Board of Governors of the Federal Reserve System

International Finance Discussion Papers

Number 402

June 1991

EXCHANGE RATE RULES IN SUPPORT OF DISINFLATION PROGRAMS IN DEVELOPING COUNTRIES

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ABSTRACT

This paper analyzes how exchange rate policies can best support the sustainability of disinflation programs. Freezing the nominal exchange rate frequently has been recommended as a means of suppressing inertial inflation and accelerating the disinflation process. However, because any resultant real exchange rate appreciation often must be corrected through a subsequent devaluation, targeting the nominal exchange rate may merely postpone inflation rather than eliminate it once-and-for-all. This paper argues that because excessive inflation during any particular period may jeopardize the stabilization program, exchange rate policies should be designed to smooth inflation across all phases of the disinflation experience. Toward that end, an initial devaluation followed by partial indexation of the exchange rate to domestic prices may be useful. The paper then considers how inconsistencies between an exchange rate rule and balance-of-payments viability may lead to "reserves crises". Depending upon the credibility of the government's commitment to stabilization, the devaluation prompted by a reserves crisis could trigger additional inflation sufficient to cause the failure of the disinflation program. These considerations underscore the importance of policies that prevent excessive appreciation of the real exchange rate during the disinflation process.

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Steven Kamin[1]

I. Introduction

The reduction of inflation represents one of the most important challenges facing many developing countries today. It is generally agreed that the key to disinflation is the reduction of the government's fiscal deficit. There is less consensus concerning the use of auxiliary policies to accelerate the transition from high to low inflation, or to ensure the sustainability of the disinflation program. Of these policies, the targeting of the exchange rate has been among the most common and the most controversial.[2] Proponents of fixing the nominal exchange rate argue that this policy speeds up the disinflation process, reduces inflationary expectations, and hence raises the probability of program success. Critics of this strategy respond that fixing the nominal exchange rate may give rise to overvaluation of the real exchange rate, balance-of-payments problems, and an eventual corrective devaluation that may destabilize the disinflation program.

1/ The author is a staff economist in the International Finance Division of the Federal Reserve Board. This paper reflects the view of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. I am grateful to Pierre-Richard Agenor, Sean Craig, Linda Goldberg, David Gordon, Dale Henderson, David Howard, Deborah Lindner, Cathy Mann, Ramon Moreno, Athanasios Orphanides, Andrew Rose, Steven Sharpe, Mark Spiegel, Tim Wilson, and Paul Wood for helpful comments and suggestions.

2/ Other policies to control the price level directly, often referred to as "nominal anchors", include wage controls and price controls. See Dornbusch (1988a), as well as Kiguel and Liviatan (1988, 1989).

The recent historical record does not help to evaluate the relative merit of these arguments. Table 1 summarizes the experience of various disinflation programs of the 1980s. Among disinflation programs incorporating nominal exchange rate freezes, Israel's July 1985 program appears to have succeeded in reducing inflation on a sustained basis, while Argentina's June 1985 and July 1989 programs, as well as Brazil's February 1986 program, all failed to achieve a lasting stabilization. Among programs employing either a managed float or a crawling peg aimed at maintaining the competitiveness of the exchange rate, the Bolivian stabilization of August 1985 represents a success, while the Brazilian program of March 1990 apparently has failed. Mexico's December 1987 program included a crawling peg aimed at depreciating the exchange rate by less than the rate of inflation, and appears to be moving toward success. It is still too early to evaluate the most recent programs initiated in Argentina, Yugoslavia, Poland and Peru.

This paper attempts to provide a framework that may be used to evaluate different (managed) exchange rate policies on a systematic basis. The analysis focuses on the optimal degree of indexation of the nominal exchange rate to the domestic price level; two polar cases are given special attention, the strategy of zero indexation, or a nominal exchange rate freeze, and the strategy of complete indexation, or a real exchange rate target. In practice, many governments have devalued the exchange rate prior to freezing it in conjunction with their disinflation program, and this option is also considered. Finally, it is recognized that regardless of the path of the real exchange rate during the transitional period, it eventually must return to its long-run equilibrium level.

Table 1. Some Recent Disinflation Programs

Country	Date Started	% Inflation in Year:[3] (-1)	(0)	(+1)	Exchange Rate Policy
Argentina	6/85	1,189	50	110	Frozen nominal rate
Israel	7/85	446	24	20	Frozen nominal rate
Bolivia	8/85	21,800	198	11	Exchange auction (dirty float)
Brazil	2/86	289	52	481	Frozen nominal rate
Mexico	12/87	159	52	20	Crawling peg at less than rate of inflation
Argentina	7/89	3,610	2,047	219 (May 91/July 90)	Frozen nominal rate
Yugoslavia	1/90	3,296	60	--	Frozen nominal rate
Poland	1/90	1,097	107	--	Frozen nominal rate
Argentina	3/90	20,274	287	--	Dirty float
Brazil	3/90	4,835	416	--	Dirty float
Peru	8/90	2,775	254 (May 91/Aug 90)	--	Dirty float

3/ Consumer inflation, month over year-earlier month. Year (-1) refers to the twelve months prior to program announcement, Year (0) to the twelve months following announcement, and Year (+1) to the following twelve months. Data for partial years are expressed at an annual rate.

To determine which exchange rate policies best support a sustained disinflation, two fundamental questions must be addressed. First, what motivates the disinflation decision? Second, what causes disinflation programs to fail? It is assumed that governments undertake disinflation programs if the benefits of reduced inflation outweigh the costs of reduced seignorage. We argue that programs may fail if high residual inflation during the course of the fiscal stabilization program creates excessive social costs which force the government to abandon the program. This approach follows Dornbusch (1988c) and Orphanides (1989) in attributing the failure of disinflation programs to uncontrollable shocks rather than the time-inconsistency problems underscored by Barro and Gordon (1983). However, the Dornbusch and Orphanides models focus on the impact of external payments shocks in a one-good model where price and exchange rate movements are identical, and therefore are not well suited to analysing the impact of different exchange rate rules on inflation performance and the balance of payments.

In a two-good model, the possibility of high non-tradeables inflation establishes a clear rationale for the use of exchange rates: to manage tradeables prices so as to distribute aggregate inflation evenly across the transition period and hence avoid a concentration of social costs during any one period. Freezing the nominal exchange rate may reduce the chance of program failure initially, but raise it later on when the exchange rate must be devalued to offset a loss in competitiveness. Conversely, full indexation of the exchange rate probably allows too much inflation to occur at the outset of the program, though it effectively dispells any transition problems toward the end of the disinflation process. Some partial degree of exchange rate indexation generally will maximize the probability of program success.

An additional contribution of this paper is an analysis of the relationship between balance-of-payments crises and the abandonment of disinflation programs. Usually, shortfalls in international reserves leading to emergency devaluations are considered to be the consequence, rather than the cause, of inadequate fiscal adjustment. This paper highlights an alternative possibility: high residual inflation may cause a reserves crisis and force a large devaluation, boosting inflation sufficiently to force the abandonment of the fiscal reform program.

Finally, the paper explores the possibility of self-fulfilling expectations of the abandonment of a disinflation program. If a breakdown of the disinflation program is expected, capital flight may trigger a reserves crisis, devaluation, and inflationary surge that could cause the fiscal program to be aborted; conversely, expectations that the fiscal program will be sustained will lead to capital inflows that reduce the probability of a destabilizing reserves crisis. In this context, it is important that the government signal its ability to withstand the political costs of a disinflation program so as to raise its credibility in the eyes of private decision-makers. Actions that shift political costs toward the outset of the program, such as a large preemptory exchange rate devaluation, may be effective in boosting credibility.

The main policy implication of our analysis -- that the exchange rate be managed to avoid excessive real appreciation -- contradicts other game-theoretic analyses of disinflation. Giavazzi and Pagano (1988) and Agenor and Montiel (1991) argue that a commitment to a fixed nominal exchange rate will discipline fiscal policy and hence improve the credibility of the stabilization program. Our view is that the residual inflation typically accompanying a stabilization program may make subsequent devaluations inevitable, regardless of government intent. Moreover, historically many developing countries with inflation problems have demonstrated an apparent predilection for overvalued exchange rates, even outside the context of viable disinflation programs. Hence, it is not clear that committing to a fixed exchange rate will provide much additional discipline and and/or credibility. In fact, the private sectors of these countries have become highly skeptical of supposedly "painless" disinflation plans, so that fixing the nominal exchange rate may be more likely to reduce than enhance the government's credibility.

The plan of the paper is as follows. Section II establishes the motive for disinflation. Section III outlines the basic structure of a disinflation program when no balance-of-payments constraints are present, and discusses the role of exchange rate rules in the breakdown of disinflation programs. Section IV describes the balance of payments and analyzes the determinants of reserves crises. Finally, Section V focuses on the interaction between reserves crises and the breakdown of disinflation programs. Section VI concludes.

II. The Decision to Disinflate

II.1 Determination of Steady-State Inflation

In the steady state, price inflation equals the rate of monetary growth needed to finance the fiscal deficit[4]:

$$\hat{P} = \hat{M} = (-S)V \qquad (1)$$

$\hat{P}$: price inflation (log-change in P)

$\hat{M}$: monetary growth (log-change in M)

S: fiscal surplus-to-GDP ratio

V: velocity, or GDP-to-money ratio

Equation (2) describes the determination of the fiscal surplus as a share of GDP. It incorporates the inverse "Tanzi effect" relation between tax revenues and inflation.

$$S = T - \bar{G} = \bar{T} - \tau\hat{P} - \bar{G} \qquad (2)$$

S: fiscal surplus-to-GDP ratio

T: taxes-to-GDP ratio

$\bar{T}$: taxes-to-GDP ratio when inflation equals zero

$\bar{G}$: spending-to-GDP ratio

τ: response of tax-to-GDP ratio to inflation

Define the structural surplus $\bar{S}$ as that surplus that would prevail in the context of zero inflation:

4/ It is assumed that the deficit is financed exclusively by money creation. Therefore,

$$\hat{M}_t = (M_t - M_{t-1})/M_{t-1} = \text{deficit}_t/M_{t-1} \approx \text{deficit}_t/M_t$$
$$= (\text{deficit/GDP})(\text{GDP}/M) = (-S)V$$

$$\bar{S} = \bar{T} - \bar{G} = S + \tau\hat{P} \qquad (3)$$

Steady-state inflation therefore depends upon the structural surplus (or deficit), velocity, and the magnitude of the Tanzi effect:

$$\hat{P} = (-\bar{S})V/(1-\tau V) \ , \qquad \tau V < 1 \qquad (4)$$

II.2 The social loss function and the disinflation decision

The decision to initiate a disinflation program is based upon the perception that the benefits to exploiting seignorage are outweighed by the costs of the resultant inflation. Equation (5) describes a stylized loss function which may be thought of as representing society's rational preferences, but which at a minimum may be correlated with the political fortunes of the government in power. Like most governments, the one envisioned here dislikes inflation (with weight λ) but also dislikes running structural fiscal surpluses (with weight $(1-\lambda)$), since large fiscal surpluses require higher tax rates and/or lower expenditures than smaller (or negative) surpluses.[5]

$$L = \lambda\hat{P} + (1-\lambda)\bar{S} \qquad (5)$$

Taking the dependence of inflation on the fiscal stance into account, losses as a function of the structural surplus are derived:

5/ The structural surplus $\bar{S}$ is included in the loss function rather than the overall surplus S since governments usually do not enjoy the political benefits resulting from lower tax revenues when these are caused by inflation rather than a lowering of official tax rates.

$$L = \bar{S}[\ (1-\lambda) - \lambda V/(1-\tau V)\ ] \qquad (6)$$

Under a zero-inflation, zero-deficit policy, social losses are exactly zero. A government with a positive deficit and positive inflation will only disinflate if losses under the inflationary regime exceed zero.[6] This will be true if the following condition holds:

$$(1-\lambda)/\lambda < V/(1-\tau V) \qquad (7)$$

The more social weight placed on the cost of inflation relative to the fiscal balance, and the more inflation associated with a given fiscal balance, the greater incentive the government will have to disinflate.

III. Fiscal Breakdown with Unlimited Reserves

If the steady-state relation between inflation and the fiscal surplus described in equation (4) held at all points in time, the disinflation process would be costless. Governments would move instantaneously from the high-deficit, high-inflation steady state with social losses as described in equation (5) to a zero-deficit, zero-inflation steady state with zero social losses. Disinflation programs, once initiated, would always succeed.

6/ This paper does not address the thornier issue of why the government implemented inflationary policies in the first place. It would be roughly consistent with the experience of many countries to assume that disinflations take place when new governments take power that better represent the interests of their constituency than the inflationary governments they replace. More realistically, it may take time for populations to acertain the full negative consequences of inflation.

The following analysis focuses upon inflationary inertia as an explanation for program failure: following elimination of the fiscal deficit, non-tradeables prices may continue rising for some indefinite transition period. This leads to social losses both directly, through the weight placed on inflation in the social welfare function, and indirectly, by forcing the government to run a positive structural budget surplus in order to maintain a zero overall budget deficit. These social losses, in turn, could be great enough to force the abandonment of the disinflation program. It is this possibility that motivates the use of exchange rate policy to contain the prices of tradeable goods, thereby repressing aggregate inflation below what it otherwise would be.

III.1 <u>Basic framework for the disinflation program</u>

A small open economy is assumed, with the price of tradeables in domestic currency fixed by exogenous world prices and the exchange rate. The aggregate price level is a geometric weighted average of the prices of tradeable and non-tradeable goods, as indicated below. For convenience, the world price PT^* is set to unity.

$$P = PN^{\alpha}PT^{(1-\alpha)} = PN^{\alpha}(E*PT^{*})^{(1-\alpha)} = PN^{\alpha}E^{(1-\alpha)} \qquad (8)$$

P : aggregate price level

α : share of non-tradeables in consumption

PT : tradeables price in domestic currency

PT^*: tradeables price in foreign currency

PN : non-tradeables price in domestic currency

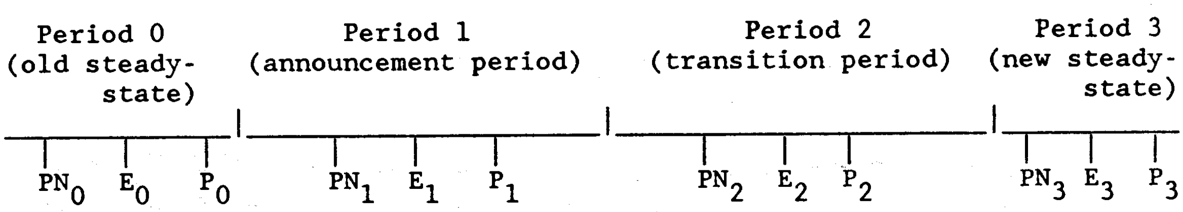
E : exchange rate (domestic currency per dollar)

Aggregate price inflation is therefore determined:

$$\hat{P} = \alpha\hat{PN} + (1-\alpha)\hat{E} \tag{9}$$

A key focus of the analysis will be the path of aggregate inflation across the transition period between the initial high-inflation state and the eventual zero-inflation state. Figure 1 identifies four sequential periods associated with the disinflation program. These are discussed in turn below.

Figure 1



Period 0 Period 0 represents the pre-program, inflationary steady state. In this steady state, non-tradeables prices grow at the rate of monetary growth Z dictated by the need to finance a steady-state fiscal deficit $(-S_0)$ associated with a steady-state structural deficit $(-\bar{S}_0)$. The exchange rate is assumed to be depreciated, using a crawling peg, at the same rate, so that overall inflation is also Z:

$$\hat{P}_0 = \hat{PN}_0 = \hat{E}_0 = \hat{M}_0 = (-S_0)V_0 = Z \tag{10}$$

Period 1 Period 1 is the announcement period for the disinflation program. As indicated in Figure 1, it is assumed that non-tradeables prices are set at the start of each period. PN_1 is determined while the economy is still in the inflationary steady state, so that $\hat{PN}_1 = \hat{PN}_0 = Z$. It is assumed that immediately following the determination of non-tradeables prices, the government announces its disinflation program. The program consists of both a fiscal adjustment policy and an exchange rate policy.

The fiscal adjustment policy represents a commitment to set the fiscal deficit to zero starting in the next period: $S_2 = S_3 = 0$. Because of the negative Tanzi effect of inflation on real tax revenues, a fiscal adjustment during the announcement period would be difficult and perhaps infeasible. We assume (somewhat arbitrarily) that the government maintains the same deficit ($-S_0$) in Period 1 that it maintained in Period 0.

The exchange rate policy consists of three elements:

(1) The Period 1 exchange rate is set so that $\ln(E_1/PN_1) = \sigma$. It is assumed that if $E_1 = PN_1$, the trade account is balanced, and that the authorities have kept $E = PN$ during the prior inflationary state. Therefore, $\sigma > 0$ represents an initial undervaluation of the real exchange rate.

(2) The Period 2 exchange rate will be set so that $\hat{E}_2 = \phi \hat{PN}_2$. As noted in the introduction, $\phi=0$ implies a fixed nominal exchange rate, $\phi=1$ implies a fixed real exchange rate.

(3) The Period 3 exchange rate will be set so that $E_3 = PN_3$. This is necessary to ensure a balanced trade account during the zero-inflation steady-state.[7]

7/ If the country in question has access to sustained capital inflows, it may want to set the exchange rate in the new steady state so as to equate its trade or current account deficit to these inflows.

Based on non-traded goods inflation of Z and the government's choice of exchange rate undervaluation σ, aggregate inflation during Period 1 is as follows:

$$\hat{P}_1 = Z + (1-\alpha)\sigma \tag{11}$$

Period 2 In Period 2, the fiscal program is put into effect, and the exchange rate is adjusted in accordance with the indexing rule announced in Period 1. The sole uncertainty faced by the government in this model is the behavior of non-tradeables prices. This uncertainty is the result of various factors. First, if non-tradeables prices primarily reflect wage costs, then to the extent that some proportion of wages paid in Period 2 are contracted prior to the announcement of the disinflation program in Period 1, average wage growth and hence price growth in Period 2 are likely to be non-zero; in the absence of exact information on the proportion of wages that are contracted in advance, the amount of this spillover will be uncertain. Second, the dynamics of the relationship between prices and monetary growth are not likely to be well understood. While in the steady state we expect price growth to equal monetary growth, it is not clear that a cessation in monetary growth will lead to the elimination of inflation in the same period.

To reflect the government's prior uncertainty about the magnitude of residual inflation during the transition period, it is assumed that $\hat{PN}_2$ is a random variable with maximum value less than Z, the prior rate of inflation. Following the non-tradeables price outcome in Period 2, the government sets the exchange rate according to its indexing rule, which then completes the determination of aggregate inflation $\hat{P}_2$, as shown below:

$$\hat{P}_2 = \alpha\hat{PN}_2 + (1-\alpha)\hat{E}_2 \quad = \hat{PN}_2(\alpha + (1-\alpha)\phi) \tag{12}$$

In order to achieve a fiscal deficit of zero, the government must run the following positive structural fiscal surplus:

$$\bar{S}_2 = S_2 + \tau\hat{P}_2 = 0 + \tau\hat{P}_2 = \tau\hat{PN}_2(\alpha + (1-\alpha)\phi) \tag{13}$$

<u>Period 3</u> Period 3 is defined to be the post-inflationary steady state, by which time all transition dynamics for non-tradeables prices have worked themselves out and non-tradeables price growth has adjusted to the no-growth monetary regime. Accordingly, non-tradeables inflation in Period 3 is zero, and any aggregate inflation will reflect a one-time devaluation of the exchange rate needed to restore the real exchange rate to unity. The greater the degree of initial undervaluation σ and the closer to unity the indexing ratio ϕ, the lower Period 3 inflation will be, as shown below:

$$\hat{P}_3 = \alpha\hat{PN}_3 + (1-\alpha)\hat{E}_3 \quad = \quad (1-\alpha)(\ (1-\phi)\hat{PN}_2 - \sigma) \tag{14}$$

Any devaluation of the exchange rate that keeps aggregate inflation above zero will also force the government to run continued structural budget surpluses:

$$\bar{S}_3 = \tau(1-\alpha)(\ (1-\phi)\hat{PN}_2 - \sigma) \tag{15}$$

III.2 Fiscal program breakdown

Consider the possibility that as a result of an exceptionally high outcome for non-tradeables inflation in Period 2, inflation in either Period 2 or Period 3, depending upon the exchange rate rule, is high enough so that social losses rise above some threshold level $\bar{L}$:

$$\begin{aligned} L_t &= [\lambda \hat{P}_t + (1-\lambda)\bar{S}_t] \qquad t = 2 \text{ or } 3 \qquad (16) \\ &= [\lambda \hat{P}_t + (1-\lambda)\tau \hat{P}_t] \\ &= [\lambda + (1-\lambda)\tau]\hat{P}_t \quad > \quad \bar{L} \end{aligned}$$

The threshold level $\bar{L}$ may reflect some absolute maximum amount of austerity the government's constituency is willing to endure before attempting to replace the government. Alternatively, it may reflect a rational, maximizing decision on the part of the government, which must weigh the cost of carrying through with the program against the cost of abandoning the fiscal balance objective and attempting to initiate the disinflation program from scratch in a subsequent period. (See Orphanides, 1989.)

In either case, we can define a maximum or threshold inflation rate $\bar{\hat{P}}$ such that inflation in excess of that rate triggers a fiscal breakdown, that is, an abandonment of the disinflation program and a return to the fiscal stance that prevailed prior to the initiation of the program:[8]

$$\bar{\hat{P}} = \frac{\bar{L}}{[(\lambda + (1-\lambda)\tau)]} \qquad (17)$$

We can also define the probability that no fiscal breakdown occurs in a particular period as the probability that overall inflation in that period is less than $\bar{\hat{P}}$.

$$\rho_t = \text{prob}(\hat{P}_t < \bar{\hat{P}}) \qquad t = 2,\ 3 \qquad (18)$$

Increases in the populace's (or government's) loss threshold $\bar{L}$ will lower the probability of fiscal breakdown, while increases in λ, the weight of inflation in the loss function, or in τ, the responsiveness of the fiscal deficit to inflation, will raise the probability of such a breakdown.

8/ In the case where the loss threshold reflects an absolute maximum degree of austerity endurable by the population, both $\bar{L}$ and $\hat{P}$ are likely to be the same for Periods 2 and 3. For simplicity, this assumption is maintained in the analysis that follows. Alternatively, if $\bar{L}$ is calculated based on rational, intertemporal, maximizing criteria, it is likely to be higher in Period 3 than in Period 2. This is because in Period 2, policymakers know some further adjustment effort must be undertaken in Period 3 before the zero inflation steady-state is to be achieved, and that cost must be considered in addition to the cost of maintaining the program in Period 2. On the other hand, by Period 3, the Period 2 adjustment costs have already been born, and only Period 3 adjustment costs must be considered.

The probability that no fiscal breakdown occurs in Period 2 is a straightforward function of the level of non-tradeables inflation in Period 2 and the government's announced exchange rate rule:

$$\rho_2 = \text{prob}(\hat{P}_2 < \bar{P}) = \text{prob}(\ \hat{PN}_2 < \bar{P}/(\alpha + (1-\alpha)\phi)\ ) \tag{19}$$

The probability of no fiscal breakdown in Period 3 is derived analogously:

$$\rho_3 = \text{prob}(\hat{P}_3 < \bar{P}) = \text{prob}(\ \hat{PN}_2 < \bar{P}/((1-\alpha)(1-\phi)) + \sigma/(1-\phi)\ ) \tag{20}$$

Note that the indexing ratio ϕ does not alter the cumulative inflation rate for Periods 2 and 3, but merely shifts inflation between the two periods. A fixed nominal exchange rate rule (ϕ=0) minimizes inflation and therefore increases the chance of program success in Period 2, but at the cost of higher depreciation, higher inflation, and a higher likelihood of fiscal breakdown in Period 3. Conversely, a fixed real exchange rate rule (ϕ=1) raises the probability of program failure in Period 2 but reduces this probability to zero in Period 3, should the program make it that far.

To reach the zero-inflation steady state, fiscal breakdown must be avoided in both Period 2 and Period 3. It is straightforward to show that maximizing the probability of overall program success requires equalizing the probability of success in both periods, which in turn requires equalizing the expected inflation rate in both periods. For a given level of σ, the initial undervaluation of the exchange rate, the optimal degree of exchange rate indexation ϕ^* is determined:

$$\phi^* = 1/2[\ 1 - \alpha/(1-\alpha) - \sigma/\hat{PN}_2^e\ ] \tag{21}$$

As we can see, the value of ϕ that minimizes the probability of fiscal breakdown in both periods is less than 1 for all positive and some negative values of the initial undervaluation ratio σ. Thus, fixing the real exchange rate may not be optimal, and some degree of real exchange rate slippage may be useful in laying the basis for program success. On the other hand, the fixed nominal exchange rate strategy ($\phi = 0$) is not necessarily optimal either. For example, if the extent of real exchange rate overvaluation in Period 1 is set at one-third the expected nontradeables inflation in Period 2 ($\sigma/\hat{PN}_2^e = 1/3$), and non-tradeables represent one-third the consumption basket[9] ($\alpha = 1/3$), the success-maximizing indexing ratio ϕ^* will be exactly 1/12. If no exchange rate undervaluation is provided for in Period 1 ($\sigma = 0$), the optimal indexing ratio rises to 1/4.

Given the choice of success-maximizing ϕ^* as shown in equation (21), equation (22) indicates the resultant level of expected inflation in each period:

9/ For purposes of simplicity, we have assumed in this paper that the prices of non-tradeables are not influenced by the value of the exchange rate. Generally, however, these prices are influenced by exchange rate changes, both because these changes affect the cost of imported inputs, and because exchange rates often are used as guides to price-setting in high inflation economies. A more sensitive interpretation of α, therefore, would be to regard it as the share of goods whose prices may exhibit some inertial behavior independent of exchange rate movements. This share may be significant, but most likely well under 50 percent.

$$\hat{P}^e_t = [\ \hat{PN}^e_2 - \sigma(1-\alpha)\ ]/2 \qquad t = 2,3 \tag{22}$$

The greater the initial undervaluation of the exchange rate σ, the lower will be the inflation rate during the transition period and the greater the probability of program success. However, depreciating the exchange rate in Period 1 raises the inflation rate in that period and therefore raises social losses in that period above the level L_0 that prevailed in the pre-program steady state.

To maximize the probability of program success, the government should depreciate the exchange to the maximum extent consistent with the social loss ceiling $\bar{L}$. The higher the initial level of social losses L_0, the smaller will be the scope for additional loss creation associated with optimal undervaluation of the exchange rate σ^*:

$$\sigma^* = \frac{\bar{L} - L_0}{(1-\alpha)[\lambda + (1-\lambda)\tau]} \tag{23}$$

IV. Reserves Crises During Disinflation Programs

When the government does not have unlimited access to foreign exchange, excessive inflation during the transition period could cause a balance-of-payments or reserves crisis that forces the government to devalue the exchange rate by more than initially planned. This, in turn, could generate higher inflation and therefore jeopardize the fiscal program. For ease of exposition, Sections IV.1 and IV.2 develop a model of foreign exchange reserve crises under the assumption that no breakdown of the fiscal program may occur. This assumption is relaxed in Section IV.3, which focuses on the possibility that a reserves crisis may be induced by anticipations of a fiscal breakdown.

IV.1 The Balance of Payments

The government is assumed to enter the announcement period, Period 1, with a supply of international reserves R_0, measured in dollars, inherited from the previous period. (These reserves might be actual foreign exchange holdings, or could represent a quantity of credit to which the country has access during the duration of the disinflation program.) In Periods 1, 2, and 3, this stock is altered by the sequence of trade balances and capital accounts in those periods.

$$R_t = R_{t-1} + TB_t + KA_t \tag{24}$$

R : reserves in dollars

TB: trade balance in dollars

KA: capital account in dollars

Ignoring lags and other plausible complications, the trade balance is assumed to depend only upon the real exchange rate:

$$TB = \beta \ln(E/PN) \tag{25}$$

The government is assumed to peg the exchange rate without exchange restrictions. To derive the capital account, a highly stylized view of the public's demand for foreign assets is exploited; it is assumed to depend only upon the expected rate of exchange rate depreciation between the current and the following period:

$$F_t = \psi(\hat{E}^e_{t+1}) \tag{26}$$

F : public's demand for foreign assets

$\hat{E}^e_{t+1}$: expected exchange rate depreciation as of time t

Assuming that no foreigners hold domestic assets or claims on private citizens, the capital account is then the negative of the change in the public's demand for foreign assets:

$$KA_t = -(F_t - F_{t-1}) = -\psi(\hat{E}^e_{t+1} - \hat{E}^e_t) \tag{27}$$

Given the exchange rate rules adopted by the government in Period 1, its resultant reserve position at the end of Period 1 is as follows:

$$R_1 = R_0 + TB_1 + KA_1 \tag{28}$$

$$= R_0 + \beta\sigma - \psi(\hat{E}^e_2 - \hat{E}^e_1)$$

$$\hat{E}^e_1 = Z$$

$$\hat{E}^e_2 = \rho'\phi\hat{PN}^e_2 + (1-\rho')\hat{E}'^e_2$$

Note that $\hat{E}^e_1$ is equal to the pre-program rate of inflation and exchange rate depreciation Z, since it was formed in Period 0, before the announcement of the disinflation program. $\hat{E}^e_2$, the rate of exchange rate depreciation in Period 2 expected in Period 1, represents the weighted average of two possibilities. With probability ρ', no balance-of-payments crisis will occur and the government will devalue the exchange rate in accordance with its indexing rule ϕ. With probability $(1-\rho')$, a balance-of-payments crisis will occur, forcing the government to devalue the exchange rate by $\hat{E}_2'$; both the probability of a balance-of-payments crisis and the size of the resultant devaluation will be derived below.

Since expected non-tradeables inflation in Period 2 is assumed to be less than Z, expected exchange rate depreciation in Period 2 will be less than Z, even in the case of a fully indexed exchange rate or in the event of a balance-of-payments crisis. Therefore, the government should experience capital inflows during Period 1.[10] It is only in Period 2 that the possibility of reserve losses arises. As equation (29) indicates, reserve losses through the trade account may develop if non-tradeables inflation in Period 2 is sufficiently high, and the indexing ratio sufficiently low, so as to more than offset the initial undervaluation of the exchange rate established in Period 1:

$$TB_2 = \beta \ln(E_2/PN_2) = \beta(\sigma - (1-\phi)\hat{PN}_2) \tag{29}$$

Equation (30) indicates the capital account in Period 2, assuming that no balance-of-payments crisis occurs. As equation (30) indicates, reserve

10/ Capital inflows have been common at the outset of many disinflation programs. (See Fischer, 1986, Dornbusch, 1988b) Note that these programs don't necessarily need to be fully credible, as evidenced by the positive pattern of capital movements in Argentina following the announcement of abortive disinflation programs in both August 1988 and July 1989. As long as the disinflation is perceived to be sustainable for some amount of time, albeit temporary, private speculators will seek to exploit high rates of return prevailing on domestic-currency assets.

losses through the capital account occur if real exchange rate appreciation in Period 2 creates the need for a devaluation in Period 3, in order to make the exchange rate competitive, which leads to an increase in the demand for foreign assets in Period 2:

$$KA_2 = -\ \psi(\hat{E}^e_3 \ - \hat{E}^e_2) = -\ \psi(\ (1-\phi)\hat{PN}_2 \ - \sigma \ - [\rho'\phi\hat{PN}^e_2 + (1-\rho')\hat{E}'_2]\ ) \tag{30}$$

Adding the Period 2 trade balance and capital account to reserve levels in Period 1 and re-arranging:

$$R_2 = R_0 + 2\beta\sigma + \psi(Z + \sigma) \ - (\beta + \psi)(1-\phi)\hat{PN}_2 \tag{32}$$

IV.2 <u>Reserves Crises With No Fiscal Breakdowns</u>

Examination of equation (32) indicates that for sufficiently high non-tradeables inflation in Period 2, and sufficiently low indexing, reserves could fall below zero in Period 2. We can define $\hat{PN}'_2$ to be that level of inflation that sets reserves exactly equal to zero; inflation rates in excess of that level will force a reserve crisis.

$$\hat{PN}'_2 \ = \ 1/(1-\phi)\lceil\ \sigma + (R_0 + \beta\sigma + \psi Z)/(\beta + \psi)\ \rceil \tag{33}$$

Analogously, the probability that no reserve crisis occurs is determined:

$$\rho' = \text{prob}(\hat{PN}_2 < \hat{PN}'_2) \tag{34}$$

If $\phi = 1$, the threshold inflation rate will be infinity and the probability of a reserves crisis will be zero. Conversely, for $\phi = 0$, we can define the minimum possible threshold inflation rate: $\sigma + (R_0 + \beta\sigma + \psi Z)/(\beta + \psi)$; this will be consistent with a maximum probability of a rserves crisis. Note that this rate must exceed the initial undervaluation of the exchange rate in Period 1, and is higher, the higher are initial reserve stocks R_0 and initial inflation Z.

In response to a reserves crisis of the sort described above, the government will be forced to violate its pre-announced exchange rate rule and devalue by a greater amount than that implied by the indexing ratio. While the government might identify any number of exchange rate targets in the event of a reserves crisis, its most straightforward policy would be to devalue the exchange rate sufficiently to achieve 0 (or some other minimum level of) reserves in Period 2. This minimum amount of devaluation $\hat{E}'_2$ can be shown to equal:

$$\hat{E}'_2 = \hat{PN}_2 - \sigma - (R_0 + \beta\sigma + \psi Z)/(\beta + \psi) \qquad (34)$$

IV.3 <u>Reserves crises with anticipated fiscal program breakdown</u>

The preceding analysis demonstrated that even in the context of a completely sustainable disinflation program, excessive transitional inflation could lead to a reserves crisis. We now show that the anticipation of a fiscal breakdown makes a reserves crisis even more likely. Subsequently, in Section V, we analyze the reverse possibility, that a reserves crisis could lead to the breakdown of an otherwise sustainable fiscal program.

Note that the only source of uncertainty in the model is non-tradeables inflation in Period 2. Therefore, following the realization of $\hat{PN}_2$, it will be evident whether or not the disinflation program will be sustained. Because the transitional phase of a disinflation program is more costly than either a high- or a low-inflation equilibrium, we assume that a government faced with the failure of its program in Period 3 will abort its program in Period 2 and return to its initial structural deficit S_0.

Without commiting ourselves to a particular specification of the dynamics linking monetary growth and non-tradeables prices, denote non-tradeables inflation in Period 3, conditional on a fiscal program breakdown in Period 2, by $\hat{PN}_3^f > 0$. We assume that in the event of a fiscal breakdown, the government adheres to its commitment to adjust the real exchange rate to its trade-balancing level in Period 3 ($E_3 = PN_3$). Therefore, anticipated exchange rate depreciation in Period 3 will be higher than it would be otherwise, and this means capital outflows in Period 2 will be higher (or capital inflows lower) as well.

We can repeat the analysis presented in Sections IV.1 and IV.2 to determine how the anticipation of a resumption of inflation in Period 3 will affect the likelihood of a reserves crisis in Period 2, as well as the magnitude of the resultant devaluation in that period. Skipping to the solution, equation (46) below indicates that the threshold non-tradeables inflation rate for a reserve crisis will be lower in the event of a fiscal program breakdown than in the case where the disinflation program is assumed to be sustainable; this effect is more marked, the higher is anticipated Period 3 inflation $\hat{PN}_3^f$. Thus, the anticipation of a fiscal program breakdown raises the probability of balance-of-payments problems. At the same time, the breakdown of the disinflation program raises the extent of devaluation necessary to keep reserves above zero, as indicated in equation (47).

$$\hat{PN}_2'^{f} = 1/(1-\phi)\left[\sigma + (R_0 + \beta\sigma + \psi(Z-\hat{PN}_3^{f}))/(\beta + \psi)\right] \tag{46}$$

$$< \hat{PN}_2'$$

$$\hat{E}_2'^{f} = \hat{PN}_2 - \sigma - (R_0 + \beta\sigma + \psi(Z-\hat{PN}_3^{f}))/(\beta + \psi) \tag{47}$$

$$> \hat{E}_2'$$

V. Reserve Crises, Fiscal Breakdown, and Credibility

The results described above constitute one explanation for the frequent coincidence of substantial exchange rate depreciation with the breakdown of fiscal stabilization programs. Alternatively, it is possible that reserves crises, by causing greater devaluation and inflation than initially anticipated, might trigger the abandonment of otherwise sustainable fiscal programs. Section V.1 explores this possibility in the case where the government's loss function is known by the private sector. In Section V.2, this assumption is relaxed, and the importance of government credibility is underscored.

V.1 Fiscal Breakdown with Symmetric Information

To identify the specific impact of a reserve crisis on the disinflation program, assume that in the absence of a reserves crisis, the program would succeed, that is, $\hat{P} < \bar{\hat{P}}$ in both periods. Note that a brakdown of the government's exchange rate rule caused by a reserves crisis will not necessarily lead to a fiscal breakdown. Recalling that $\hat{E}_2'$ represents the devaluation of the exchange rate in Period 2 in response to a reserve crisis, we express the condition for this possibility:

$$\hat{P}_2 = \alpha\hat{PN}_2 + (1-\alpha)\hat{E}'_2 \tag{43}$$

$$= \hat{PN}_2 - (1-\alpha)[\sigma + (R_0 + \beta\sigma + \psi Z)/(\beta + \psi)]$$

$$< \bar{\hat{P}}$$

If the inequality in equation (43) is reversed, however, then the additional devaluation triggered by the reserve crisis will cause sufficient inflation to induce the abandonment of the fiscal program. In essence, the reserve crisis interrupts the policymakers' plan to smooth inflation across Periods 2 and 3, shifting enough inflation toward Period 2 to raise that inflation above the threshold rate $\bar{\hat{P}}$. It is this possibility that highlights the importance of sufficient reserve stocks, or access to foreign loans, at the outset of a stabilization program. As in the case where the government has unlimited access to foreign reserves, this possibility also affirms the importance of undervaluing the exchange rate in Period 1, both to reduce the probability of a reserve crisis and to reduce the extent of devaluation required if a crisis does occur.

Discussions of inflation stabilization often focus upon the importance of expectations of program success to the actual success of the program. Our analysis shows that under some circumstances, expectations of program success can indeed be crucial; specifically, it is possible that for the same rate of Period 2 non-tradeables inflation, expectations that the fiscal program will be maintained will result in the maintenance of the program, while expectations that the fiscal program will fail will lead to a devaluation sufficient to derail the program in Period 2.

The equations below summarize the conditions underlying this possibility. Equations (48a) and (48b) establish that in the absence of a reserve crisis, the fiscal program will succeed. Equation (48c) establishes that if no fiscal breakdown is expected, the minimum degree of devaluation needed to keep reserves above zero is compatible with fiscal program maintenance in Period 2. Finally, equation (48d) establishes that if a fiscal program breakdown in expected in Period 3, the devaluation needed to offset additional capital outflows resulting from this expectation will push inflation over the fiscal threshold level in Period 2.

$$\hat{PN}_2(\alpha + (1-\alpha)\phi) < \bar{\hat{P}} \tag{48a}$$

$$(1-\alpha)(\hat{PN}_2(1-\phi) - \sigma) < \bar{\hat{P}} \tag{48b}$$

$$\alpha\hat{PN}_2 + (1-\alpha)\hat{E}_2' < \bar{\hat{P}} \tag{48c}$$

$$\alpha\hat{PN}_2 + (1-\alpha)\hat{E}_2'^{f} > \bar{\hat{P}} \tag{48d}$$

These equations confirm the possibility of dual rational equilibria associated with self-fulfilling expectations of either program failure or program success.[11] Which equilibrium will occur? There is no obvious answer. However, it is possible that if the government maintains the fiscal program and either adheres to its announced exchange rate rule, or devalues by no more than $\hat{E}_2'$ in the event of a reserves crisis, it will be apparent to the public sector that the fiscal program will be maintainable in Period 3, and they will adjust their capital outflows accordingly.

V.3 Credibility and fiscal program breakdown

So far, our analysis assumes that once Period 2 inflation is revealed, all uncertainty about the sustainability of the disinflation program is removed, with the possible exception of the case in which multiple equilibria are possible. In practice, uncertainties about program success are likely even when the objective macroeconomic situation is believed to be fairly predictable in the short run. The literature on time-inconsistent policy (see, for example, Barro and Gordon, 1983) highlights the government's incentive to create "surprise" inflation as the source of this uncertainty. In the analysis below, we consider an alternative possibility, that uncertainties about the sustainability of the program reflect the private sector's ignorance concerning the amount of pain the government is willing to endure in its effort to reduce inflation.

11/ Blejer and Ize (1989) use a model of multiple expectational equilibria much like this to explain the decline of investment spending in Latin America. In their model, a low perceived probability of program success leads to low investment, which in turn increases the adjustment effort required to complete the program. However, the higher the adjustment effort required, the lower the probability the government will be able to bear the social cost of adjustment. Hence, investor expectations concerning the economy's prospects can be self-fulfilling.

Assume the private sector does not know the exact level of $\bar{L}$, the maximum social losses the government is willing to sustain, and therefore $\bar{\hat{P}}$, the threshold inflation rate for fiscal program breakdown. If the government lacks credibility, in the sense that the private sector's estimate of $\bar{\hat{P}}$ is considerably lower than the government's, the government's attempt to choose the successful equilibrium can fail: excessive capital outflows in Period 2 can force the government to devalue by more than it intended to initially, thereby triggering higher inflation and abandonment of the fiscal program in that period.

Consequently, it is in the government's interest to implement measures that will raise the private sector's estimates of $\bar{L}$, thereby raising their estimates of $\bar{\hat{P}}$ and increasing their confidence in the program's eventual completion. One way to do this would be to implement painful measures at the outset of the program to convince the private sector that the government is willing to endure more pain than they initially anticipated. That is, if the private sector estimates the government's loss threshold (maximum endurable losses) to be $\bar{L}^e$, and the government takes actions that raise its losses above $\bar{L}^e$ while continuing to implement the fiscal adjustment program, this will force the private sector to revise upwards its estimates of the government's loss threshold.[12]

12/ In a game-theoretic context, this would be an example of a "separating equilibrium" in which a government with a high tolerance for social cost signals this characteristic to the private sector by taking actions that a government with a lower pain threshold would not take.

(Footnote continues on next page)

Because of the high visibility of the exchange rate, the choice of exchange rate rule may be important to establishing the government's reputation. Raising the degree of initial undervaluation σ clearly will work in the direction of raising the government's credibility, since that measure is implemented and the associated social cost is experienced in Period 1.[13] Announcement of a high indexing ratio ϕ may also be an effective way of raising the government's credibility, since a high value for ϕ will raise inflation and hence the government's political losses in Period 2. To some extent, of course, announcement of a high indexing ratio ϕ may not be fully convincing, since the government will not be able to demonstrate that it can live with the consequences of that policy until Period 2 is completed. However, a government that plans to endure necessary adjustment costs early on presumably will generate greater confidence than a government that plans to push these costs as far into the future as possible.[14]

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Rodrik (1989) presents a thorough discussion of signalling issues in policy reform programs. Kiguel and Liviatan (1990) discuss signaling issues connected specifically with the disinflation process.

13/ This is consistent with Rodrik's (1989) recommendation that governments pursue excessive adjustments at the beginning of the program to establish their "reformist" character.

14/ To some extent, our analysis is overly constraining in limiting the transition period, Period 2, to only one period. If the transition period is sufficiently long, one could think of it as being divided into a sequence of sub-periods comprising a sequence of payments balances and fiscal adjustment steps. In this context, adoption of a high indexing

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Our conclusion that the government's reputation will be enhanced by "front-loading" exchange rate devaluations contradicts the predictions of other game-theoretic analyses of disinflation. Giavazzi and Pagano (1988) argue that by committing to a fixed exchange rate, a government can establish a credible incentive to restrain inflation, since otherwise an undesirable real appreciation of the exchange rate would result; the fixed exchange rate reduces the government's incentive to create surprise inflation and hence moderates the time-inconsistency problem undermining the government's credibility. Agenor and Montiel (1991) extend this insight to a signalling framework to show that by fixing, or even revaluing, the exchange rate, a government can credibly signal its preference for price stability relative to exchange rate competitiveness.

These conclusions differ from those established in this paper for two reasons. First, they depend upon the government's ability to restrain domestic inflation sufficiently to keep a fixed exchange rate competitive. However, this ignores the inertial inflation that can be so critical during disinflation programs, and which may make subsequent devaluations inevitable, regardless of government intent. Second, game-theoretic arguments for a fixed exchange rate depend crucially upon the assumption that exchange rate competitiveness enters positively into the

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ratio ϕ surely would help raise credibility, since capital flows toward the end of the transition period would reflect a revision of the government's reputation based on its performance earlier in the transition.

government's utility function. Given that many countries have combined high inflation rates with overvalued exchange rates for sustained periods of time (for example, Argentina and Peru), the applicability of this assumption is unclear. The assumption used in our analysis is that governments devalue because they are forced to by balance-of-payments problems, not because devaluations raise their utility directly.

VII. Conclusion

This paper provides a systematic way of reconciling two conflicting views about the rôle of exchange rate policy in disinflation programs. One of these views stresses the importance of stabilizing the exchange rate in order to reduce inflation and inflationary expectations as soon as possible. The opposing view admonishes the policymaker against allowing slippages in the real exchange rate that must be corrected later on. Our analysis indicates that the probability of a successful disinflation program may well be maximized by a compromise between the two strategies: an initial "pre-program" devaluation combined with a crawling peg rule providing less-than-full indexation of the exchange rate to the domestic price level.

Three considerations recommend such a strategy. First, it will lead to a smoothing of inflation, and related social costs, over the course of the stabilization program. Second, it will tend to moderate abrupt movements in the exchange rate, either because of a reserves crisis in the middle of the program or a corrective adjustment at the end of the transition period. Finally, by pushing at least some of the political costs of the stabilization toward the outset of the program, it will enhance the government's credibility.

This latter point cannot be over-emphasized. The "heterodox shock" programs of Argentina, Brazil, and Israel in the mid-1980s were premised on the ability of the nominal anchors to reduce inflation quickly and costlessly. The failure of these programs to achieve their aims, in most cases, has led the private sector to be doubly suspicious of supposedly painless strategies to reduce inflation. By acknowledging the probability of residual inflation during the transition period, and by adjusting its policy rules accordingly, the government can strengthen its credibility and hence improve its chances of sustaining the disinflation program.

REFERENCES

Agenor, Pierre-Richard and Peter J. Montiel, "Credibility and Exchange Rate Commitment in Developing Countries," unpublished draft, May 1991.

Barro, Robert and David Gordon, "A Positive Theory of Monetary Policy in a Natural Rate Model," Journal of Political Economy, vol. 91, 1983.

Blejer, Mario I. and Alain Ize, "Adjustment Uncertainty, Confidence, and Growth: Latin America After the Debt Crisis," IMF Working Paper WP/89/05, December 1989.

Dornbusch, Rudiger, "Lessons From the German Inflation Experience of the 1920s," in Exchange Rates and Inflation, MIT Press, Cambridge, Mass., 1988a.

__________________, "Inflation Stabilization and Capital Mobility," in Exchange Rates and Inflation, MIT Press, Cambridge, Mass., 1988b.

__________________, "Notes on Credibility and Stabilization," NBER Working Paper No. 2790, December 1988c.

Fischer, Stanley, "Exchange Rates versus Monetary Targets in Disinflation," in Indexing, Inflation, and Economic Policy, MIT Press, Cambridge, Mass., 1986.

Giavazzi, Francesco and Marco Pagano, "The Advantage of Tying One's Hands: EMS Discipline and Central Bank Credibility," European Economic Review, Vol. 32, 1988.

Kiguel, Miguel and Nissan Liviatan, "Inflationary Rigidities and Orthodox Stabilization Policies: Lessons from Latin America," World Bank Economic Review, Vol. 2, No. 3, 1988.

__________________, "The Old and the New in Heterodox Stabilization Programs," The World Bank, PPR Working Paper 323, December 1989.

__________________, "Some Implications of Policy Games for High Inflation Economies," The World Bank, PPR Working Paper 379, March 1990.

Orphanides, Athanasios, "The Timing of Stabilizations," mimeo, MIT, October 1989.

Rodrik, Dani, "Promises, Promises: Credible Policy Reform via Signalling," The Economic Journal, Vol. 99, September 1989.

Tanzi, Vito, "Inflation, Lags in Collection, and the Real Value of Tax Revenue," IMF Staff Papers, Vol. 24, No. 1, March 1977.