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RATIONAL INFLATION AND REAL INTERNAL DEBT BUBBLES IN ARGENTINA AND BRAZIL?

by

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Federal Reserve Bank of Dallas

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*Economist, Research Department, Federal Reserve Bank of Dallas. The views expressed in this paper are those of the author and do not reflect the views of the Federal Reserve Bank of Dallas or the Federal Reserve System. I would like to thank Shengyi Guo for careful research assistance and Thomas Fomby and Paul Beckerman for their excellent comments. Of course, any remaining errors and omissions are the responsibility of the author.

Introduction

The recent stabilization attempts in Argentina (December 1989 and January 1990) and Brazil (March 1990) which entailed the freezing and forced conversion of the government's liabilities implicitly or explicitly assumed either that a rational inflationary bubble existed or that the internal public sector debt was following an explosive path [Welch 1990]. Such contentions, however, were never tested in any systematic way prior to the effective repudiation of (a portion) of the internal public debt. The empirical evidence reported in this study strongly rejects the existence of either condition.

The internal debt reschedulings that were based upon these apparently false assumptions followed a long series of failed stabilization attempts in each country. Figures 1 and 2 show the seemingly relentless march toward hyperinflation in both countries during the 1980 and identify the "heterodox shock" stabilization plans which of the governments tried and failed to abate inflation.[1] In Argentina, the first and most successful plan, the Austral Plan, lasted from June 1985 to the elections of September 1987. After most price and wage controls had been dismantled by April 1987, inflation accelerated from April to through the September elections. In early 1988, a strict orthodox plan based upon fiscal restraint was implemented. In preparation for the presidential elections in 1989, a new

[1]These programs entailed a combination of exchange rate pegging, incomes policies, monetary reform, deindexation of wages and financial assets, and (mostly temporary and failed) fiscal adjustment. For a more detailed institutional analysis of this period in Argentina and Brazil, see Welch (1991b). Also, see Beckerman (1991) for an analysis of the Argentine experience. For analysis of the "heterodox shock" Austral and Cruzado Plans, see Bruno *et al* (1988).

Figure 1
Argentina: Monthly (logarithmic) Inflation Rates July 1985 to December 1989

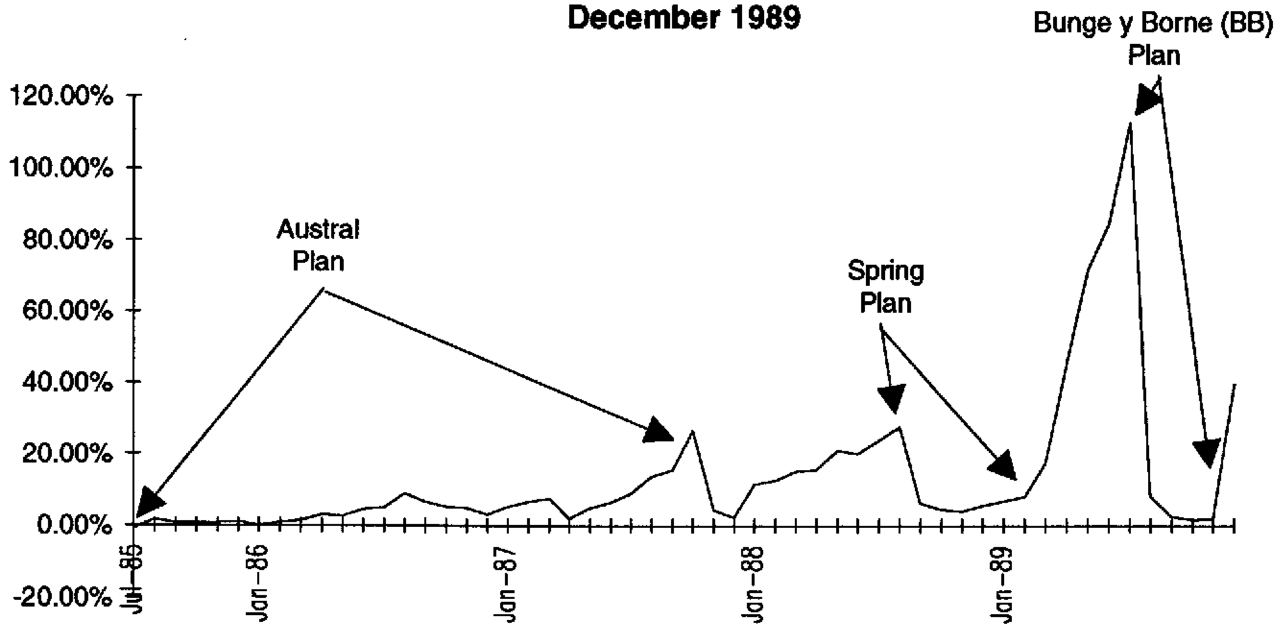
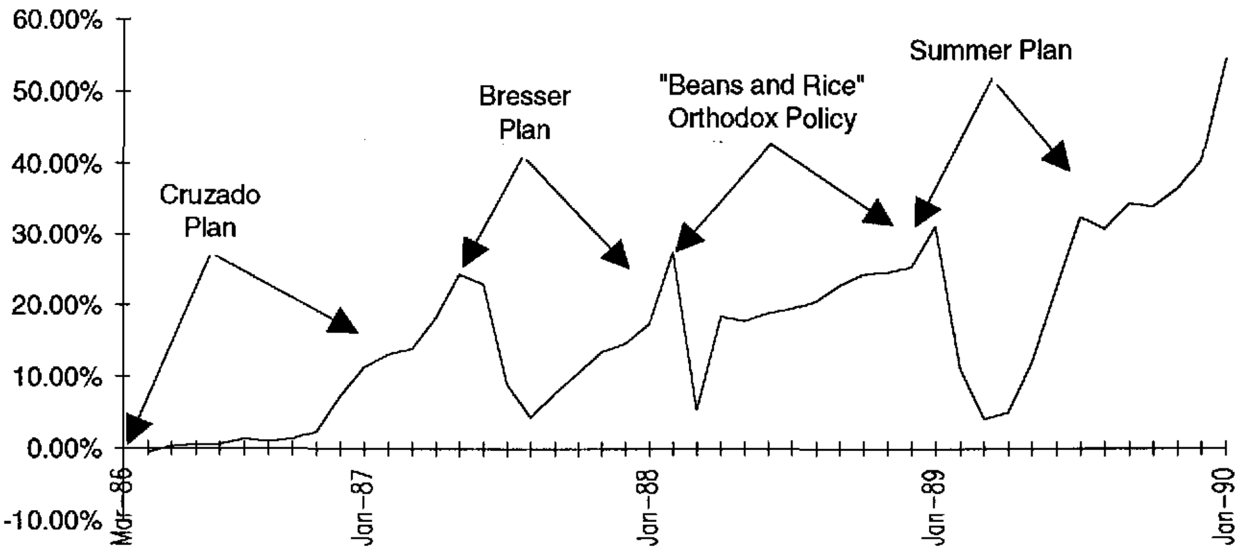


Figure 2
Brazil: Monthly (logarithmic) Inflation Rates March 1986 to February 1990



"shock" policy was put into place in August 1988 named the "Spring Plan." As in the prior attempts, the package fell apart in February 1989 after initial success culminating in hyperinflation in June and July 1989. A final "heterodox" policy was implemented immediately after President Menem took office in July 1989 based mainly upon exchange rate stabilization. This policy ended in a speculative run on the Central Bank in December of 1989.

The Brazilian experience shows a larger number of stabilization "plans" than the Argentine case with poorer results. The original "heterodox" policy package, the "Cruzado Plan," was implemented at the end of February 1986. By the end of 1989, the plan had completely broken down only to be followed by another "heterodox" attempt in April 1987 named the "Bresser Plan" after the new Minister of Finance Luis Carlos Bresser Pereira. The Bresser Plan collapsed at the end of 1987 and was succeeded by an orthodox stabilization effort based upon fiscal adjustment euphemistically referred to as a "beans and rice" (Brazilian "bread and butter") policy. By December, inflation had accelerated to such a point that a new "shock" plan - the "Summer Plan" - was initiated in January 1989. Again, after initial success, inflation accelerated in August of 1989 as the as full fledged indexation returned to the system.

Figures 1 and 2 clearly show that as each subsequent package unraveled in each country, inflation accelerated to levels higher than those that had existed prior to the policy's implementation. A large debate ensued on the causes of inflation in both of these countries as well as Latin America. This paper addresses some of the issues and policy prescriptions which are the fruit of this debate. According to models with rational expectations, hyperinflations could arise from a rational bubble due to the fact that current inflation is determined by future expected inflation rates. Models of dynamic government budget constraints also display the possibility of having a rational bubble on the value of real internal debt.[2] Hence, even if a rational inflationary bubble does not exist, a debt bubble could spawn a hyperinflation due to the acceleration in the growth of the monetary base necessary to meet internal debt service.

Prior work [Welch 1991a] for the period 1970-1985 for both Brazil and Argentina showed no evidence of rational inflationary bubbles. Diba and Grossman (1988b) show that if a rational bubble did not exist when fiat money was introduced, then no rational inflationary bubble can exist at a later date. However, a reintroduction of fiat money which is overvalued might do the trick. Perhaps one can envision the heterodox shock *cum* monetary reform packages of the Austral Plan of 1985 in Argentina and the Cruzado Plan of 1986 in Brazil as events which introduced a new fiat money not valued according to fundamentals due to wage and price controls. I do not argue that the case described in Diba and Grossman (1988b) is equivalent to these monetary reforms. However, for a rational inflationary bubble to exist during the period prior to the recent stabilization packages in each country, it had to be introduced in some such form.

The theoretical basis for the debt bubble-hyperinflation link is succinctly laid out in

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[2] Actually, government debt does not contain a bubble but acts like a bubble due to the fact that it is rolled over. For convenience, I will a "rational internal debt bubble" refers to an expected violation of the government's intertemporal budget constraint or, in other words, the government is insolvent. For a nice discussion, see Trehan and Walsh (1988 and 1991) and Hakkio and Rush (1991). For general treatments of bubbles in an overlapping generations model, see Tirole (1985).

Blanchard and Fischer (1989: 512-517) and Bruno and Fischer (1990). If the burden of the debt renders the primary deficit of the government larger than the maximum seignorage which can be obtained at constant inflation, then the government will continuously accelerate the rate of growth of the monetary base to finance this high deficit. If government debt is nominal, the hyperinflation will quickly erode the burden of this debt. On the other hand, if the debt is "real," i.e. indexed, the ability of inflation to deflate the debt is limited and the government must accelerate money growth even faster [Dornbusch, Blanchard, and Buiter 1986].[3] If such a situation were to arise, one would find that the real level of the internal debt would rise along with the inflation rate.

This paper explores the possibility that the monetary reform *cum* incomes policy stabilizations in Argentina - the so-called Austral Plan of July 1985 - and Brazil - the so-called Cruzado Plan of March 1986 - may have introduced rational inflationary and debt "bubbles" to the respective economies. Whether or not the recent internal debt moratoria undertaken by the Argentina and Brazilian governments is a reasonable policy for bursting an alleged inflationary bubble is an open question.[4] Welch (1990), however, shows that if there is an internal debt bubble, a moratorium on the internal debt without full fiscal adjustment will temporarily improve the government's cash position but this improvement

[3]The ability for the government to collect higher seignorage by continuously accelerating money growth presupposes either adaptive inflation expectations or lagged adjustment of real money balances.

[4]For a critical analysis, see Welch (1991b). Simulation results in Bastos Marques and Werlang (1989) tell a similar story. In a related paper, Bastos Marques and Werlang (1990) estimate the default premium in Letras Fiscais do Tesouro (LFT) in Brazil. They show that the risk premium is very sensitive to increases in the probability of internal debt default.

will ultimately degenerate as the bubble explodes faster in the post-moratorium period.

Recent developments in empirical economics allow testing for the necessary conditions for inflation and debt bubbles in Argentina and Brazil. In contrast to the efforts of Casella (1989) who follows the procedure outlined by West (1985) for testing for bubbles from structural forms in the German hyperinflation, this paper takes the non-structural approach of Hamilton and Whiteman (1985) and Diba and Grossman (1988a). The results, therefore, do not depend upon the functional form of the demand for money function.[5] The organization of this paper is as follows. The tests for government solvency are also not non-strucutural in nature following Trehan and Walsh (1988 and 1991). The first section outlines a classical model of inflation. The second section describes the stationarity implications of rational inflationary bubbles. The third presents a model of the government internal debt determination. The fourth investigates the stationarity properties of real government debt. The fifth section presents empirical evidence concerning inflation bubbles in Argentina and Brazil while the sixth section presents empirical evidence on debt bubbles. The seventh section summarizes the findings.

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[5]Tirole (1985) criticizes the structural approach to bubbles tests which assume the *ad hoc* Cagan money demand function in that the bubble's evolution does not depend on interest rates. He generalizes the solution for the price level in terms of intertemporal marginal utilities [Tirole 1985: 1087]. The stochastic behavior of the bubble, however, is observationally equivalent to the one posited in this paper as the bubble cannot be differenced away.

I. A Classical Model of Inflation

The choice of a classical model reflects a need to present a simple model which can theoretically generate a rational inflationary bubble. Even if the model is misspecified, however, the misspecification could not hide any non-stationarities in the data. A full test of the structure of this model for Argentina, Brazil, and Mexico appears in Feliz and Welch (1991).

The model starts with the money demand specification of Cagan (1956).

$$m_t - p_t = y_t - \alpha i_t + \epsilon_t \tag{1}$$

where m_t is the natural logarithm of the money stock, p_t is the natural logarithm of the price level, y_t is the natural logarithm of real output, i_t is the nominal interest rate, and ϵ_t is a zero mean random error term all evaluated at time t.[6] The standard assumption describes ϵ_t as a random walk of the form

$$\epsilon_t = \epsilon_{t-1} + \eta_t \tag{2}$$

[6]This error term can be viewed as one which is either viewed by market participants or constructed by them. ϵ_t, however, is not observed by the researcher. See Diba and Grossman (1988a) and Campbell and Shiller (1987 and 1988). Further, the assumption that ϵ_t follows a random walk as opposed to being stationary is not necessary for the results. A stationary error process indicates that m_t, p_t, y_t, and i_t are cointegrated in levels as opposed to growth rates. Such a relationship more strictly rules out rational inflationary bubbles than the tests used here.

where η_t is white noise.[7]

The next feature of this classical model posits a Fisher relationship for the nominal interest rate.

$$i_t = r_t + E[\pi_{t+1}|\Phi_t] \tag{3}$$

where r_t is the real interest rate, E[·] is the expectations operator, $\pi_{t+1} = p_{t+1} - p_t$ is the logarithmic inflation rate, and Φ_t is the information set at time t. The model subsumes rational expectations, i.e. individuals use all information available to them to form expectations about future inflation rates.

Classical models usually contain a form of the "dichotomy" between real variables and nominal variables. In this spirit, real output and real interest rates are assumed to follow random walks (real output also has a drift).

$$y_t - y_{t-1} = \tilde{y} + \omega_{1t} \tag{4}$$

$$r_t - r_{t-1} = \omega_{2t} \tag{5}$$

where ω_{1t} and ω_{1t} are white noise.

Taking first differences on equation (1) and combined with equations 2-5 yields the following expression.

[7]The assumption that ϵ_t follows a random walk, i.e. m, p, y, and y are not cointegrated, is not necessary for the conclusions of this paper. A stationary error term in the money equation would rule out *a fortiori* rational inflationary bubbles.

$$\mu_t - \pi_t = \tilde{y} - \alpha\left(E[\pi_{t+1}|\Phi_t] - E[\pi_t|\Phi_{t-1}]\right) + \xi_t \tag{6}$$

where μ_t is the logarithmic growth of money and

$$\xi_t = \eta_t + \omega_{1t} - \alpha\omega_{2t} \tag{7}$$

is white noise.

Rearranging equation (6) yields

$$\pi_t = \mu - \tilde{y} + \alpha\left(E[\pi_{t+1}|\Phi_t] - E[\pi_t|\Phi_{t-1}]\right) - \xi_t \tag{8}$$

Taking expectations on equation (8) conditional on Φ_{t-1} yields

$$E[\pi_t|\Phi_{t-1}] = -\frac{1}{1+\alpha}\tilde{y} + \frac{\alpha}{1+\alpha}E[\pi_{t+1}|\Phi_{t-1}] + \frac{1}{1+\alpha}E[\mu_t|\Phi_{t-1}] \tag{9}$$

Substituting iterations of these rational forecasts n periods into the future into equation (9) yields

$$\begin{aligned} E[\pi_t|\Phi_{t-1}] = \frac{1}{1+\alpha}&\left[-\sum_{i=0}^{n-1}\left(\frac{\alpha}{1+\alpha)}\right)^i\tilde{y} + \sum_{i=0}^{n-1}\left(\frac{\alpha}{1+\alpha}\right)^i\left(E[\mu_{t+i}|\Phi_{t-1}]\right)\right] \\ &+ \left(\frac{\alpha}{1+\alpha}\right)^n E[\pi_{t+n}|\Phi_{t-1}] \end{aligned} \tag{10}$$

There exists an infinitum of solutions to the difference equation (8). They will be of the form

$$\pi_t = F_t + B_t \tag{11}$$

where F_t represents the fundamental solution and B_t represents a rational bubble. For the evolution of inflation expectations (and thus inflation) to be stable (no bubbles), they must satisfy the following transversality condition

$$\lim_{n \to \infty} \left(\frac{\alpha}{1 + \alpha} \right)^n E[\pi_{t+n} | \Phi_{t-1}] = 0 \tag{12}$$

If equation (12) is satisfied, then the fundamental solution for inflation expectations is

$$E[\pi_t | \Phi_{t-1}] = -\tilde{y} + \frac{1}{1 + \alpha} \sum_{i=0}^{n-1} \left(\frac{\alpha}{1 + \alpha} \right)^i E[\mu_{t+i} | \Phi_{t-1}] \tag{13}$$

Inflation expectations are a function of real (constant) output growth and a weighted sum of expected future money growth rates. The no bubbles solution to the inflation rate is

$$\pi_t = \mu_t - \tilde{y} + \frac{\alpha}{1 + \alpha} \sum_{i=0}^{\infty} \left(\frac{\alpha}{1 + \alpha} \right)^i \left(E[\mu_{t+i+1} | \Phi_{t-1}] - E[\mu_{t+i} | \Phi_{t-1}] \right) - \xi_t \tag{14}$$

On the other hand, if the transversality condition is violated, a rational bubble can exist. For the bubble to be consistent with expectations, it must evolve in the following way

$$E[B_{t+1}|\Phi_t] - \left(\frac{1 + \alpha}{\alpha}\right)B_t = 0 \tag{15}$$

Solutions to (15) satisfy the stochastic difference equation

$$B_{t+1} - \left(\frac{1 + \alpha}{\alpha}\right)B_t = \zeta_{t+1} \tag{16}$$

where the random variable ζ_t satisfies

$$E[\zeta_t|\Phi_{t-k}] = 0 \quad \forall\ k \geq 0 \tag{17}$$

The solution of inflation expectations with a bubble is thus

$$E[\pi_t|\Phi_t] = -\bar{y} + \frac{1}{1 + \alpha}\sum_{i=0}^{n-1}\left(\frac{\alpha}{1 + \alpha}\right)^i E[\mu_{t+i}|\Phi_{t-1}] + B_t \tag{18}$$

and the solution for the inflation rate with a bubble is[8]

$$\pi_t = \mu_t - \bar{y} + \frac{\alpha}{1 + \alpha}\sum_{i=0}^{\infty}\left(\frac{\alpha}{1 + \alpha}\right)^i \left(E[\mu_{t+i+1}|\Phi_t] - E[\mu_{t+i}|\Phi_{t-1}]\right) + B_t - \xi_t \tag{19}$$

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[8]To see this note that

$$E[B_{t+1}|\Phi_t] - B_t = \frac{1}{\alpha}B_t$$

Substituting this value into equation (8) yields the additive term B_t.

II Stationarity Properties of Inflation

The presence of bubbles carries a number of implications [Diba and Grossman 1988a: 522-523]. The first is that the presence of bubbles precludes the stationarity of any degree of differencing of the inflation series. Taking first differences of the bubble in equation (16) using the lag operator L yields[9]

$$\left[1 - \left(\frac{1 + \alpha}{\alpha}\right)L\right](1 - L)B_t = (1 - L)\zeta_t \tag{20}$$

One could continue differencing this representation of the bubble. The ARMA representation of equation (20), however, will never be stationary (as the root of the AR process lies inside the unit circle) nor invertible. The bubble introduces a non-stationarity which cannot be differenced away.

The presence of bubbles would also rule out cointegration between inflation and money growth. Rearranging equation (19) with a small change of notation yields

$$\pi_t - \mu_t + \tilde{y} = \sum_{i=0}^{\infty}\left(\frac{\alpha}{1 + \alpha}\right)^{i+1}\Delta E[\mu_{t+1+i}|\Phi_{t-1}] + B_t - \xi_t \tag{21}$$

Suppose both inflation and money growth are stationary after first differencing (i.e. integrated of order 1 or I(1)) and recall that the growth rate of real output is assumed to be constant. In this classical representation, the left hand side of equation (21) is an equilibrium relationship of inflation and money growth with cointegrating vector ß' = [1, -

[9]The following discussion follows Diba and Grossman's (1988a and 1988b).

1] and an intercept while the right hand represents the residuals Z_t.[10] If there are no bubbles, the residuals are stationary and inflation and money growth are cointegrated of order (1,1). In the presence of bubbles, however, the residuals of the cointegrating regression are not stationary. Hence, if inflation and money growth are cointegrated, no bubbles exist [Feliz 1990: 5]. Further, cointegration of money growth and inflation rules out any non-stationarity of the unobserved variables [Diba and Grossman 1988a: 525-526]. Hamilton and Whiteman (1985) come to similar conclusions by showing that if money growth is stationary after d differences and inflation is stationary after differencing d times, then speculative inflationary bubbles cannot exist.

The discussion thus far presupposes that rational deflationary bubbles cannot exist. Blanchard and Watson (1982) and Obstfeld and Rogoff (1983) show that rational deflationary bubbles cannot exist in the context of infinitely lived optimizing agents. The reasoning is that individuals would have to expect the purchasing power of their money holdings to grow without bounds. The economy's productive capacity precludes such a phenomenon and, therefore, rational individuals could not expect a deflationary bubble. Consequently, the bubble cannot be negative at any point in time. Therefore, if $B_{t+1} \geq 0$, rearranging equation (16) yields

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[10]The definition of Cointegration: Suppose an (Nx1) vector time series X_t is integrated of order d, i.e. is stationary after differencing d times, or I(d). The vector X_t is said to be **cointegrated** of order (d,b) or CI(d,b) if there exists a vector ß such that $Z_t = ß'X_t$ is integrated of order (d-b) [Granger and Engle 1987: 252].

$$\zeta_{t+1} \geq -\left(\frac{1+\alpha}{\alpha}\right)B_t \quad \forall t \geq 0 \tag{22}$$

If $B_t = 0$, since the expected value of ζ_{t+1} is zero, then ζ_{t+1} must equal zero with probability one [Diba and Grossman 1988b: 41]. This non-negativity constraint on the stochastic component of the bubble implies that if the bubble does not exist at time t, then a rational bubble cannot start at time t+1 due to a large error, i.e. a sunspot. If a rational bubble exists, therefore, it had to exist when fiat money was introduced. In other words, fiat money would have to be undervalued at its inception.[11] The set of bubbles tests are introduced and reported in section V to investigate whether the monetary reforms in Argentina (1985) and Brazil (1986) introduced a rational inflationary bubble.

III A Model of Government Debt

This section develops a simple model of government internal debt formation.[12] We start with the government dynamic budget constraint

$$\Delta D_t + \Delta M_t = (G_t - T_t) + i_t D_t + i_t^* D_t^* \tag{23}$$

[11]The non-negativity constraint also rules out bubbles which start and then burst. Such a bubble could generate a stationary pattern of real money growth as bubbles burst and reemerge. However, by the argument above, once a bubble has burst, a sunspot cannot generate a new bubble. Hence, it seems unlikely that a bubble could somehow "hide" in stationary real money growth.

[12]The model follows the discussion of Welch, Primo Braga, and André (1987) and Trehan and Walsh (1988).

where D_t is internal government debt, M_t is monetary base, G_t is the totality of government spending, T_t is the totality of government non-borrowed revenues, i is the average rate of interest on domestic government debt, i^* is the average rate of interest on foreign debt, and D^*_t is the stock of government foreign debt, all at time t.

Letting the exchange rate be indexed to the inflation rate, equation (23) becomes after some arranging

$$D_{t+1} = (G_t - T_t) + (1 + \rho_t)(1 + \pi_t^e)D_t + (1 + \rho_t^*)(1 + \pi_t^e)D_t^* - \Delta M_t \tag{24}$$

Dividing both sides of equation (24) by the price level in the next period yields

$$\frac{D_{t+1}}{P_{t+1}} = \frac{(G_t - T_t)}{P_{t+1}} + \frac{(1 + \rho_t)(1 + \pi_t^e)}{(1+ \pi_t^e)}\frac{D_t}{P_t} + \frac{(1 + \rho_t^*)(1 + \pi_t^e)}{(1 + \pi_t^e)}\frac{D_t^*}{P_t} - \frac{\Delta M_t}{P_{t+1}} \tag{25}$$

Let the real level of domestic debt be d_t, the real level of foreign debt be d_t^*, the real government deficit be δ_t, and the real value of seignorage be $\sigma_t = \Delta M_t/P_{t+1}$. Taking expectations conditional on Φ_t and rewriting yields

$$E[d_{t+1}|\Phi_t] = \delta_t + (1 + \rho_t)d_t + (1 + \rho_t^*)d_t^* - \sigma_t \tag{26}$$

Rearranging

$$d_t = -\frac{\delta_t + (1 + \rho_t^*)d_t^* - \sigma_t}{(1 + \rho_t)} + \frac{E[d_{t+1}|\Phi_t]}{(1 + \rho_t)} \tag{27}$$

The general solution for debt will be of the form

$$d_t = F_t + \hat{B}_t \tag{28}$$

where F_t is the fundamental solution and B_t is a rational bubble.

Iterating n periods forward yields

$$d_t = -\sum_{i=0}^{n-1} E\left(\frac{\delta_{t+i} + (1 + \rho_{t+i}^*)d_{t+i}^* - \sigma_{t+i}}{\prod_{j=0}^{i}(1 + \rho_{t+j})}|\Phi_t\right) + \left(\frac{1}{\prod_{j=0}^{n}(1 + \rho_{t+j})}\right)E[d_{t+n}|\Phi_t] \tag{29}$$

There will not be a bubble if the following transversality condition is fulfilled

$$\lim_{n \to \infty}\left(\frac{1}{\prod_{j=0}^{n}(1 + \rho_{t+j})}\right)E[d_{t+n}|\Phi_t] = 0 \tag{30}$$

If there is no bubble, then the solution to equation (6) is

$$d_t = -\sum_{i=0}^{n-1} E\left(\frac{\delta_{t+i} + (1 + \rho_{t+i}^*)d_{t+i}^* - \sigma_{t+i}}{\prod_{j=0}^{i}(1 + \rho_{t+j})}|\Phi_t\right) \tag{31}$$

If the transversality condition (30) is violated, the solution will be

$$d_t = -\sum_{i=0}^{n-1} E\left(\frac{\delta_{t+i} + (1 + \rho_{t+i}^*)d_{t+i}^* - \sigma_{t+i}}{\prod_{j=0}^{i}(1 + \rho_{t+j})} \middle| \Phi_t \right) + \hat{B}_t \tag{32}$$

For the bubble to conform to the government budget constraint (4), it must evolve in the following way

$$E[\hat{B}_{t+1} | \Phi_t] - (1 + \rho_t)\hat{B}_t = 0 \tag{33}$$

Solutions to equation (33) take the form

$$\hat{B}_{t+1} - (1 + \rho_t)\hat{B}_t = U_t \tag{34}$$

where the random variable U_t obeys

$$E[U_t \; | \Phi_t] = 0 \quad \forall t \geq 0 \tag{35}$$

Once again, the AR process governing the bubble is not stationary which means that differencing cannot eliminate a bubble from the data if it exists. AgaIn, the bubble is not really a bubble. The lack of cointegration of the domestic debt, foreign debt, the primary deficit, and seignorage signifies insolvency of the government or in other words that the dynamic government budget constraint does not hold.

IV The Stationarity Properties of Government Debt

Suppose the time series vector $X_t = [\delta_t, d_t, d^*_t, \sigma_t]$ is first difference stationary. By the Wold decomposition theorem, X_t can be represented

$$(1 - L)X_t = \mu + C(L)v_t \tag{36}$$

where C(L) is a 4 x 4 matrix in the lag operator, μ is a drift term, and v_t is a vector white noise process with $v_t = [v_{1,t}, v_{2,t}, v_{3,t}, v_{4,t}]$. We can form the net of internal debt interest government deficit which is the numerator of the expressions for internal government debt in equations (31) and (32), by multiplying X_t by the cointegrating vector $\beta' = [1, \rho, (1+\rho^*), -1]$.[13] This yields the following expression

$$(1 - L)\beta' X_t = \beta'\mu + \beta' C(L)v_t \tag{37}$$

One can use equation (37) to rationally forecast the value of future government debt. Substituting equation (37) into equation (27) and iterating forward, one finds the solution to the value of d_t. As Trehan and Walsh (1991) show, equation (37) implies that if intertemporal budgets are satisfied (no bubbles), real government debt will follow the

[13] An implicit assumption of the analysis is that the country in question cannot borrow on international markets. Hence, the real (dollar) value of foreign debt stays constant. This assumption is in line with the experiences of both countries over this period.

following process[14]

$$(1 - L)d_{t+1} = \delta_t + \rho_t d_t + (1 + \rho_t^*)d_t^* - \sigma_t = \frac{\beta' \mu}{\rho} + D(L)v_t \tag{38}$$

where $D(L)v_t$ is stationary. Equation (38) implies that the first difference of the real debt is stationary or, equivalently, that the primary deficit, the stock of internal debt, the stock of foreign debt, and seignorage are cointegrated with cointegrating vector $\beta' = [1, \rho_t, (1+\rho^*_t), -1]$.

Because of data limitations, the tests for internal debt bubbles carried out in this paper looks at the stationarity of the first difference of the internal debt. Data on primary government deficits is notoriously suspect, especially in Brazil, as well as the fact that a consistent time series is virtually unobtainable. Further, estimating the actual level of seignorage collected from discretely collected data will understate the true level as the monetary base expands in a more or less continuous fashion. For more on this point, see Welch, Primo Braga, and André (1987) and Cukierman (1988).

[14]Trehan and Walsh (1991) extend their results of (1988) to the case where the real interest rate on government debt is not constant, as in this case. Their results show that if ρ_t is a stochastic process bound strictly below by $\lambda > 0$ in expected value and $(1-L)d_t$ is a stationary process, then intertemporal budget balance is satisfied. Real interest rates on internal government debt were positive in both Argentina and Brazil over the period.

V Inflation Bubble Test Results

If inflation and monetary growth are CI(1,1), then rational bubbles cannot exist. In a prior study, I showed that over the in the pre-Cruzado Plan (1974-1986) period for Brazil and the pre-Austral (1970-1985) period for Argentina, inflation and money growth are CI(1,1) and, hence, rational bubbles did not exist. We look now at the post-incomes policies *cum* monetary reform period to see if the monetary reforms created rational bubbles. The data for Brazil are monthly data from March 1986 through February 1990.[15] The Argentine data are monthly data for the period June 1985 through December 1989.[16] Figure 3 shows inflation and money (M_1, M_2, and M_3) growth while figure 4 shows the growth in real balances in Argentina. Figures 5 and 6 show the same variables for Brazil respectively. Growth in real balances appears to be stationary in both countries. Tables 1 and 2 show the augmented Dickey and Fuller (1979) and Phillips and Perron (1988) tests for stationarity of Brazilian inflation and money growth and the first differences, respectively. Tables 3 and 4 test the stationarity of Argentine inflation and monetary growth and the first differences of the same variables.

The Brazilian inflation rate, M_2 growth rate, and M_3 growth rate significantly reject the null hypothesis of normality, hence the more relevant statistics are the Phillips and Perron tests for these three variables.[17] Only M_1 growth shows any evidence of stationarity

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[15]The Brazilian data comprised the different monetary aggregates monetary base, M_1, M_2, and M_3 , and the wholesale price index (IGP-DI). The sources of the data were Conjuntura Economica and the Fundação Getulio Vargas.

[16]The Argentine data comprised the monetary aggregates M_1, M_2, and M_3, and the wholesale price index published by INDEC.

[17]The test of normality is based upon those developed in Jarque and Bera (1980).

Figure 3
Argentina: Inflation and M1, M2, and M3 Growth June 1985 to December 1989

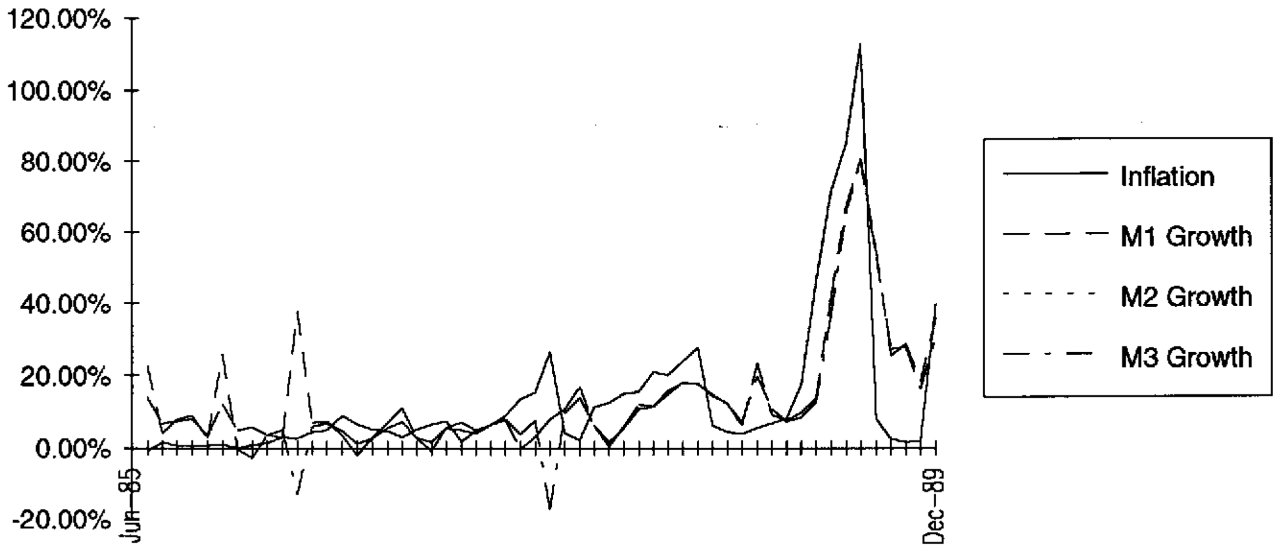

Figure 4
Argentina: Growth in Real M1, M2, and M3 June 1986 to December 1989

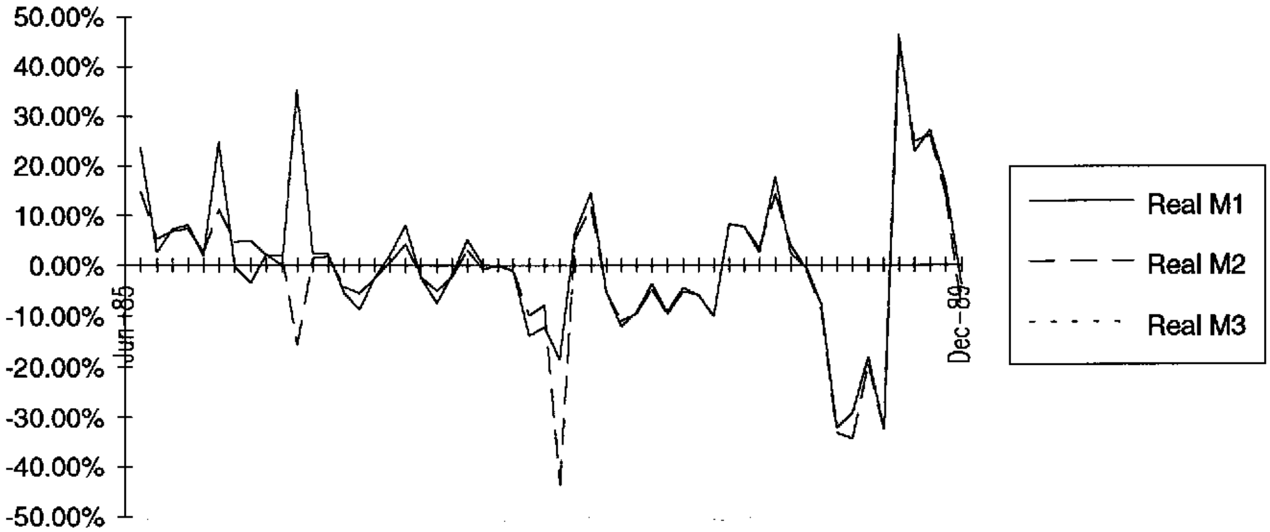

Figure 5
Brazil: Inflation and M1, M2, and M3 Growth March 1986 to February 1990

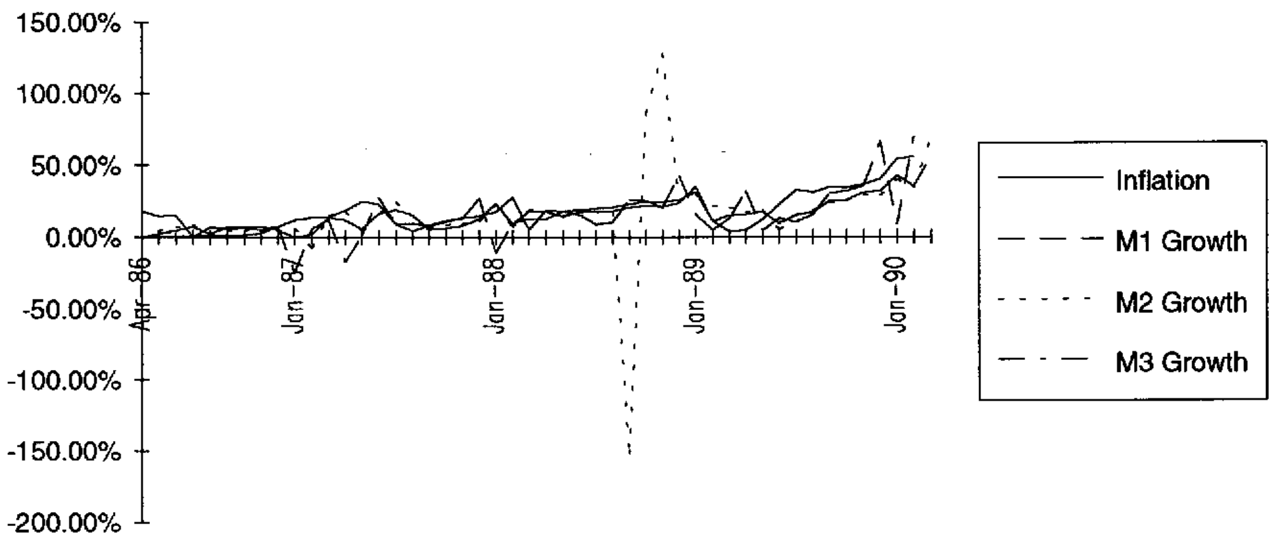

Figure 6
Brazil: Growth in Real M1, M2, and M3 April 1986 to February 1990

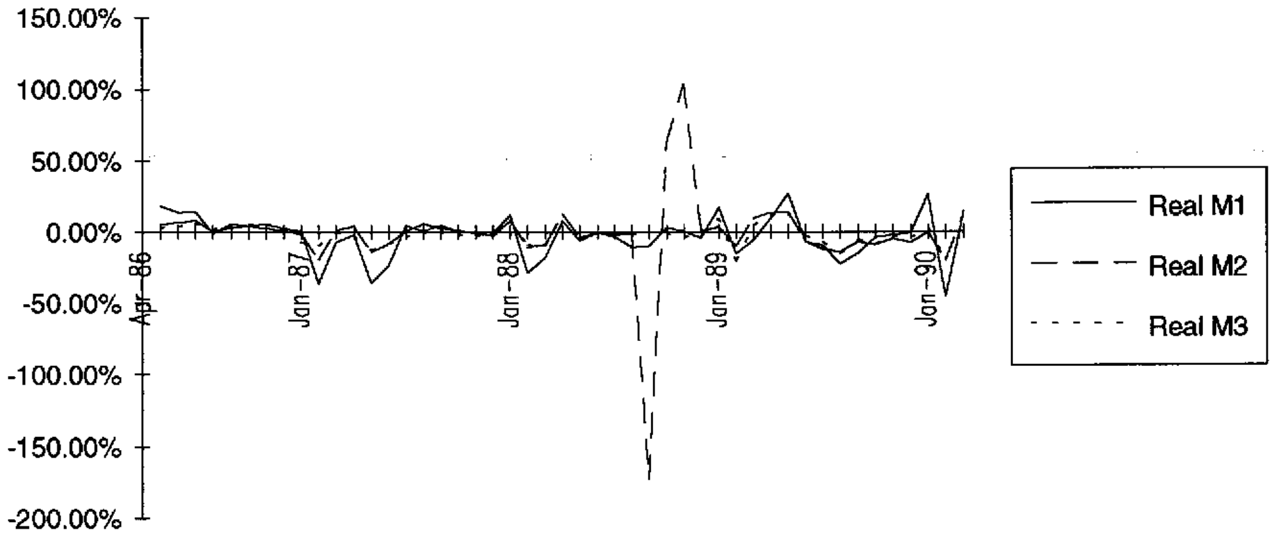

Table 1
Brazil: Tests of a Unit Root 1986:3-1990:2

a. Null Hypothesis: Variable has a Unit Root (no time trend)

Variable	Phillips-Perron Test[(a)] T-ratio	Augmented Dickey-Fuller Test[(a)] T-ratio
inflation[(b)]	-0.77	-0.68
money growth (M_1)	-4.32***	-2.19
money growth (M_2)[(b)]	0.29	0.085
money growth (M_3)[(b)]	0.02	-0.40

b: Null Hypothesis: Variable has Unit Root (with time trend)

Variable	Phillips-Perron Test[(a)] T-ratio	Augmented Dickey-Fuller Test[(a)] T-ratio
inflation[(b)]	-2.20	-2.33
money growth (M_1)	-6.62***	-4.13***
money growth (M_2)[(b)]	-2.59	-1.47
money growth (M_3)[(b)]	-2.95	-1.72

Notes: (a) The tests used one lag of the differenced variables. The number of lags were chosen so that the Q(21) statistic when a trend was included and Q(22) statistic with no trend did not reject the null hypothesis of stationary residuals in the augmented regression at the 10% level.

(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jargue and Bera (1980).

* signifies significance at the $\alpha=0.10$ level, ** signifies significance at the $\alpha=0.05$ level, and *** signifies significance at the $\alpha=0.01$ level.

Table 2
Brazil: Tests of a Unit Root 1986:3-1990:2

a. Null Hypothesis: Variable has a Unit Root (no time trend)

Variable	**Phillips-Perron Test[a] T-ratio**	**Augmented Dickey-Fuller Test[a] T-ratio**
Δinflation[b]	-7.04***	-4.61***
Δmoney growth (M_1)	-12.74***	-8.97***
Δmoney growth (M_2)[b]	-8.59***	-5.85***
Δmoney growth (M_3)	-9.61***	-6.01***

b: Null Hypothesis: Variable has Unit Root (with time trend)

Variable	**Phillips-Perron Test[a] T-ratio**	**Augmented Dickey-Fuller Test[a] T-ratio**
Δinflation[b]	-11.31***	-2.61*
Δmoney growth (M_1)	-12.77***	-9.20***
Δmoney growth (M_2)[b]	-8.78***	-6.13***
Δmoney growth (M_3)[b]	-9.73***	-8.62***

Notes: (a) The tests used one lag of the differenced variables. The number of lags were chosen so that the Q(21) statistic when a trend was included and Q(22) statistic with no trend did not reject the null hypothesis of stationary residuals in the augmented regression at the 10% level.

(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jargue and Bera (1980).

* signifies significance at the $\alpha=0.10$ level, ** signifies significance at the $\alpha=0.05$ level, and *** signifies significance at the $\alpha=0.01$ level.

Table 3
Argentina: Tests of a Unit Root 1985:7-1989:12

a. Null Hypothesis: Variable has a Unit Root (no time trend)

Variable	Phillips-Perron Test[a] T-ratio	Augmented Dickey-Fuller Test[a] T-ratio
inflation[b]	-2.86*	-2.54
money growth (M_1)[b]	-6.22***	-4.24***
money growth (M_2)[b]	-4.98***	-3.66***
money growth (M_3)[b]	-3.00**	-4.39***

b: Null Hypothesis: Variable has Unit Root (with time trend)

Variable	Phillips-Perron Test[a] T-ratio	Augmented Dickey-Fuller Test[a] T-ratio
inflation[b]	-3.44*	-3.15
money growth (M_1)[b]	-6.49***	-4.76***
money growth (M_2)[b]	-5.71***	-4.08***
money growth (M_3)[b]	-5.37***	-3.82***

Notes: (a) The tests used one lag of the differenced variables. The number of lags were chosen so that the Q(21) statistic when a trend was included and Q(22) statistic with no trend did not reject the null hypothesis of stationary residuals in the augmented regression at the 10% level.
(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jargue and Bera (1980).

* signifies significance at the $\alpha=0.10$ level, ** signifies significance at the $\alpha=0.05$ level, and *** signifies significance at the $\alpha=0.01$ level.

Table 4
Argentina: Tests of a Unit Root 1985-1990

a. Null Hypothesis: Variable has a Unit Root (no time trend)

Variable	Phillips-Perron Test[a] T-ratio	Augmented Dickey-Fuller Test[a] T-ratio
Δinflation[b]	-7.47***	-5.73***
Δmoney growth (M_1)[b]	-13.28***	-7.96***
Δmoney growth (M_2)[b]	-12.26***	-6.66***
Δmoney growth (M_3)[b]	-12.14***	-6.20***

b: Null Hypothesis: Variable has Unit Root (with time trend)

Variable	Phillips-Perron Test[a] T-ratio	Augmented Dickey-Fuller Test[a] T-ratio
Δinflation[b]	-7.40***	-3.37*
Δmoney growth (M_1)[b]	-13.07***	-7.86***
Δmoney growth (M_2)[b]	-13.99***	-5.17***
Δmoney growth (M_3)[b]	-4.39***	-3.00

Notes: (a) The tests used three lags of the differenced variables of the M_1, and M_2 equations and one lag of the differenced variables in the inflation and M_3 equations. The number of lags were chosen so that the Q(21) statistic when a trend was included and Q(22) statistic with no trend did not reject the null hypothesis of stationary residuals in the augmented regression at the 10% level.

(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jargue and Bera (1980).

* signifies significance at the $\alpha = 0.10$ level, ** signifies significance at the $\alpha = 0.05$ level, and *** signifies significance at the $\alpha = 0.01$ level.

from the regressions with a trend at the 5% level from table 1. On the other hand, the first differences of all four variables in table 2 are significantly stationary at the 1% level. The assumption that money growth and inflation are I(1) is consistent with the data.[18]

The Argentine inflation rate in table 3 is weakly stationary at the 10% level. The money growth rates are significantly stationary at the 5% level. Table 4 shows that the first differences of all variables including inflation are stationary. These results indicate that the likelihood of a rational inflationary bubble in Argentina are extremely remote as the money growth rates are stationary while the inflation rate seems to be marginally stationary. A first implication of these results is that there may be two cointegrating vectors in terms of inflation and money growth rates. A second one is that the price level and the stock of money in Argentina are cointegrated, a condition if satisfied rules out the existence in a stronger way the cointegration conditions discussed above.

Cointegration means that (non-stationary) time series variables tend to move together such that a linear combination of them is stationary. Some have interpreted cointegration as representing a long run equilibrium relationship. Cointegration also has implications for the statistical analysis of these series. Further, differencing X_t d times to generate a stationary time series and then estimating a VAR based upon the differenced series is inappropriate in the presence of cointegration. Granger (1981) develops what has come to be known as the Granger representation theorem: If the (px1) vector time series X_t ($p=2$ in this case) is first difference stationary, i.e. I(1), and cointegrated, i.e. $b=1$, there exists an

[18]If inflation and money growth were stationary in levels, no rational inflationary bubbles could exist. The cointegration tests, however, would be irrelevant.

error correction form

$$\Delta X_t = A_1 \Delta X_{t-1} + \dots + A_{k-1} \Delta X_{t-k+1} + \Pi X_{t-1} + \varepsilon_t \tag{39}$$

where $\Pi = \alpha\beta'$, $\beta' = [\beta_\pi, \beta_\mu]$ is the cointegrating vector, $\alpha' = [\alpha_\pi, \alpha_\mu]$ is the error correction coefficient (or speed of adjustment).

An important point of this theorem is that the VAR should incorporate the long run equilibrium relationship between the levels. A VAR based purely upon differences would exclude this relevant information in addition to displaying infinite variance.

In general, there can exist (p-1) independent cointegrating vectors. A weakness in the Engle and Granger (1987) approach is that it offered no clear criterion for choosing the number of cointegrating vectors. Johansen and Juselius (1990) take a general maximum likelihood approach to choosing the number of independent cointegrating vectors, estimating Π, α, β', and testing restrictions on α and β. Their technique is based upon the following general version of equation (1).[19]

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + \varepsilon_t \tag{40}$$

The analysis of the negative of the growth in real money balances looks at the behavior of $\beta' = [1, -1]$ of the vector time series $X_t = [\pi_t, \mu_t]$. The maximum likelihood

[19]The Π matrix is the same in equation (1) and equation (2). It can be shown that the level variable can take on any lag from 1 to k without affecting Π. The coefficients on the lagged differenced variables, of course, change.

estimates for Brazil appear in tables 5 through 7.[20] All monetary aggregates show one cointegrating vector. The cointegrating vector ß' is not significantly different from [1, -1] and each component is significantly different from zero. The coefficient on the equilibrium error term α showed significant adjustment in monetary aggregates and not in the inflation rate except in the case of the estimates with M_3. A further discussion of these results, however, is beyond the scope of this present paper. Since the tests conducted above showed that inflation and the monetary aggregates M_2 and M_3 were non-normal, a Phillips and Perron test was conducted on the growth in real balances. These test significantly rejected non-stationarity for all monetary aggregates.

The results for Argentina appear in tables 8 through 10. In all cases, the Π matrix is full rank, i.e. $r=p=2$, at the 5% significance level confirming suspicions based upon the Phillips and Perron tests above that inflation and money growth are stationary time series.[21] Hence, one cannot perform tests of restrictions on the ß' matrix. Instead, we impose ß' = [1, -1] and test the stationarity of (the negative of) the growth in real balances using both Dickey-Fuller and Phillips-Perron tests, the latter being the more relevant due to the non-normalities in the series. Growth in real money balances is significantly stationary at the 1% level showing that rational inflationary bubbles were absent in Argentina as well as Brazil in the post-heterodox policy period.

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[20] The Johansen and Juselius (1990) procedure assumes normality. The equations are estimated using RATS 3.10 software.

[21] The fact that the matrix Π has full rank indicates that the vector process X_t is stationary [Johansen and Juselius 1990: 170].

Table 5a

Brazil: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with M_1[a]

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	21.41***	0.01
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	24.42***	0.01
UNRESTRICTED ESTIMATES	β_π	β_μ
	1.000	-1.071
	α_π	α_μ
	-0.172	0.872

Notes: (a) One lag was used in these maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 5b
Brazil: Tests on ß' and α for inflation and M_2

H_o: $\beta_\pi=1$, $\beta_\mu=-1$,	H_o: $\beta_\pi=0$	H_o: $\beta_\mu=0$
$\chi^2_{(2)}=0.126$	$\chi^2_{(1)}=15.858^{***}$	$\chi^2_{(1)}=19.46^{***}$
	H_o: $\alpha_\pi=0$	H_o: $\alpha_\mu=0$
Unrestricted	$\chi^2_{(1)}=3.51^{*}$	$\chi^2_{(1)}=18.43^{***}$
Restricting ß'=[1, -1]	$\chi^2_{(2)}=3.65$	$\chi^2_{(2)}=18.43^{***}$

Final Values of ß and α:

$$\beta = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$\alpha = \begin{bmatrix} 0 \\ 0.925 \end{bmatrix}$$

Dickey-Fuller and Phillips-Perron Tests on the Final $\beta' X_t$[a]

H_o: $\beta' X_t$ is non-stationary	
Augmented Dickey-Fuller	-4.77^{***}
Phillips-Perron	-6.824^{***}

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 6a
Brazil: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with M_2[(a)]

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	25.19***	0.001
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	25.19***	0.001
UNRESTRICTED ESTIMATES	β_π	β_μ
	1.000	-1.055
	α_π	α_μ
	-0.170	0.882

Notes: (a) One lag was used in the maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 6b
Brazil: Tests on ß' and α for inflation and M_2

H_o: $ß_\pi=1$, $ß_\mu=-1$,	H_o: $ß_\pi=0$	H_o: $ß_\mu=0$
$\chi^2_{(2)}=0.256$	$\chi^2_{(1)}=24.896^{***}$	$\chi^2_{(1)}=18.22^{***}$
	H_o: $\alpha_\pi=0$	H_o: $\alpha_\mu=0$
Unrestricted	$\chi^2_{(1)}=0.82$	$\chi^2_{(1)}=23.03^{***}$
Restricting ß'=[1, -1]	$\chi^2_{(2)}=1.07$	$\chi^2_{(2)}=23.05^{***}$

Final Values of ß and α:

$$\beta = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$\alpha = \begin{bmatrix} 0 \\ 0.908 \end{bmatrix}$$

Dickey-Fuller and Phillips-Perron Tests on the Final $ß'X_t$[(a)]

H_o: $ß'X_t$ is non-stationary	
Augmented Dickey-Fuller	-4.44^{***}
Phillips-Perron	-5.763^{***}

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 7a

Brazil: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with $M_3^{(a)}$

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	24.93***	0.05
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	24.88***	0.05
UNRESTRICTED ESTIMATES	β_π	β_μ
	1.000	-1.174
	α_π	α_μ
	-0.483	0.653

Notes: (a) One lag was used in these maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 7b
Brazil: Tests on ß' and α for inflation and M_3

H_o:$\beta_\pi=1$, $\beta_\mu=-1$,	H_o: $\beta_\pi=0$	H_o: $\beta_\mu=0$
$\chi^2_{(2)}=2.704$	$\chi^2_{(1)}=24.672^{***}$	$\chi^2_{(1)}=21.957^{***}$
	H_o: $\alpha_\pi=0$	H_o: $\alpha_\mu=0$
Unrestricted	$\chi^2_{(1)}=6.69^{***}$	$\chi^2_{(1)}=15.11^{***}$
Restricting ß'=[1, -1]	$\chi^2_{(2)}=8.51^{**}$	$\chi^2_{(2)}=16.70^{***}$

Final Values of ß and α:

$$\beta = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$\alpha = \begin{bmatrix} -0.445 \\ 0.621 \end{bmatrix}$$

Dickey-Fuller and Phillips-Perron Tests on the Final ß'X_t[a]

H_o: ß'X_t is non-stationary	
Augmented Dickey-Fuller	-4.556***
Phillips-Perron	-6.197***

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 8a

Argentina: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with M_1[a]

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	26.38***	6.42**
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	29.95***	6.42**

Notes: (a) One lag was used in these maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 8b

Argentina: Tests on ß' and α for inflation and M_1

Dickey-Fuller and Phillips-Perron Tests on Growth in Real Balances[a]

H_o: $\beta'X_t$ is non-stationary	
Augmented Dickey-Fuller	-3.88***
Phillips-Perron	-5.38***

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 9a

Argentina: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with M_2[(a)]

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	21.79***	4.566**
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	17.23***	4.566**

Notes: (a) One lag was used in the maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 9b

Argentina: Tests on ß' and α for inflation and M_2

Dickey-Fuller and Phillips-Perron Tests on Growth in Real Balances[(a)]

H_o: $ß'X_t$ is non-stationary	
Augmented Dickey-Fuller	-3.98***
Phillips-Perron	-5.21***

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 10a

Argentina: Tests for number (r) of Cointegrating Vectors for $X_t = [\pi_t, \mu_t]$ with $M_3^{(a)}$

TRACE TESTS	H_o:r=0 H_1:r=2	H_o:r=1 H_1:r=2
test statistic	20.62***	5.96**
MAXIMUM EIGENVALUE	H_o:r=0 H_1:r=1	H_o:r=1 H_1:r=2
test statistic	14.67**	5.96**

Notes: (a) One lag was used in these maximum likelihood estimates. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

Table 10b

Argentina: Tests on ß' and α for inflation and M_3

Dickey-Fuller and Phillips-Perron Tests on Growth in Real Balances[(a)]

H_o: $ß'X_t$ is non-stationary	
Augmented Dickey-Fuller	-3.46***
Phillips-Perron	-4.71***

Notes: (a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

** signifies rejection of H_o at a 5% significance level, *** signifies rejection of H_o at a 1% significance level.

VI Debt Bubble Test Results

As shown in section IV, a real debt bubble cannot occur, i.e. intertemporal budget balance is maintained, if real debt is first difference stationary. The Brazilian data are monthly observations on bond debt outside of the Central Bank deflated by the wholesale price index.[22] The Argentine debt are internal debt in U.S. dollars evaluated at the average monthly "free-market" exchange rate from October 1986 to June 1989.[23] The level of real government debt and its first differences in Argentina appear in figures 7 and 8, respectively, while the same variables for Brazil appear in figures 9 and 10. In each country, the level of real debt appears to be non-stationary while the first differences show mean reversion. Tables 11 and 12 show the results of the formal tests of stationarity for Brazil and Argentina. Real internal government debt in both Brazil and Argentina is first difference stationary at a significance level of 1%. The necessary conditions for thegovernment's intertemporal budget constraint to be violated, as in the case of an inflationary bubble, are

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[22]Ideally, one would like to have monthly observations on the net debt of the public sector as public sector entities hold some of this bond debt as well as borrow in other forms such as loans, etc.. A monthly time series of net debt, however, is currently unavailable and is only published on an annual basis. For a full discussion how net debt is calculated, see Banco Central do Brasil (1986). The data comes from the Banco Central do Brasil, Brasil: Programa Econômico, various issues. Further, the nominal debt for Brazil is deflated by a geometric average of the adjacent price indexes as the debt is the end of month balance while the price index measures on the fifteenth day of the same month. The results, however, are not sensitive to the choice of price deflator.

[23]Data for Argentine internal debt are calculated by the author from Estudio M. A. M. Broda y Asoc. Carta Economica, various issues. The data are monthly values for internal government debt converted to U.S. dollars at the average parallel market exchange rate and include the debt of the Central Bank.

Figure 7
Argentina: Internal Public Debt January 1986 to December 1989
(in U.S.$ Billions)

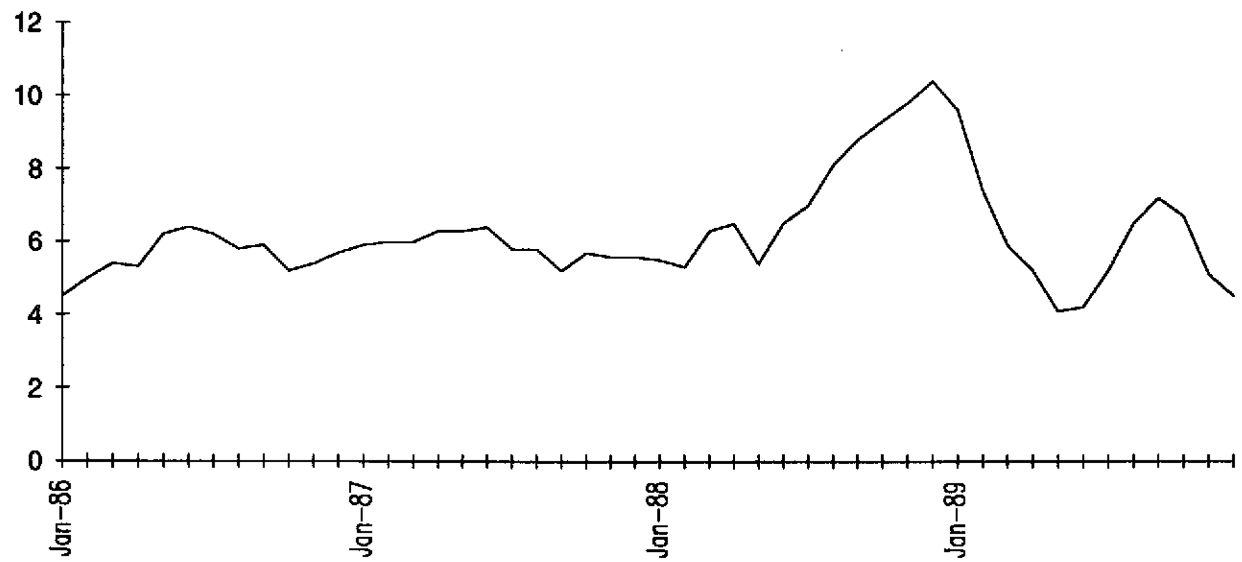

Figure 8
Argentina: First Differences of Real Public Debt
February 1986 to December 1989
(in U.S.$ Billions)

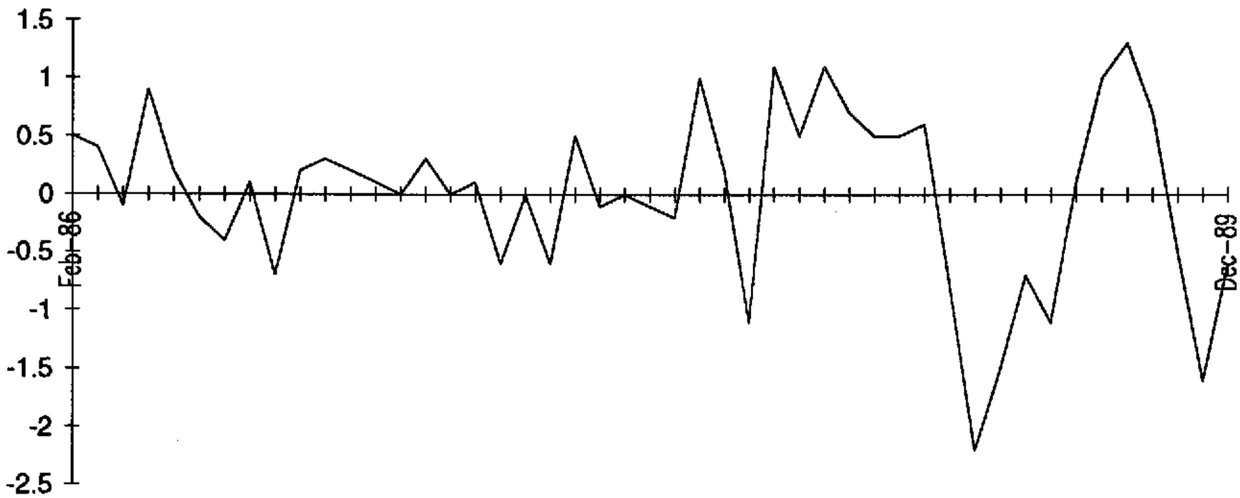

Figure 9
Brazil: Real Internal Public Debt March1986 to February 1990
(in 1986 Cruzados Millions)

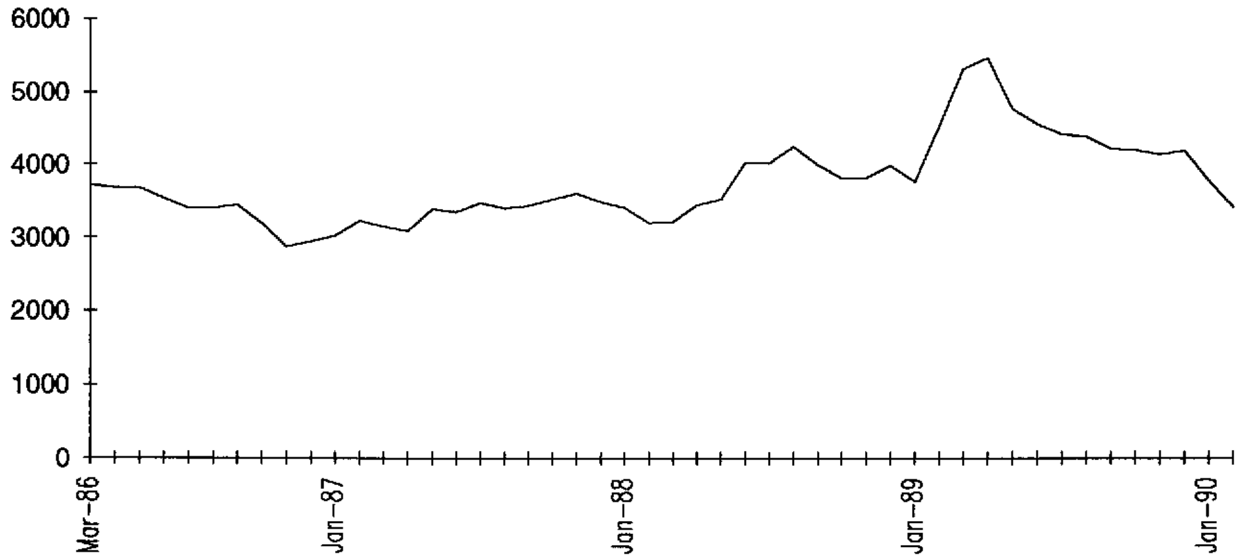

Figure 10
Brazil: First Difference of Real Internal Debt April 1986 to February 1990

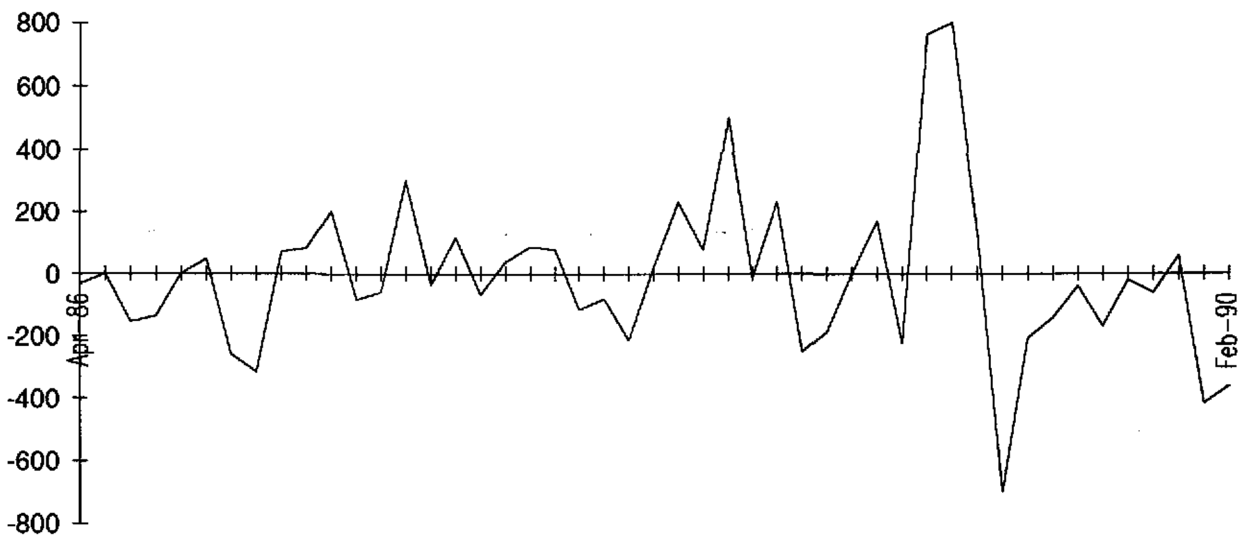

Table 11
Brazil: Tests of a Unit Root and Time Trend 1986:3-1990:2
Real Internal Government Debt

a. Null Hypothesis: Variable has a Unit Root (with time trend)

Variable	**Phillips-Perron Test T-ratio**	**Augmented Dickey-Fuller Test[a] T-ratio**
Δreal government debt(b)	-5.02***	-4.56***

b: Null Hypothesis: Variable has Unit Root (with no time trend)

Variable	**Phillips-Perron Test T-ratio**	**Augmented Dickey-Fuller Test[a] T-ratio**
Δreal government debt(b)	-4.94***	-4.50***

Notes:
(a) One lag was used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.
(b) Variable significantly violates normality assumption either because of skewness or kurtosis using the tests developed in Jargue and Bera (1980).

* signifies significance at the $\alpha=0.10$ level, ** signifies significance at the $\alpha=0.05$ level, and *** signifies significance at the $\alpha=0.01$ level.

Table 12

Argentina: Tests of a Unit Root and Time Trend 1986:3-1990:2
Real Internal Government Debt

a. Null Hypothesis: Variable has a Unit Root (with time trend)

Variable	Phillips-Perron Test T-ratio	Augmented Dickey-Fuller Test[(a)] T-ratio
Δreal government debt	-4.17***	-4.17***

b: Null Hypothesis: Variable has Unit Root (no time trend)

Variable	Phillips-Perron Test T-ratio	Augmented Dickey-Fuller Test[(a)] T-ratio
Δreal government debt	-4.07***	-4.07***

Notes: (a) Zero lags were used in these tests of stationarity. The lag structure was chosen by adding lags until the Q(22) statistic did not reject the null hypothesis of autocorrelated residuals.

* signifies significance at the $\alpha=0.10$ level, ** signifies significance at the $\alpha=0.05$ level, and *** signifies significance at the $\alpha=0.01$ level.

significantly rejected for Brazil and Argentina.

VII Conclusions

This paper endeavored to find evidence of rational inflationary bubbles and real internal debt bubbles in Brazil and Argentina. The first section described a classical model of inflation and the possibility of rational inflationary bubbles. The second looked at the stationarity characteristics of rational bubbles and showed that if inflation and money growth are cointegrated, rational bubbles cannot exist. The third section developed a model of real internal debt. The fourth section looked at the stationarity properties of real government internal debt. The fifth section presented evidence that inflation and money growth are cointegrated for both Brazil and Argentina and, hence, no inflationary bubbles exist. Finally, the sixth section showed that real debt in Argentina and Brazil was first difference stationary and, hence, no real internal debt bubbles existed in either country.

The conclusion which emerges from this empirical study is that inflation in Argentina and Brazil is driven primarily by fundamentals as opposed to purely speculative bubbles. Further, seignorage adjusts in a stable way to render real government debt stationary. The implication of this last statement is that the real level of the government deficit inclusive of interest never reached a level which could not be financed by seignorage, the condition that would imply an ever increasing growth rate of money, inflation, and debt. In spite of the fact that the real monetary base in each of these countries has shrunk dramatically, seignorage adjusts to make the government's internal debt accumulation stable.

These empirical regularities call for a brief interpretation of the Argentine and

Brazilian inflation experiences over the period in question. The Argentine excursion into hyperinflation at the end of 1989 reflects a speculative attack on the Central Banks foreign currency holdings to the collapse of stabilization programs due to the inconsistency of lack of fiscal reforms combined with fixed exchange rates. The role the internal debt played in the Argentine case was that the cost of borrowing domestically rose on fears of an exchange rate collapse. Without adjustment of the primary deficit to finance these interest charges, the government had to increase seignorage hastening the arrival of the collapse. A similar story can be told for the Brazilian case. The Workers Party (PT) presidential candidate Luis Ignacio da Silva or Lula in the 1989 presidential elections promised a unilateral government moratorium on the internal and external debts. As Lula's campaign gained momentum, real interest rates rose reflecting the risk of government default [Bastos Marques and Werlang 1990]. Again, as no fiscal adjustment was forthcoming especially by the lame duck President Sarney, seignorage increased accelerating the inflation rate. The evidence presented above, however, indicates that in each case the process was not self generating, i.e. a debt led continuous acceleration of the inflation rate was not at hand. Rather, the higher interest costs of government finance quickly moved each economy to a higher inflation equilibrium.

Certainly, this study suffers from a number of shortcomings. Firstly, the short time series limits the strength of these tests, especially in case of testing the dynamic budget constraint. The main problem lies in the fact that any finite series can be differenced to stationarity. The fact that significant stationarity obtained after differencing only a few times lends credence to the results. Another well know qualification of the results is the fact that the stationarity and cointegration tests are notoriously low in power in addition to the fact the size of the tests depends upon the number of lags used in the regressions. Again, the fact that non-stationarity was significantly rejected at low levels of integration suggests that the results are reasonable.

The study showed that rational inflationary bubbles generated outside of the "fundamentals" are not part of the inflationary processes of Argentina and Brazil. The possibility of "intrinsic bubbles" or bubbles which are functions of the fundamentals as in Froot and Obstfeld (1989) may prove useful in explaining the explosiveness of inflation in these two countries. Further, the linear methods employed here may not pick up important non-linearities which have been the focus of the recent "target zone" literature on exchange rates stating with Krugman (1988). Bubbles which appear as non-linearities during exchange rate collapse may go unnoticed by the techniques used here. Understanding the link between hyperinflation and speculative attack, especially in the Argentine case, along the lines of Krugman and Rotemberg (1990), should aid in the analysis of the inflation experiences of these countries. Finally, tests of the classical model with well defined alternative hypotheses are still needed. Such investigation, however, is left to future research.

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