equilibrium path:

$$\begin{aligned} V^*(0) &= -\phi\left(\frac{S}{e-2J}\right) - \tau 2J + \delta V^*(\pi) \\ V^*(\pi) &= -\phi\left(\frac{S}{e-3J}\right) - \tau 3J + \delta V^*(\Pi) \\ V^*(\Pi) &= \delta V^*(0) \end{aligned}$$

To compute value of deviation for group we must first determine what restriction does the monetary equilibrium imply. For monetary equilibrium under this deviation (that results in lower inflation rates today) we require the somewhat stricter,

$$i') \quad \tau < \frac{1}{2} \left[\frac{S/2}{e-2J} + \frac{S}{e-3J} \right].$$

If it is satisfied, then the value of the deviation is,

$$V^0(0) = -\frac{S}{2} - \phi\left(\frac{S/2}{e-2J}\right) - \tau 2J + \delta V^*(\pi)$$

Since the monetary equilibria remains unaltered, the state of the system next period will not change between the equilibrium path to the out of equilibrium path. The profitability condition is,

$$iii) \quad V^*(0) - V^0(0) = \frac{S}{2} - [\phi(\frac{S}{e-2J}) - \phi(\frac{S/2}{e-2J})] > 0 \text{ iff } \frac{S}{2} > [\phi(\frac{S}{e-2J}) - \phi(\frac{S/2}{e-2J})]$$

which is our standard assumption on the cost function except that now $e > 3J$ and hence the inflation rates over which marginal cost are calculated are lower.

A second local deviation is to restrain from asking for subsidies when last period inflation was intermediate. $V^0(\pi)$.

The monetary equilibria will remain the same if $\tau < \frac{S/2}{e-3J}$ which is always true if $i')$ is satisfied. The group value function is then,

$$V^0(\pi) = -\frac{S}{2} - \phi(\frac{S/2}{e-3J}) - \tau 3J + \delta V^*(\pi)$$

which gives a profitability condition:

$$iv) \quad V^*(\pi) - V^0(\pi) = \frac{S}{2} - [\phi(\frac{S}{e-3J}) - \phi(\frac{S/2}{e-3J})] > 0 \text{ iff } \frac{S}{2} > [\phi(\frac{S}{e-3J}) - \phi(\frac{S/2}{e-3J})]$$

Which should now resemble the conditions imposed by theorem 4 (given the relative size of e and $3J$).

Finally, we must check the case when subsidies are demanded following periods of high inflation and hence a stabilization program is not accepted. $V^S(\pi)$. If condition $i')$ holds the costs of operation in a financially adapted economy are low. Hence, individuals will prefer to remain financially adapted or, even more, will fully dollarize. If this is the case, even when only one group demands subsidies, hyperinflation results. But this is infinitely costly, and so the deviation can never be profitable. The conclusion once again is that when the economy gets close to the hyperinflation threshold it will be individually optimal to accept a stabilization program that cuts subsidies for all.

The four conditions established above state that oscillating equilibria of phase three are feasible. In fact, the conditions do not seem to be much more restrictive than those established in theorem 4 in the text.

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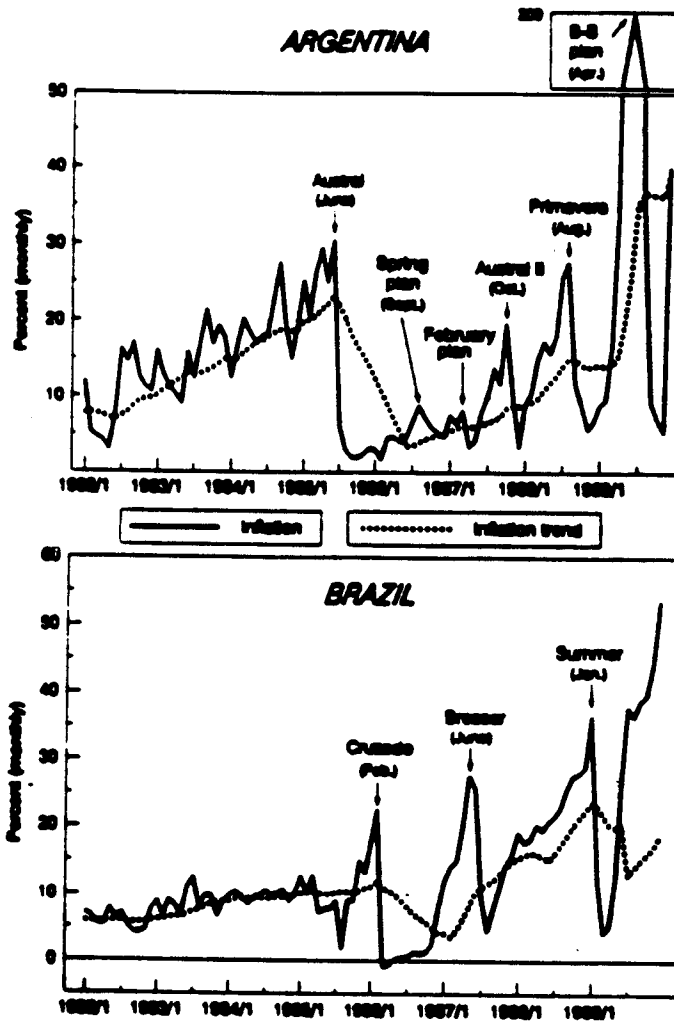
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Fig. 1

Inflation Cycles: Argentina and Brazil



CPI inflation and inflation trend. Sources: Argentina—Indicadores de Coyuntura; Brazil—Conjuntura Econômica. Note: Inflation trend = $CPI / (CPI_{t-1})^{1/12}$.

Source: Kiguel and Liviatan (1991)

Fig. 2

Costs of Financial Adaptation

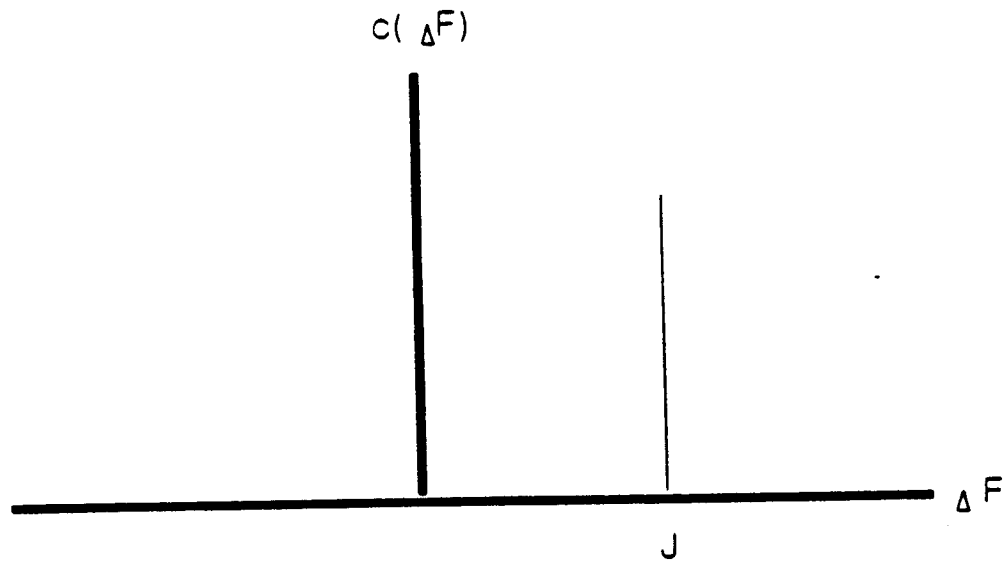


Fig. 3
Equilibria with Steady Inflation
 Linear Cost of Inflation Function $\phi = \alpha \tau$

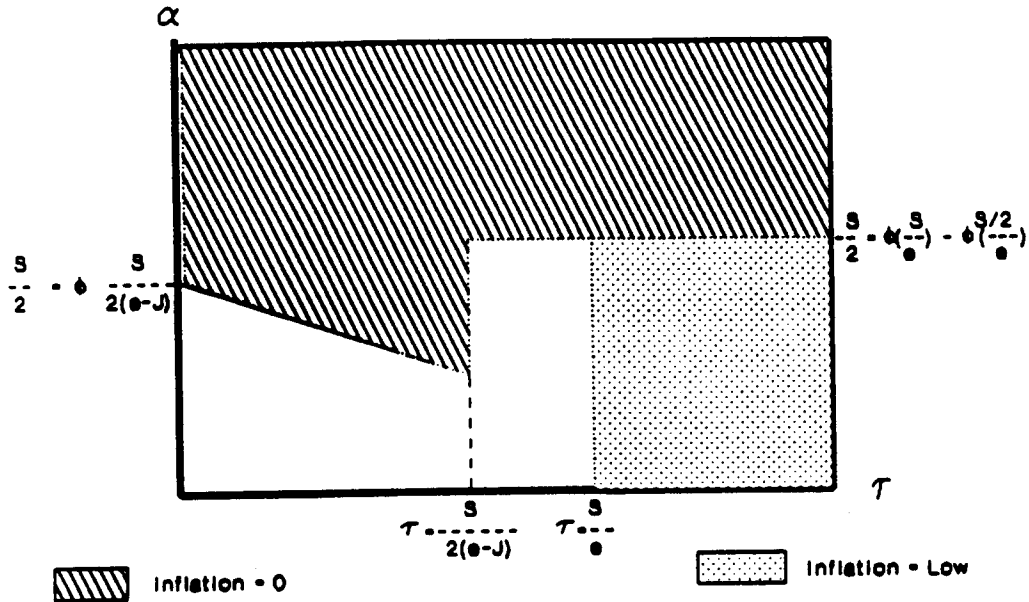


Fig 4
Equilibria with Inflation Cycles

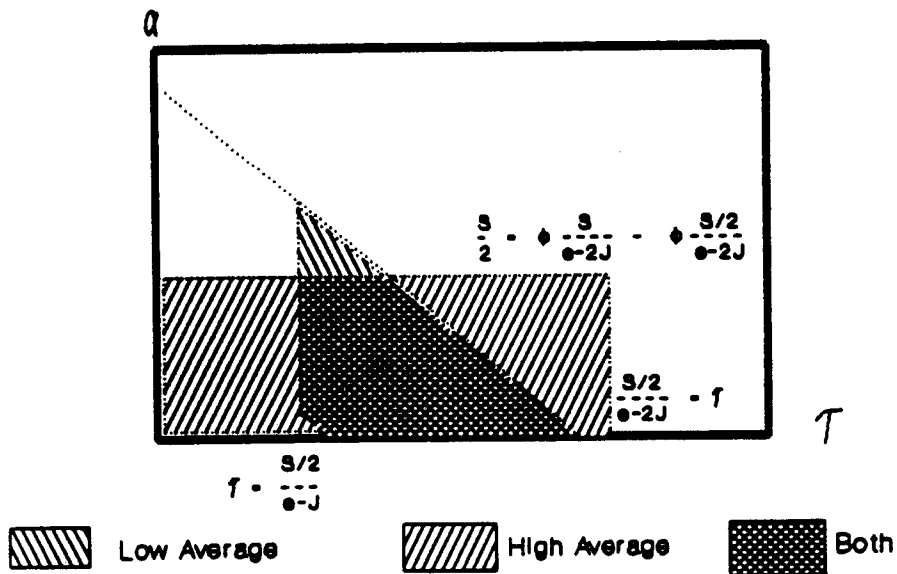


Fig. 5

Alternative Cost of Fin. Adaptation

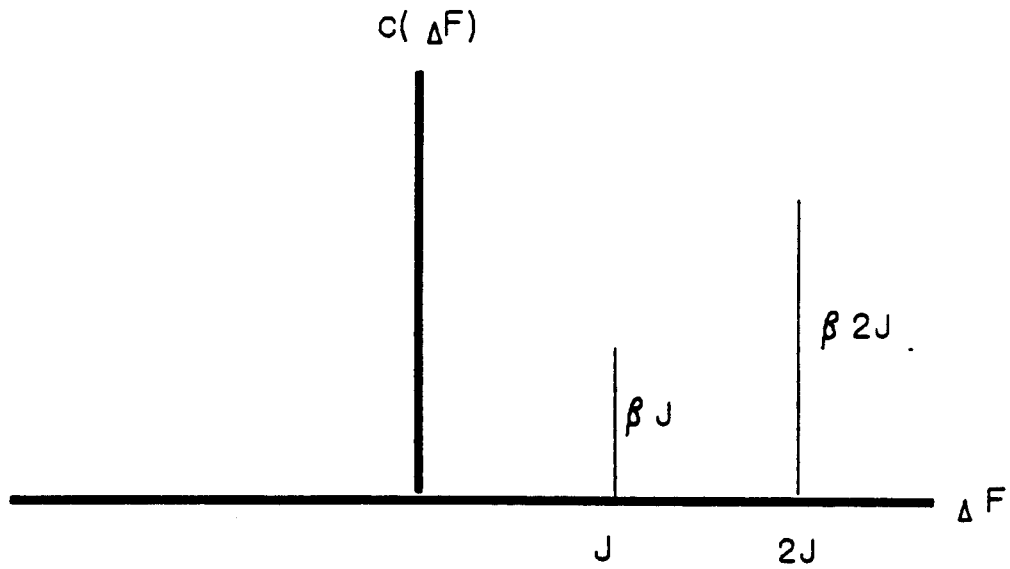


Table 1

Inflation Equilibria

τ

ϕ	Constant $\pi = 0$	Constant $\pi = 0$
	Cycles High Avg Low Avg	Constant $\pi = \text{Low}$