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Virtual Deficits and the Patinkin Effect ¹

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Abstract

The paper develops a model of inflationary finance that defines the fiscal deficit as a function of the virtual deficit—a deficit that would be observed if inflation were zero. It studies the negative relationship between the inflation rate and real government expenditures—the Patinkin effect. The model outperforms others in explaining four-digit inflation rates that never explode into hyperinflation. It also explains how apparently expansionist fiscal policies end in real deficits that are small and compatible with the small amount of seigniorage that can be collected at high inflation rates. Finally, it applies the model to the case of Brazil.

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SUMMARY

This paper introduces the concept of a virtual budget deficit—a deficit that would be observed if inflation were zero—and the concept of a reverse Tanzi effect, which is referred to as the Patinkin effect. The Tanzi (1978) effect predicts that real tax revenues decline as inflation rises, and thus the budget deficit is higher at higher inflation rates. The Patinkin (1993) effect predicts a negative relationship between the inflation rate and the budget deficit: at higher inflation rates, real expenditures appear lower than they would be if there were no inflation. Consequently, the Patinkin effect is a powerful stabilizer during megainflation, as it can dominate the Tanzi effect at high inflation rates.

The paper develops a model of inflationary finance that defines the fiscal deficit as a function of the virtual deficit and inflation, with the Patinkin effect dominating the Tanzi effect at high inflation rates. Multiple equilibria exist if the virtual deficit is small. But even if the virtual budget deficit exceeds the maximum amount of seigniorage that the government can collect, there will be a stable high inflation equilibrium if the Patinkin effect is strong. This model outperforms other seigniorage models in explaining the persistence of four-digit inflation rates in countries where inflation never explodes into an open hyperinflation. Furthermore, it explains how expansionist fiscal policies end in measured real deficits consistent with the small amount of seigniorage that can be collected at high inflation rates.

The model is modified to study equilibria when the shares in seigniorage of the central bank and deposit banks vary. It is then applied to the case of Brazil's inflationary finance in the 1980s and 1990s.

In a situation where—because of coalition considerations—the finance minister does not have the power to force individual ministries to make adequate reductions in their respective budgetary demands and is thus confronted with an overall budget whose planned expenditures far exceed its expected revenues, he may seemingly accept these demands and then finance the deficit by printing money and letting the resulting inflation enforce the necessary reduction in real government expenditures.
Don Patinkin (1993)

I. INTRODUCTION

Economists think of extreme inflation as an unstable process, the instability reinforced by the Tanzi effect—a decline in real tax revenues as inflation rises. But empirical evidence suggests a powerful effect that runs in the other direction through declining real spending levels—the Patinkin effect. This paper introduces the concept of a virtual budget deficit—a deficit that would be observed if inflation were zero—, develops a model of inflationary finance, and applies the model to the case of Brazil.

Observed aggregate budget data on nominal, operational, and primary deficits contain very little information about the true fiscal position of the public sector when inflation exceeds 500 percent a year. The Tanzi effect predicts that real tax revenues decline as inflation rises and thus the budget deficit is higher at higher inflation rates. But there is also a reverse Tanzi effect—referred to here as the Patinkin effect. If the Patinkin effect dominates at high inflation rates, real expenditures appear lower than they would be if there were no inflation, and real expenditures tend to increase when inflation disappears. Thus, the fiscal adjustment needed once inflation disappears is usually underestimated. Several factors explain this phenomenon:

- Real interest rates decline with increasing inflation rates and usually rise following stabilization. This rise in real interest rates contributes to the increase in real government expenditures once inflation disappears.
- During periods of high inflation local governments usually delay payments of salaries and wages. When inflation exceeds 1,000 percent a year, this delay produces a substantial decline in real expenditures. When inflation disappears, delaying payments no longer reduces real expenditures.
- Although governments have learned to lessen gaps in tax collections and index delayed tax payments to inflation, they still program expenditures with a forecast for inflation that is usually lower than observed inflation. As a consequence, realized real expenditures are much lower than programmed expenditures. When inflation disappears, actual expenditures will be closer to their programmed levels.

- The inflationary revenue of state banks can finance credit subsidies that are not recorded. This revenue disappears when inflation disappears. Furthermore, if inflation were concealing banks' weaknesses, and these weaknesses are accentuated by the rise in real interest rates that follows stabilization, the government will have to use fiscal revenues to rescue banks, and recorded real expenditures will increase with stabilization.

Because inflation reduces real expenditures but not real taxes when governments fully index taxes and reduce gaps in tax collections, inflation can be used to accommodate conflicting spending programs of different government levels. Thus inflation produces operational budget deficits consistent with the amount of real seigniorage that the government needs to finance the deficit.

Section II introduces the concept of a virtual budget deficit and the concept of a Patinkin effect.² It also develops a model of inflationary finance. The section discusses multiple equilibria and shows that, even if the virtual budget deficit exceeds the maximum amount of seigniorage that the government can collect, one stable high-inflation equilibrium exists if the Patinkin effect is strong enough. The model outperforms other seigniorage models in explaining the persistence of four-digit inflation rates in countries where inflation never explodes into an open hyperinflation. Furthermore, it explains how expansionist fiscal policies end in measured real deficits compatible with the small amount of seigniorage that can be collected at high inflation rates. The model can also accommodate the traditional analysis of explosive hyperinflations if the Patinkin effect is not strong or if indexing breaks down at extremely high inflation rates. The last part of section II discusses the shares in seigniorage accruing to the central bank and deposit banks.

Section III applies the model to the case of Brazil, discussing the banking sector's share of seigniorage, interest rate spreads, and nonperforming loans following the Real Plan, instituted in mid-1994. The reduction of the banking sector's share of seigniorage immediately after the stabilization was a consequence of the changes in required reserves. The increase in required reserves and the decline in seigniorage of the banking sector in part explains the increase in interest rate spreads, the high active real interest rates, and the increase in nonperforming loans after stabilization. The last part of section III offers concluding remarks.

² The concept of the virtual deficit is mentioned by Fischer (1994) in a footnote. He claims that there is a case for calculating a "zero-inflation deficit" (different from the operational deficit) because of the Tanzi effect and because the real interest rate might change if inflation were stabilized.

II. BUDGET DEFICITS AND INFLATIONARY FINANCE

Tanzi (1978) was among the first to explore the impact of inflation on tax revenues. He observed that a rise in inflation could increase or reduce real tax revenues depending on lags in tax collection, built-in elasticity, and indexation. In general, tax collection lags in developing countries, where real tax revenues are assumed to decline as inflation rises, are thought to be long relative to those observed in industrial countries. A rise in inflation would thus increase the budget deficit in developing countries, a process known as the Tanzi effect.

But inflation also affects real expenditures. Bresciani-Turroni (1937), one of the first economists to study the relationship between the inflation rate and the budget deficit, observed that as inflation accelerates, the relationship between the budget deficit and inflation can become negative:

“...the German authors, who have maintained that the depreciation of the mark was the cause of the disequilibrium between income and expenditure (in Germany) because given the imperfect adaptation of income to the monetary depreciation, the yield was diminished, have not considered that in the period now under examination the depreciation of the mark influenced both income and *expenditure* in the same direction. Computed in gold marks, the total expenditure also diminished considerably from July 1919 to February 1920 and more rapidly than the income.”

Patinkin (1993) shows how pressure among political coalitions can lead to the use of inflation to erode the real burden of conflicting nominal expenditure demands by different ministries, as in the case of Israel before 1985. Guardia (1992) reports that during high inflation years in Brazil realized real deficits were always smaller than the programmed real deficits. According to Bacha (1994), programmed real expenditures in Brazil exceeded realized real expenditures because projected inflation was always less than observed inflation, and indexation of expenditures was always avoided.³

A. Government Spending, Deficits, and Inflation

How are spending decisions actually made, in a high inflation country such as Brazil? In the early and mid-1990s, Brazil's Treasury would collect actual federal revenues 10 days at a time, allocate the constitutional shares to state and municipal governments, cover current interest on the public debt, meet the payroll for federal employees, and then allocate the remaining balance to investment and other current expenditures in proportion to congressional appropriations. Then, individual ministries would have discretion over which projects or programs to finance. This system created an arena for bargaining between the national

³Bacha (1994) also proposes a deficit finance model in which the budget deficit is represented by a linear inverse function of inflation.

administration and politicians. And bargaining became an important element in securing congressional support for legislation catering to pork and patronage interests of congress members. It also meant that actual real expenditures deviated from programmed real expenditures in significant ways.

Of course, in high inflation countries some expenditures—such as wages—are indexed. Because indexation is imperfect and linked to past inflation, rising inflation implies declining real wages. Moreover, local governments in Brazil, for instance, used to postpone wage payments when they were short of cash. With double-digit monthly inflation, a 15-day delay in payments implies a significant decline in real expenditures. When the annual inflation rate reaches 4,000 percent a year—as it did in mid-1994—a 15-day delay in payments reduces real expenditures by 15 percent.⁴

With some expenditures indexed and more rigid than others, one would not expect inflation to reduce all expenditures equally in real terms but to affect expenditures that are not subject to strict rules, such as investments by both government agencies and public enterprises. It is this negative relationship between high inflation and real expenditures that can be attributed to the Patinkin effect. When inflation exceeds 1,000 percent a year, observed budget deficits reveal very little about the true fiscal position once inflation is curtailed. If inflation disappears and expenditure commitments remain unchanged, the virtual budget deficit would be much higher than the observed budget deficit at high inflation rates.

One could thus argue that the budget deficit increases with inflation when inflation is low and declines with inflation when inflation is high. At low inflation rates there may be no motivation to index taxes and reduce tax collection gaps, and the Tanzi effect will produce a positive relationship between deficits and inflation. In contrast, when inflation is high, there is a clear incentive to introduce indexation and reduce tax collection gaps. It can also be argued that once arrangements to avoid losses of tax revenues are put in place, they would continue to be used even if inflation were to decline. Thus in countries with long inflationary histories, we would not observe a positive relationship between inflation and the budget deficit because the Tanzi effect would cease to work. Yet because indexation is perceived as a mechanism that perpetuates inflation, stabilization programs often introduce a clause forbidding indexation, as did the Real Plan in Brazil. In an attempt to eliminate the indexation habit, fines on delayed tax payments were no longer indexed to the price level. This policy could reintroduce the Tanzi effect and the positive association between inflation and the budget deficit at low inflation rates.

At the same time, in a country where political coalitions generate conflicting expenditure demands, inflation can be used to accommodate those demands, and the Patinkin effect becomes operative. Payment delays also start to have a significant impact on real

⁴ If payment is postponed by 15 days, real outlays are reduced by 3 percent if inflation is 100 percent, by 7 percent if inflation is 500 percent, and by 10 percent if inflation is 1,000 percent.

expenditures. In these circumstances if tax collection continues relatively well, a rise in inflation will reduce the budget deficit. Nonetheless, under extremely high inflation rates, any indexation scheme would break down, and the possibility of declining real taxes and increasing deficits would reappear.

B. A Formal Model

The inflationary finance model developed in this section is general enough to accommodate different scenarios, that is, at low inflation rates the budget deficit can be assumed to be increasing with inflation, or it may be constant. At high inflation rates the model assumes that the Patinkin effect is operative and that it could dominate the Tanzi effect. At even higher inflation rates indexation could break down and the budget deficit could once again increase with inflation. Thus a cubic function is a natural candidate to express the share of the budget deficit in GDP as a function of the inflation rate in a form consistent with the stylized findings described previously.

Equation 1 shows the share of the budget deficit in GDP, g , as a function of the inflation rate, π :

$$g = g(0) + a\pi^3 + b\pi^2 + c\pi, \quad a > 0, b < 0, c > 0, \quad (1)$$

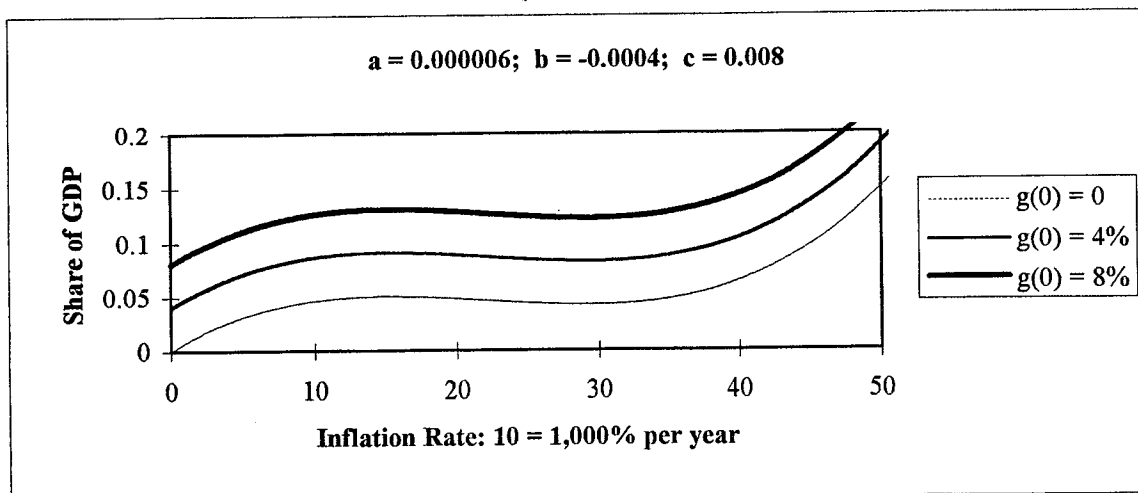
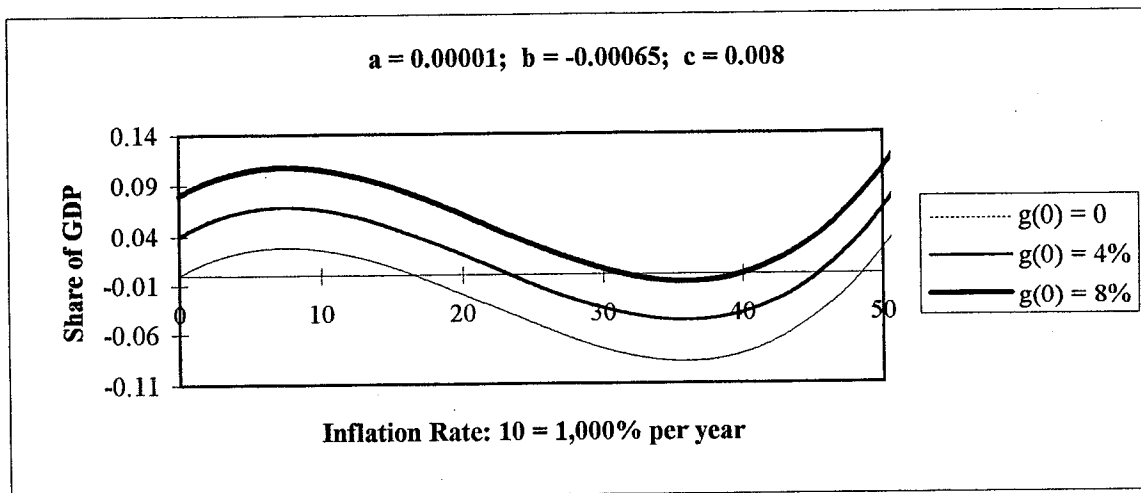
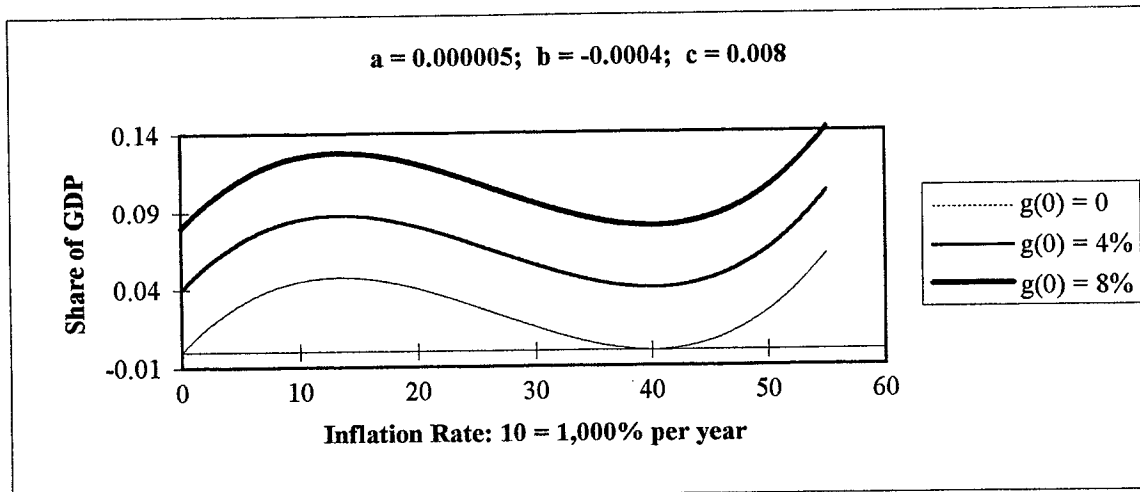
where $g(0)$ is the virtual deficit.

The response of the budget deficit to the inflation rate in equation 1 depends on how strong the Tanzi and the Patinkin effects are at different levels of inflation, that is, it depends on the relative sizes of a , b , and c . Figure 1 shows three different possibilities.

In the first case both effects are relatively modest (a , b , and c are small, that is, the budget deficit does not respond very strongly to inflation). Also, b is big enough relative to a and c to permit the Patinkin effect to dominate the Tanzi effect at annual inflation rates between 1,500 percent and 4,000 percent. The case of a very strong Patinkin effect (a very big b) that would produce a downward sloping schedule starting at low inflation rates cannot be ruled out but is not considered here.

In the second case, the Patinkin effect is strong enough to generate a budget surplus at annual inflation rates between 2,500 percent and 4,000 percent when the virtual deficit is 4 percent of GDP. This case is of interest if we consider Brazil's experience. Between 1990 and 1994, when inflation averaged close to 2,000 percent per year, the primary surplus was 3.5 percent of GDP. It exceeded 5 percent of GDP in 1994 when inflation reached 2,500 percent. The operational balance was also in surplus in 1993 and 1994. In 1995, when inflation fell to 15 percent, the 1994 operational surplus turned into an operational deficit of approximately 5 percent of GDP. Appendix 1 discusses in more detail the empirical evidence on the relation-

Figure 1: The Response of the Deficit to Inflation



Note: a , b , and c are parameters of equation 1 and $g(0)$ is the virtual deficit.

ship between inflation, taxes, expenditures, and the different measures of the fiscal deficit in Brazil.

In the third case the Patinkin effect is not strong enough to generate a declining a relationship between the budget deficit and inflation. That is, b is not big enough relative to a and c to produce a downward sloping schedule at any level of inflation.

Equation 2 expresses seigniorage collected by the central bank as a function of the inflation rate:⁵

$$\Delta H/Y = \mu z/v(\pi), \quad \delta v/\delta \pi > 0 \quad (2)$$

where $\Delta H/Y$ is the ratio of the increase in the monetary base to income, z is the ratio of the monetary base to money, and v is velocity, with a Cagan-type velocity functional form:⁶

$$v = v(0)e^{k\pi} \quad (3)$$

Since the budget deficit is financed by money creation:

$$g(g(0), \pi) = \mu z/v(\pi), \quad (4)$$

it follows that the required money growth to finance the budget is $\mu = g v / z$. Money growth increases when the budget deficit, g , exceeds the amount of seigniorage, $z\mu/v$, generated by the current rate of money growth:

$$\delta \mu / \delta t = \phi(gv/z - \mu) \quad (5)$$

⁵ To obtain equation 2, define the share in income of seigniorage collected by the central bank as $s \equiv \Delta H/Y$. Given $\Delta H \equiv z\Delta M$, where $z \equiv$ the inverse of the money multiplier (or the ratio of H to M), substitution yields $s \equiv z \Delta M/Y$. Divide and multiply this expression by M , define $\Delta M/M$ (money growth) $\equiv \mu$, and assume that the money supply is equal to the demand for money, $M/Y = 1/v(\pi)$.

⁶ In the simulations the parameters of the Cagan function are consistent with those observed in Brazil, where between 1950 and 1995 the central bank's seigniorage averaged about 2 percent of GDP, but never exceeded 4 percent of GDP, even at four-digit inflation rates. Appendix 2 contains the empirical evidence on velocity in Brazil between 1950 and 1995.

In Figure 2 the constant money growth schedule, $\delta\mu/\delta t = 0$, crosses the vertical axis at the point where money growth generates enough seigniorage to finance the virtual budget deficit, $g(0)$. If inflation is low and the Tanzi effect is strong, the schedule slopes upward but declines with inflation once the Patinkin effect becomes strong enough. The schedule would once again reverse its slope at even higher inflation rates (not represented in Figure 2). Above the curve representing constant money growth, $\delta\mu/\delta t = 0$, money growth exceeds the amount of seigniorage needed to finance the budget deficit and is declining. Below the curve money growth is not sufficient to finance the budget deficit and is increasing.

In a model with perfect information and no uncertainty, expected inflation is equal to observed inflation. Inflation inertia exists, nevertheless, as a result of formal and informal indexation mechanisms, and inflation moves slowly to catch up with monetary growth:

$$\delta\pi/\delta t = \theta(\mu - \pi) \quad (6)$$

The constant inflation rate, $\delta\pi/\delta t = 0$, is represented in Figure 2 as the 45° line from the origin. Above it the rate of inflation is lower than the rate of money growth, and inflation is rising; below it the rate of inflation exceeds the rate of money growth and inflation is falling. Inflation and money growth are constant and equal at the point where the two schedules cross, that is, where:

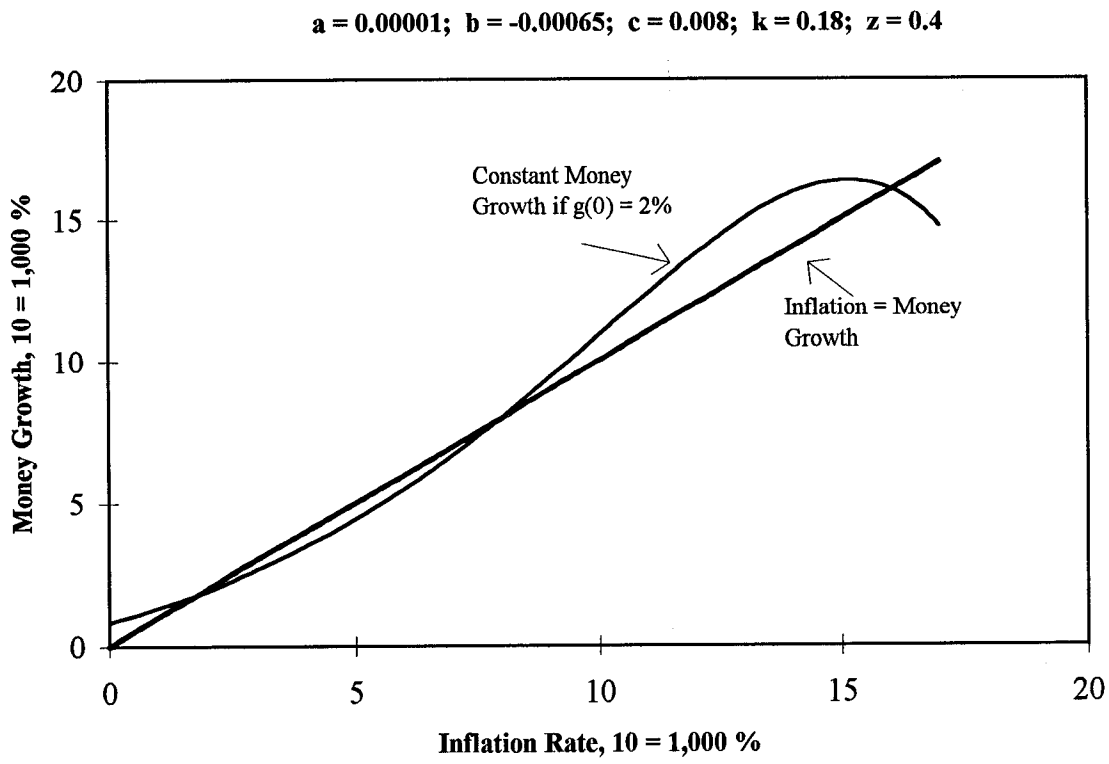
$$\pi = gv/z \quad (7)$$

Observe that the necessary condition for a stable equilibrium is that the constant money growth schedule cross the 45° line from above. Figure 2 shows three equilibria for the set of parameters of the budget function shown in the middle panel of Figure 1 and a virtual deficit of 2 percent of GDP. The parameters of the velocity function are those of Brazil, an economy that has been demonetized by a long inflationary history. There is one stable equilibrium at an inflation rate equal to 190 percent, one unstable equilibrium at an inflation rate equal to 790 percent, and another stable equilibrium at an inflation rate equal to 1,600 percent. There is also a fourth unstable equilibrium at an inflation rate in excess of 4,500 percent (not represented in Figure 2).

C. Expansionary Fiscal Policy

An expansionary fiscal policy is defined here as an increase in the virtual budget deficit—that is, a policy that increases $g(0)$, the difference between expenditures and revenues under a zero inflation rate. If the virtual budget deficit is small relative to the amount of seigniorage that can be collected in the economy, multiple equilibria will arise. As fiscal policy becomes more expansionary, the schedule that shows constant money growth shifts upward (Figure 3). If the virtual budget deficit is higher than the amount of seigniorage that can be raised at any inflation rate, and the Patinkin effect is very strong, the schedule showing constant money growth crosses the 45° line once from above. This equilibrium is stable. If the

Figure 2: Money Growth and Inflation



Note: a, b, and c are parameters from equation 1. k and z are defined in equations 2 and 3.

Patinkin effect is not strong, the schedule showing constant money growth does not slope downwards and expansionary fiscal policies would lead to hyperinflation.

If the Patinkin effect is strong, there is one stable equilibrium for a large range of budget deficits even if seigniorage collection is small and the revenue-maximizing inflation rate generates an amount of seigniorage that is less than the virtual budget deficit. Convergence to this stable equilibrium is through oscillations. As fiscal policy becomes more expansionary, money growth increases ahead of inflation to generate more seigniorage. Inflation catches up with money growth and then exceeds it.

Expansionary fiscal policies, which induce an increase in the virtual budget deficit in excess of maximum seigniorage, increase the steady-state inflation rate (Figure 3 and Figure 9). In the new steady state the share of seigniorage in GDP and the share of the realized budget deficit in GDP are smaller than in the initial steady state, as both decline with inflation when the Patinkin effect dominates the Tanzi effect. This model describes the experience of megainflation countries, such as Brazil from the 1980s to the mid-1990s or Israel before 1985, better than other models of seigniorage, in which very expansionary fiscal policies—policies that imply a virtual budget deficit in excess of optimal seigniorage—result in open hyper-inflation.⁷ In Brazil and in Israel inflation was used to reduce real expenditures and inflation remained at megainflationary levels for long periods without ever exploding into open hyperinflation.

D. Reserve Requirements and Inflation

The model assumes that the ratio of the monetary base to $M1$, z , is a constant. This section examines this assumption more closely. An increase in the ratio of required reserves to deposits raises z and should in principle increase the central bank's share of total seigniorage, reducing money growth and inflation.⁸ If the Patinkin effect is operative, the reduction in inflation would increase the budget deficit which would be financed by higher seigniorage in the new equilibrium. The higher seigniorage, in return, is a result of the decline in velocity in response to the lower inflation rate. Thus an increase in the reserves-to-deposit ratio can produce lower inflation even with an unmodified fiscal policy (unchanged $g(0)$).

The combinations of the long-run equilibrium inflation rate and the central bank's seigniorage share (equation 7)—given the virtual budget deficit, $g(0)$, and demand for money, $v(\pi)$ —are shown in Figure 4. If the virtual budget deficit equals two percent of GDP and the

⁷ The literature on seigniorage defines optimal seigniorage as that obtained at the revenue maximizing rate of inflation.

⁸ Before calculating the tax on cash balances in Austria, Germany, Greece, Hungary, Poland, and Russia after World War I, Cagan (1956) observes that institutions other than the government typically receive some of the revenue from issuing money.

Figure 3: Money Growth and Inflation Equilibria under Different Virtual Deficits

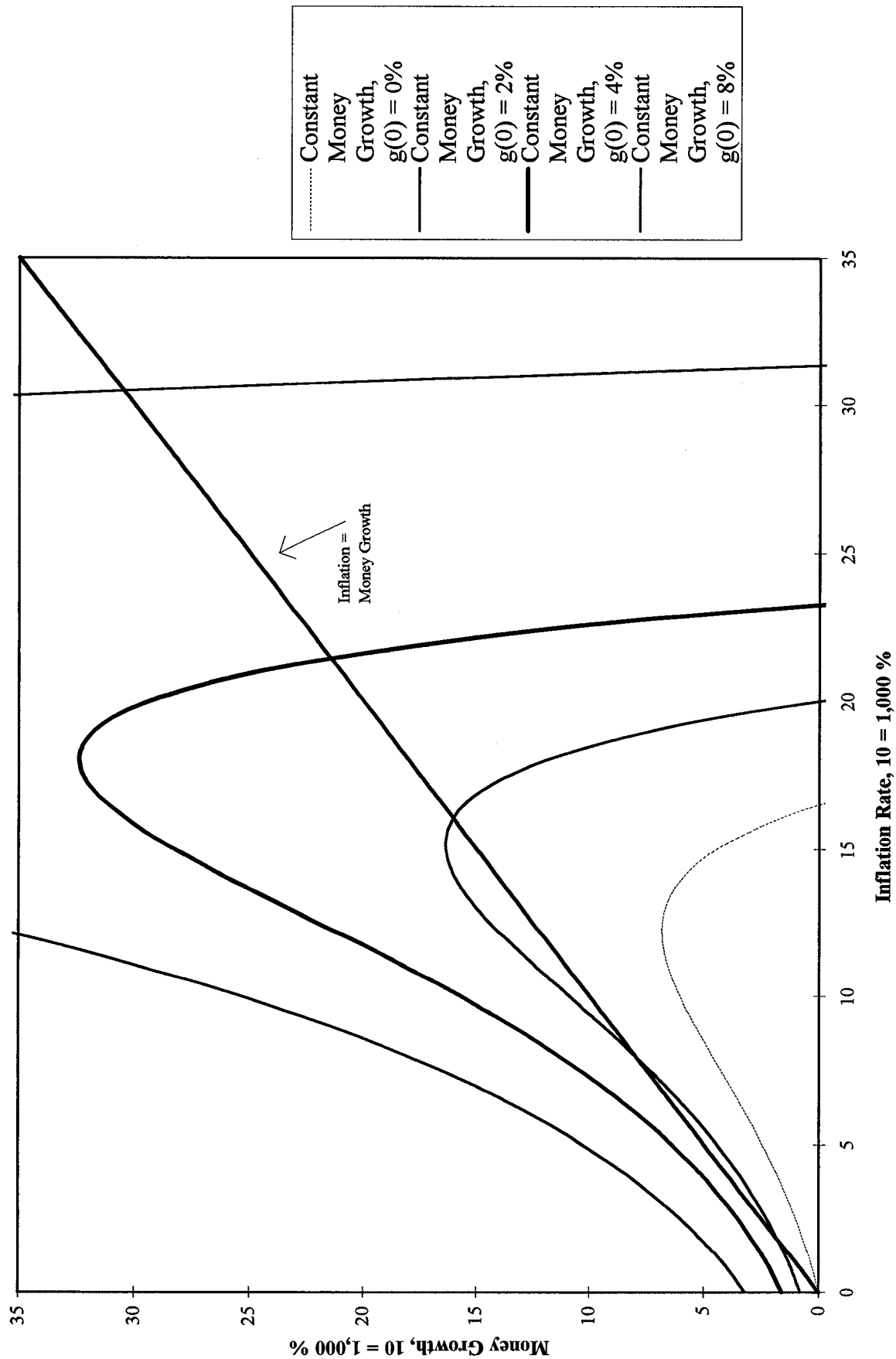
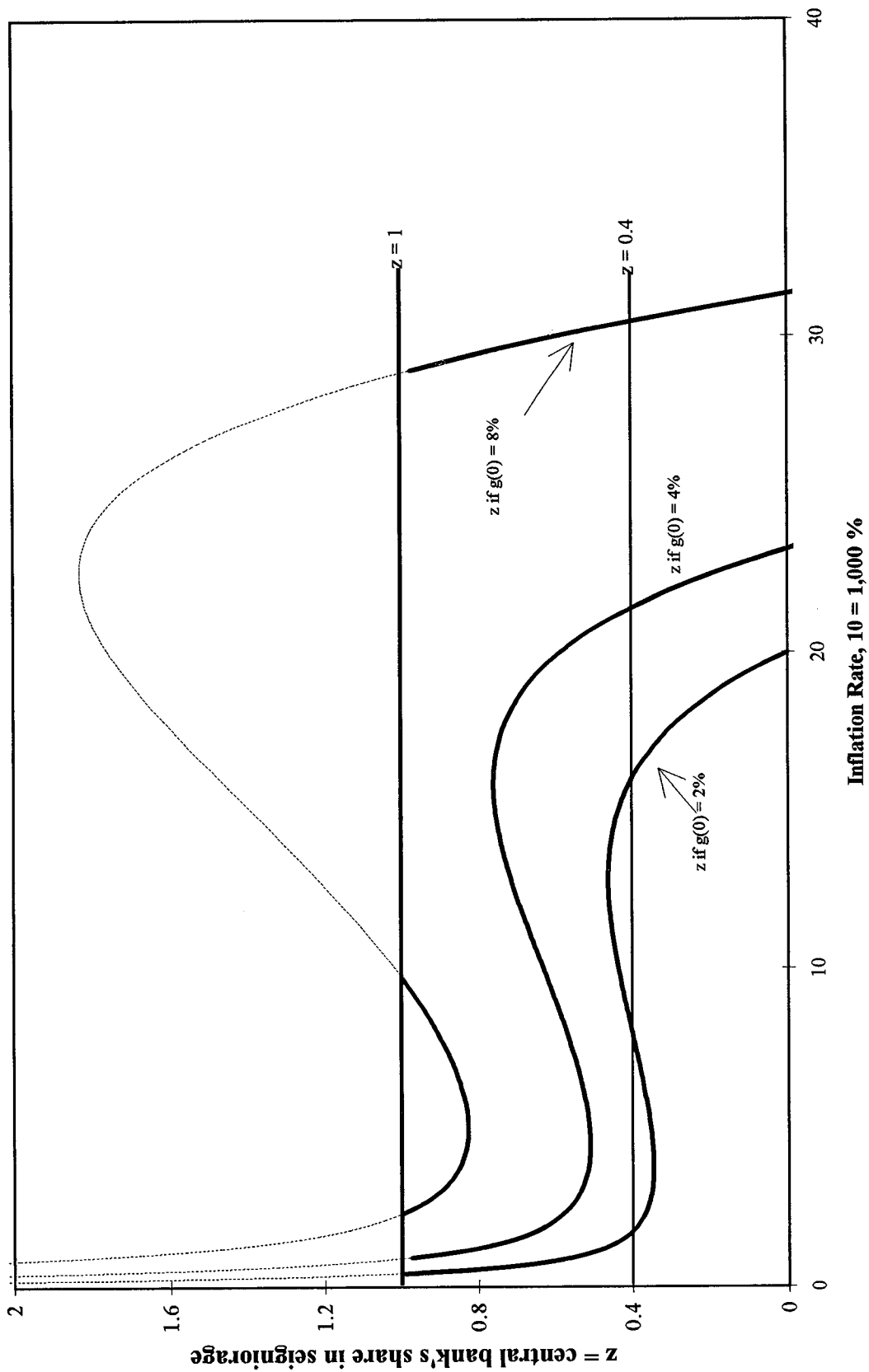


Figure 4: The Central Bank's Share in Seigniorage and Inflation

$a = 0.00001$; $b = -0.00065$; $c = 0.008$; $k = 0.18$



central bank gets two fifths of the seigniorage revenue ($z = 0.4$) four possible equilibria exist (the fourth, unstable equilibrium at inflation in excess of 4,500 percent is not shown in Figure 4). Among the three equilibria, those corresponding to low inflation rate and the high inflation rate are stable, while that corresponding to the average inflation rate is unstable. Starting from a stable equilibrium, an increase in the reserves-to-deposit ratio moves the central bank's share in seigniorage upward and reduces inflation.

If the virtual deficit is very high—for instance, $g(0) = 9$ percent—the possibility of using the required reserves-to-deposit ratio to reduce inflation practically disappears. Inflation then becomes very inelastic with respect to z because the amount of seigniorage that can be collected at high inflation rates is very low. Thus increasing the central bank's share of a very small amount of seigniorage (because inflation is very high) will not significantly increase the amount of the budget that can be financed by seigniorage.

If the virtual budget deficit is not so high, but still high relative to optimal seigniorage collection—for instance, $g(0) = 8$ percent of GDP—the schedule becomes discontinuous. But it is still possible to observe different inflation equilibria at very high required reserves-to-deposit ratios. If the economy is stuck at a high inflation equilibrium, a monetary reform that curtails inflation combined with an increase in the reserves-to-deposit ratio can move the economy from a high inflation equilibrium to a low inflation equilibrium. It is not clear how long this new equilibrium can be sustained if the higher reserves-to-deposit ratio reduces the profits of deposit banks substantially. The increase in required reserves will also have an impact on interest rate spreads that depend on the average costs of funds and the level of reserve requirements. If both spreads and real interest rates increase with stabilization, nonperforming loans may also increase and further contribute to reducing banks' profitability.

III. RESERVE REQUIREMENTS, INTEREST RATES SPREADS, AND NONPERFORMING LOANS AFTER STABILIZATION IN BRAZIL

In mid-1994 Brazil's Real Plan reduced inflation using three types of reforms: a short-lived fiscal adjustment, a monetary reform, and the use of the exchange rate as a nominal anchor. A temporary monetary reform measure linked contracts, prices, wages, and the exchange rate to a single daily escalator and unit of account, the *unidade real de valor* (URV). The adjustment, which began on March 1, 1994, lasted four months. The central bank established a daily parity between the cruzeiro real and the URV based on the current rate of inflation, as reflected in the three most closely watched price indices. Since the cruzeiro real and the URV depreciated relative to the U.S. dollar at roughly the same rate, most prices and contracts were implicitly set in U.S. dollars. On July 1, 1994 a new currency, the real, was introduced by converting contracts denominated in URVs into reals at a rate of one to one. Brazil's success in bringing down inflation was associated with real exchange rate appreciation. This pattern, similar to that observed in other countries where the exchange rate was used as a nominal anchor runs as follows: there is a real exchange rate appreciation, a rise in real wages, a deterioration in external accounts, an economic boom, and then a slowdown.

Brazil's stabilization was supported by tight monetary policy that was based on an increase in reserve requirements. The increase in required reserves and the decline of inflation led to a substantial decline in the inflationary revenues of deposit banks (Table 1 and Table 2). The required reserves-to-deposit ratio increased from an average of 26 percent during January-June 1994 to an average of 64 percent during November 1994-April 1995.⁹ With the increase in reserve requirements following implementation of the Real Plan, the share in total seigniorage seized by the central bank (z , the inverse of the money multiplier) increased from an average of 60 percent during January-June 1994 to an average of 84 percent in the period January-June 1995. As a consequence the share in GDP of seigniorage seized by deposit banks fell from 2 percent to close to zero (Figure 5).¹⁰ This decline is consistent with estimates by the *Instituto Brasileiro de Geografia e Estatística* (IBGE 1997) calculated using a different methodology (Table 2). IBGE calculated banks' inflationary revenue in two steps. First, the difference between the monthly average stock of noninterest bearing-liabilities and the noninterest-earning assets, NNL, was multiplied by the monthly inflation rate of the general price index (IGP-DI) to obtain the inflationary revenue. Then monthly revenues were added and the annual sums were divided by GDP. Although IBGE found higher inflationary revenues in deposit banks, the magnitude of the change in the seigniorage revenue of deposit banks between 1993 and 1994 was 2 percent, as it is here.

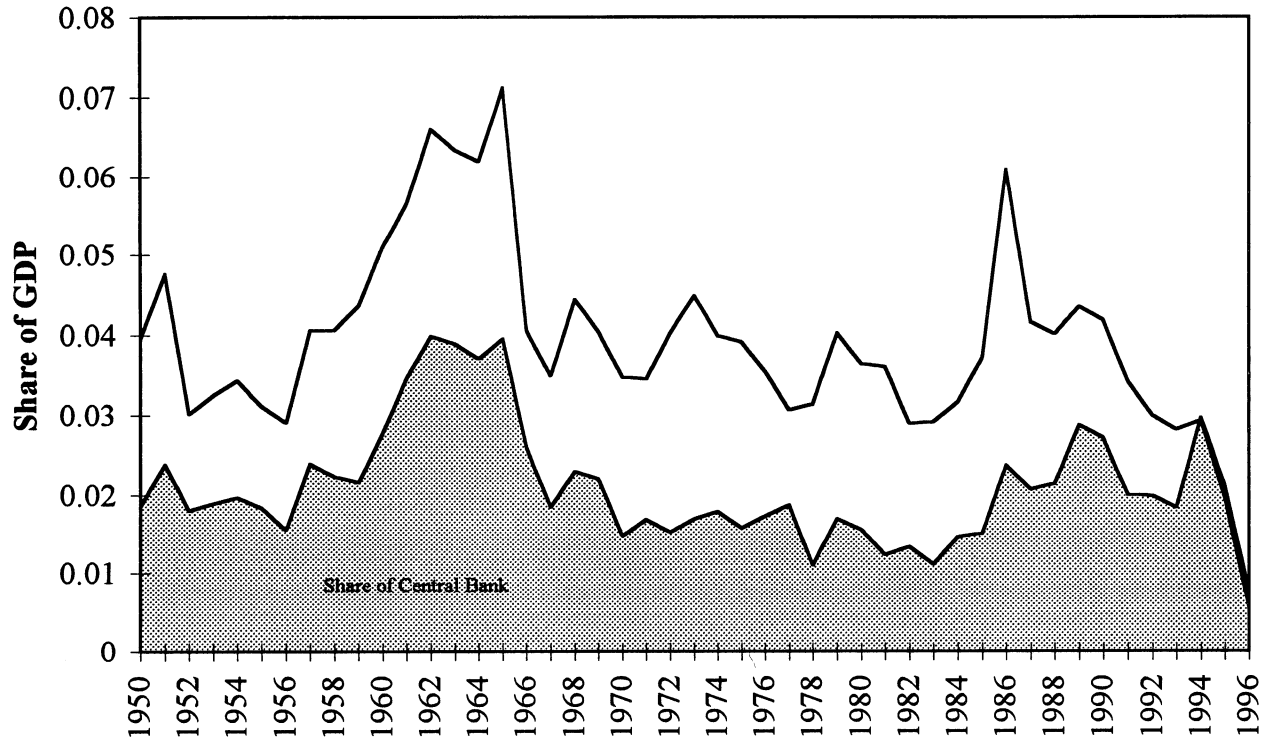
The reduction of the deposit banks' share in total seigniorage is explained by the increase in required reserves. Following the stabilization, the rise in required reserves not only contributed to the increase in seigniorage collection by the central bank, but it also explains in part the increase in spreads between passive and active rates. This spread increased from 4 percent per year in January-June 1994 to 86 percent per year in January-June 1995 (Campelo, 1997). Required reserves were gradually reduced, but other factors contributed to keeping the spreads high—such as taxes on financial transactions and the increase in nonperforming loans motivated by the increase in real interest rates. Nonperforming loans doubled from an average of 7.8 percent of total loans during July-September 1994 to an average of 15.6 percent during February-August 1997.

Seigniorage collected by banks did decline with stabilization but not seigniorage collected by the central bank. At least, not immediately. In 1993, the peak inflation year, seigniorage collected by the central bank was 1.8 percent of GDP. It increased to 3 percent in

⁹ In the second half of 1994 the required reserves-to-loans ratio increased from 0 to 15 percent, the required reserves-to-savings deposits rose from 20 to 30 percent, and in May 1995 required reserves to time deposits also increased from 20 to 30 percent (source: Brazil's central bank).

¹⁰The share in GDP of deposit banks' seigniorage is: $(1 - z)\Delta M1/GDP = [(1 - R/D)/(1 + C/D)]\Delta M1/GDP = (\Delta M1 - \Delta H)/GDP$, where R/D is the reserves to deposit ratio and C/D is the currency deposit ratio. This share was calculated using changes in the average money balances during the year.

Figure 5: Brazilian Banks' Seigniorage Revenue as Percentage of GDP, 1950-1996



Source: Banco Central do Brasil, *Boletim do Banco Central* (monetary base from table II.2 and non-interest bearing required reserves from table II.4)

Total seigniorage = change in annual average M1.

Central bank's seigniorage = change in annual average monetary base + noninterest bearing required reserves.

Deposit banks' seigniorage = difference between total and central bank's seigniorage.

1994, the year of the Real Plan and was 2 percent in 1995—the level of average seigniorage during the high inflation years.¹¹ This evidence supports the view that the decline in the inflation rate was achieved through the monetary reform, the fixing of the exchange rate, and tight monetary policy. Stabilization was not achieved through a tightening of fiscal policy which would have reduced financing of the deficit through seigniorage collected by the central bank. A more balanced policy would not have transferred the revenues from money creation so drastically from deposits banks to the central bank and would have avoided the increase in interest rate spreads and nonperforming loans.

IV. CONCLUDING REMARKS

The Patinkin effect contributes to the understanding of sustained extreme inflation rates. Using parameters of Brazil's velocity function between 1950 and 1995, and evidence from the relationship between inflation and fiscal deficits in Brazil, the paper simulates an inflationary model in which extremely high inflation rates are stable and do not explode into open hyperinflation.

The paper also argues that in analyzing inflation stabilizations, attention should be paid to the virtual deficit—an estimate of what the deficit would be if inflation were reduced to zero. The virtual deficit is different from the operational or inflation-adjusted deficit, which deducts the decline in the real value of government debt caused by inflation from the nominal deficit, because it takes into account both the Tanzi and Patinkin effects and because the real interest rate might change if inflation were stabilized.

Following stabilization, fiscal adjustment may have to be more severe than projected, since inflation clouds structural fiscal problems if expenditures are not indexed and the Patinkin effect is strong. Moreover, the high real interest rates that follow stabilization expose banks' weaknesses, which demand fiscal resources for restructuring. If many public banks have accumulated bad loans to local governments, sustainable reform will require an even harsher fiscal effort. By mid-1997 Brazil's fiscal adjustment that could sustain recently achieved low inflation had not yet been undertaken.

¹¹ Because a decline in total seigniorage collection was matched by a decline in seigniorage collection by the commercial banks, leaving seigniorage collected by the central bank unchanged, there was not a wealth effect from the decline in inflation, but only a transfer between the banking sector and the nonbanking sector. In 1996 though, the central bank's seigniorage did decline to 1 percent of GDP.

THE BUDGET DEFICIT AND INFLATION IN BRAZIL

In the model developed in the paper, two important empirical relationships play a role in determining equilibria: the effect of inflation on the budget deficit and the response of velocity to inflation. This appendix examines the empirical evidence on the relationship between the budget deficit and inflation, and then studies the relationship between velocity and inflation in Brazil during 1949-95.

An analysis of Brazil's public finances relies on three concepts of fiscal balance: the public sector borrowing requirement (PSBR), the operational balance, and the primary balance. The PSBR is equal to total revenues less total expenditures of the public sector which includes all government levels, the central bank, and public enterprises, but excludes state and federal banks. Traditional analysis uses the PSBR—which peaked at 83 percent of GDP in 1989 (Table 3)—to assess the impact of the government's actions on aggregate demand and inflation. But the PSBR may not be the appropriate measure of the deficit in countries with high inflation and a high ratio of domestic public debt to GDP (see for instance, Blejer and Cheasty, 1993). Interest payments rise with the increase in the inflation component of the nominal interest rate on the domestic debt. But these increased payments represent compensation for the erosion of the real value of the debt principal. Payment of the inflation component of the nominal interest rate is thus equivalent to a financing item used to amortize the public debt. It follows that a more meaningful measure of the deficit should exclude the payment of the inflation component of the nominal interest from the PSBR. Exclusion of this component yields the operational balance, which uses the real interest rate in calculating interest payments. Because real interest rates are sensitive to monetary policy and the level of activity in the economy and because interest payments are the result of deficits incurred in previous years, a narrower definition of fiscal balance, which excludes interest payments from expenditures, could reflect more clearly the discretionary budgetary stance. This measure is the primary balance.¹²

The relationship between the primary budget deficit and inflation in Brazil during 1983-96 was negative; at very high inflation rates the primary balance was in surplus. The relationship between the operational budget deficit and inflation also seems to be negative

¹² A difficult issue, which the fiscal figures in Table 3 do not reflect, concerns the quasi-fiscal deficits in federal and state banks, which could be substantial. For instance, the federally owned Banco do Brasil has traditionally subsidized credit to agriculture, and the National Bank of Development (BNDES) subsidizes credit to exporters. In 1996 the Treasury recapitalized Banco do Brasil by 7.9 billion reals (more than one percent of GDP). This recapitalization has contributed to the increase of total net public debt, estimated to have risen from 30 percent of GDP in 1995 to 35 percent in 1996. The costs of restructuring the banking sector and the impact of these changes on the fiscal budget are not yet clear. And with the end of high inflation, bad loans from state banks to state governments have also emerged as a serious problem.

(Figure 6). There is no consistent information that would allow the calculation of operational deficits before 1981, ruling out observations for periods of low inflation. Among the 15 observations for the operational budget deficit, only five correspond to inflation rates below 200 percent. The 15 observations are too few to permit meaningful empirical results. In a simple ordinary least square regression, the relationship between the budget deficit and inflation is negative and thus consistent with a strong Patinkin effect.

Even though data for the operational deficit do not exist before 1981, data for some components of expenditures and taxes are available. To show that the existing information is consistent with the hypotheses in section II of the paper, empirical tests should: reject the hypothesis that there is an inverse relationship between taxes and inflation and reject the hypothesis that there is a positive relationship between investment spending and inflation, since investment expenditures are easier to cut than wages and salaries. The relationship between consumption expenditures and inflation is trickier: part of these expenditures (such as wages and salaries) were indexed until recently. Furthermore, there could be a positive relationship between expenditures and inflation with causality running from expenditures to inflation.

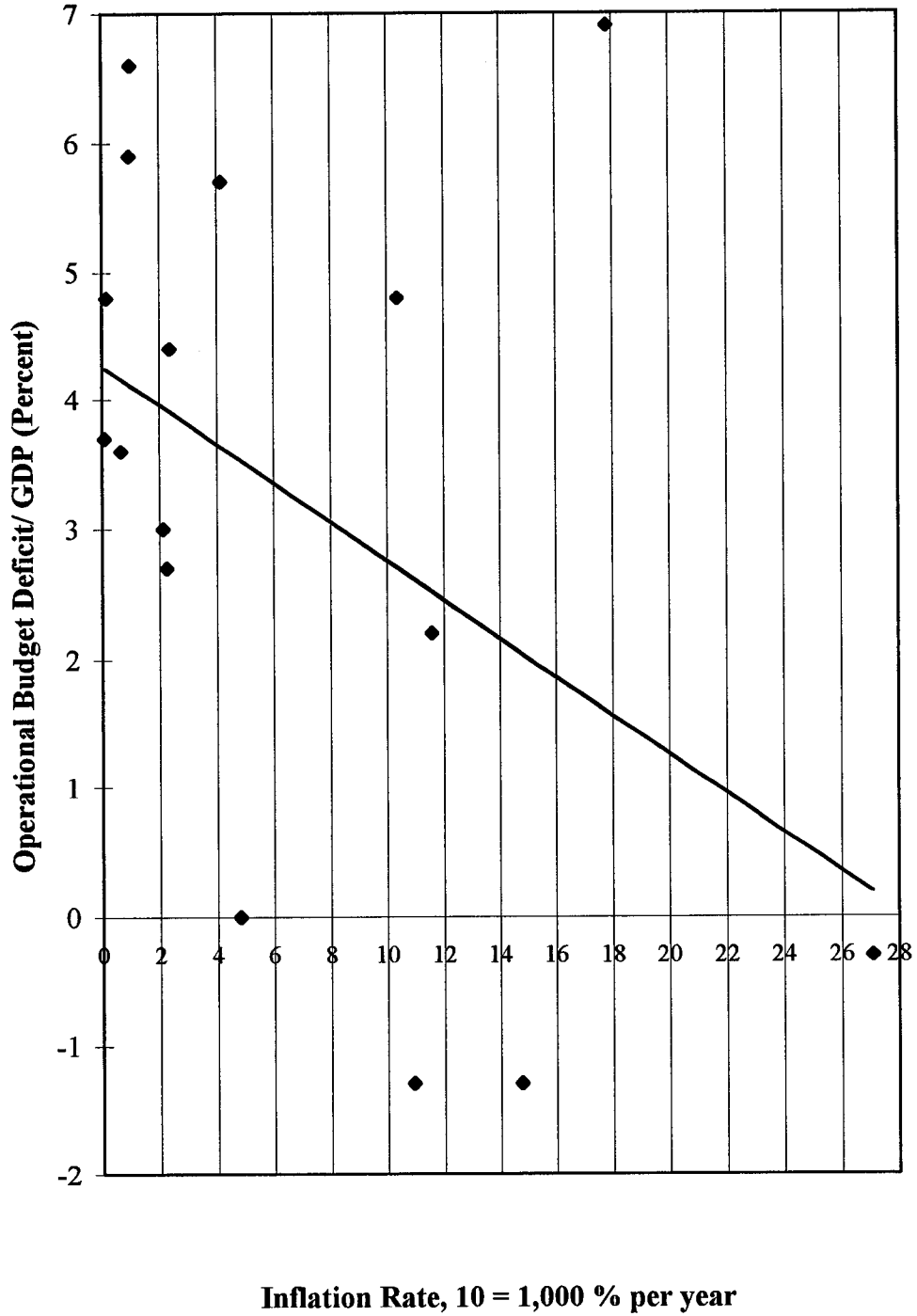
Table 4 shows the results of unit root tests for the shares in GDP of income taxes, sales taxes, government consumption expenditures, and investment by public enterprises.¹³ The hypothesis that the share in GDP of income taxes, sales taxes, and government's consumption expenditures have a unit root cannot be rejected. The Dickey-Fuller statistic for the share of investment by public enterprises in GDP rejects the unit root hypothesis at the 1 percent and 5 percent levels.

Table 5 shows the results of cointegration tests for income taxes, sales taxes, and inflation. The tests reject any cointegration at the 5 percent significance level. The evidence does not support the existence of a Tanzi effect during the high inflation years in Brazil.

On the consumption expenditure side, the Johansen cointegration test indicates one cointegrating equation at the 5 percent significance level, and the relationship between consumption expenditures and inflation is positive (Table 6). But considering wage indexation and the reversed causality between expenditures and inflation, this result, even if it does not support the Patinkin effect, is not surprising. A Granger causality test gives mixed results: with a one-year lag, the test cannot reject the hypothesis that government spending does not cause inflation. But with a one-year lag and a two-year lag, the test rejects the

¹³ Data for taxes and government consumption expenditures are from Brazil's national accounts for the years between 1965 and 1994, except where noted. Income taxes are collected by the central government. The sales taxes are value-added taxes collected by state governments (ICMS) and by the central government (IPI). Data for investment by public enterprises between 1980 and 1996 are from the Treasury Department of the Finance Ministry.

Figure 6: Operational Budget Deficit as Share of GDP and Inflation, Brazil, 1981-1996



hypothesis that government spending does not cause inflation. With a two-year lag the test indicates that there is a 22 percent probability that inflation does not cause government spending (Table 7).

There are fewer observations for investment by public enterprises than for the other variables, and thus the tests are weaker. Still they reject the hypothesis of a unit root for the share of investment by public enterprises in GDP. The OLS regressions reported in Table 8 show that an increase in inflation reduces this share. The coefficient is significant and robust to different specifications.

The empirical findings are broadly in line with the hypothesis of a negative relationship between real budget deficits and high inflation rates in Brazil. Such a relationship stems from the interaction of two forces. First, Brazil's tax system has been continuously adjusted to protect real tax collections; collection lags are small, and until mid-1994 late payments and fines were indexed. As a consequence, the ratio of tax revenues to GDP varied little despite enormous oscillations in inflation. The share of central government revenues in GDP remained around 15 percent of GDP between 1986 and 1993, when inflation peaked. In contrast, not all expenditures were indexed and realized real expenditures were less than programmed real expenditures. Furthermore, the share of investment by public enterprises shows a significant negative relationship with inflation.

VELOCITY AND SEIGNIORAGE

Velocity—defined as the ratio of income to M1—increased in Brazil from 4.5 in 1950 to 32 in 1993, when annual inflation reached 2,700 percent. At the same time the ratio of income to high-powered money peaked at 52. Basic descriptive statistics for velocity and inflation in Brazil between 1950 and 1995 appear in Table 9. Figure 7 shows the very strong positive relationship between the growth rate of velocity and the growth rate of inflation during that period.

Unit root tests on velocity and inflation cannot reject the hypothesis that velocity and inflation have unit roots (Table 10). Velocity and inflation are endogenous variables in models in which the demand for money depends on expected inflation and inflation depends on money growth. These models predict that velocity and inflation are cointegrated. Cointegration tests strongly reject the hypothesis that there is no cointegration of velocity and inflation—that is, that velocity and inflation do not have an equilibrium condition that keeps their proportion constant in the long run. The logarithm of velocity and inflation are also cointegrated, and the normalized cointegrating vector shows a coefficient of -0.18, a value consistent with the theoretical prediction of a positive relationship between the logarithm of velocity and inflation, as in Cagan's function for the demand for money (Table 11).

As in Cagan's specification of the velocity function, the short-run relationship between velocity and expected inflation in log-linear form is:

$$\log (v_t) = a_0 + a_1 \pi_t^e + a_2 \log (v_{t-1}) + \varepsilon_t \quad (8)$$

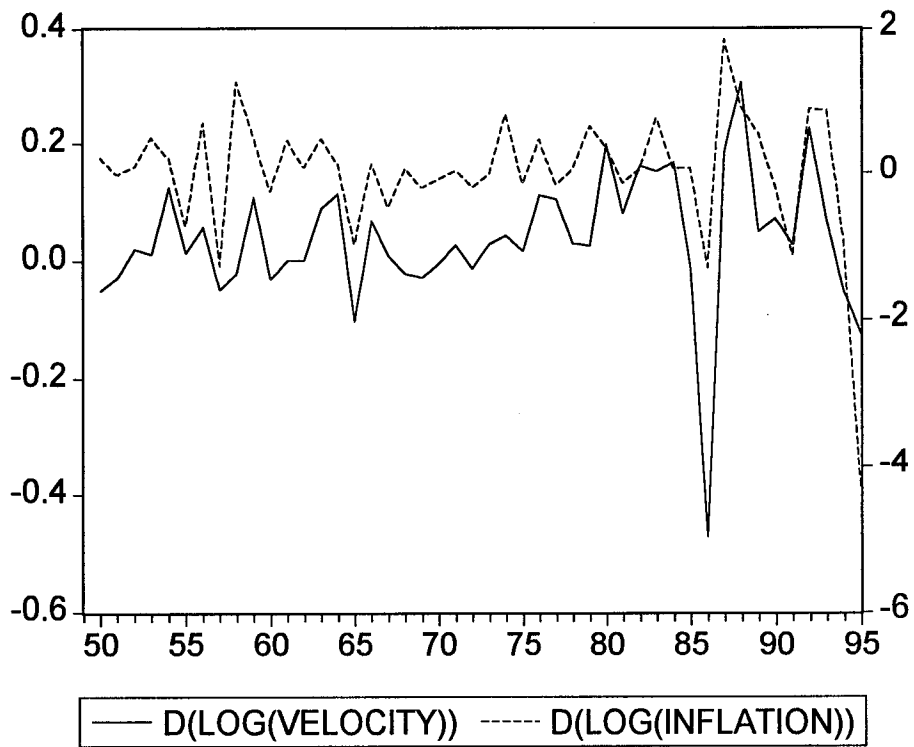
where v is velocity, π^e is expected inflation, and ε is a random error.

A regression analysis was performed using annual data for Brazil from 1950 to 1995 (Table 12). As instruments for inflation, the equations use the lagged inflation rates in the four previous years and dummies for the periods before and after the introduction of formal indexation in 1968, for the periods before and after the oil shock in 1974, for the Cruzado Plan in 1986, and for the Real Plan in 1994–95.

The log-linear equation reported in column 1 of Table 12 implies that, in the long run, the response of the logarithm of velocity to inflation equals $a_1/(1-a_2) = 0.15$. This value is very close to 0.18, the long-run estimate in the cointegrating equation in Table 11. If inflation is zero in the long run, the natural logarithm of velocity equals $a_0/(1-a_2) = 2.354$, close to the constant in the cointegrating equation in Table 11. It follows that when inflation is zero, the long-run velocity is 10.25.

Section II of this paper used the parameters estimated here in the simulations of the inflationary finance model. These parameters imply a Laffer curve for the inflation tax, with a

Figure 7: Growth Rate of Velocity and Growth Rate of Inflation in Brazil, 1950-1995



maximum inflation tax in the steady-state equal to 4.8 percent of GDP when inflation is 213 percent.

Seigniorage

The share in GDP of seigniorage collected by the central bank in Brazil has averaged 2 percent of GDP during the past 47 years. It remained unchanged in 1994-95 after the Real Plan succeeded in sharply reducing inflation. Seigniorage collected by deposits banks declined.

Total seigniorage, the revenue from money creation collected by the central bank and deposit banks, is defined as:

$$TS_t \equiv M_t - M_{t-1} \tag{9}$$

where TS is seigniorage and M is currency and noninterest-bearing demand deposits. The portion of seigniorage that accrues to the central bank corresponds to the change in high-powered money (currency and reserves), and the portion of seigniorage that accrues to deposits banks is the change in noninterest-bearing demand deposits minus reserves.

The ratio of total seigniorage to income is denoted by ts . In the steady state:

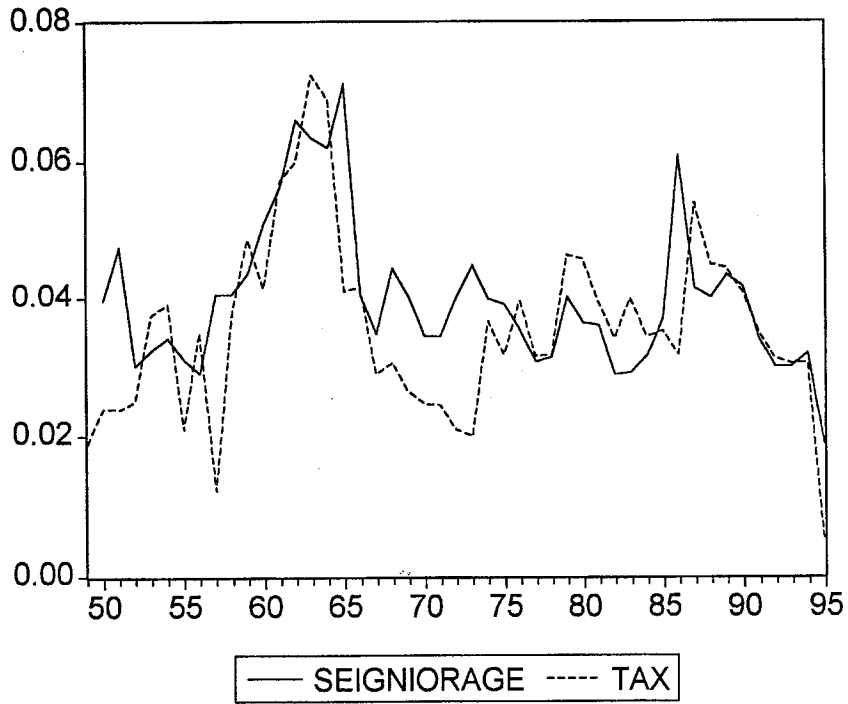
$$ts = \frac{1}{v} \left[\frac{(1+x)(1+\pi) - 1}{(1+x)(1+\pi)} \right] \tag{10}$$

where v is velocity and x is the growth rate of real income.¹⁴ If the growth rate of real income were zero in the steady state, then, in the steady state, with constant velocity, total seigniorage would be equal to the inflation tax, $\lambda = (1/v) (\pi/(1+\pi))$.

In the short run money growth is different from the inflation rate because velocity moves and the growth rate of real income is different from zero. Thus, as expected, a comparison of short-run total seigniorage to GDP ratios and short-run inflation tax to GDP ratios between 1950 and 1995 shows that the two ratios were never identical because the growth rate of money and the inflation rate differed. But during 1950-95 both short-run seigniorage and the inflation tax for the entire banking system, including the central bank, never exceeded 8 percent of GDP in any year (Figure 8). Total seigniorage collected by the central bank and deposit banks together averaged 4 percent of GDP.

¹⁴ To obtain equation 10, divide equation 9 by current income, Y_t , then divide and multiply by lagged income. In steady state $v_t = v_{t-1} = v$, and $(1 + \mu) = (1 + \pi)(1 + x)$, where μ is the growth rate of money, π is the inflation rate, and x is the growth rate of real income.

Figure 8: Seigniorage and Inflation Tax of Brazilian Banks as Share of GDP, 1950-1995

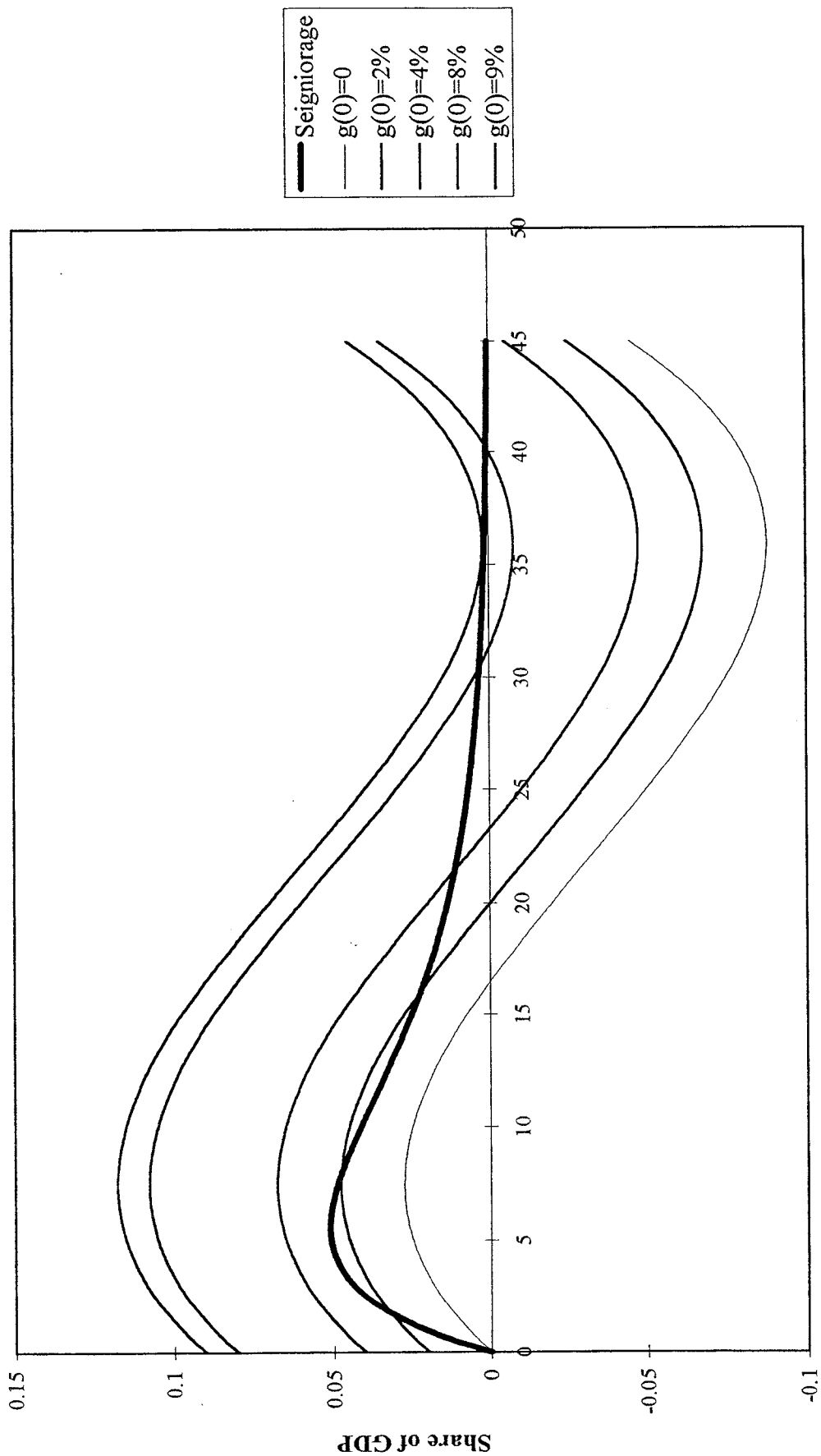


AN ALTERNATIVE REPRESENTATION OF THE INFLATIONARY FINANCE MODEL

Figure 9 shows an alternative representation of the model presented in section II. Inflationary revenue in the steady state is represented by the thick Laffer curve labeled seigniorage. The budget deficit as a function of the inflation rate, equation 1, is shown for different levels of the virtual budget deficit (between 0 and 9 percent). The figure exhibits multiple equilibria for virtual budget deficits of 2, 4, and 8 percent of GDP. There is only one stable equilibrium for virtual budget deficits between 4 and 8 percent of GDP. As the virtual deficit increases, the inflation rate increases as the economy moves from one stable equilibrium to the next. In this example, for virtual budget deficits in excess of 9 percent of GDP, there is no equilibrium.

Figure 9: An Alternative Representation of Equilibria in the Inflationary Finance Model

$a = 0.00001$; $b = -0.00065$; $c = 0.008$; $k = 0.18$; $z = 0.4$



Inflation Rate, 10 = 1,000 %

Table 1. Seigniorage in Brazil, 1950–95

Institution	Average (percentage of GDP)	Standard Deviation (percent)
Central Bank	2.1	7.5
Deposit Banks	1.8	7.5
Total	3.9	1.2

Note: Total seigniorage is calculated as the increase of the annual average M1 relative to the annual average M1 one year before. Seigniorage collected by the central bank is equal to the increase of the annual average monetary base inclusive of all noninterest bearing required reserves relative to the same variable one year before. The seigniorage collected by deposit banks is equal to the difference between total seigniorage and seigniorage collected by the central bank.

Source: Banco Central.

Table 2. Inflationary Revenue of Private and Public Banks in Brazil, 1990–95

(percentage of GDP)

Deposit Banks	1990	1991	1992	1993	1994	1995
Private Banks	1.4	1.4	1.7	1.6	0.7	-0.0
Public Banks	2.6	2.4	2.3	2.7	1.3	0.0
Total	4.0	3.8	4.0	4.2	2.0	0.0

Source: Instituto Brasileiro de Geografia e Estatística (1997).

Table 3. Brazil: Public Sector Balance, 1983–96

(percentage of GDP)

Year	Public Sector Borrowing Requirement	Primary Balance (PB) (- = deficit)	Real Interest Payments (RIP)	Operational Balance (OB = PB - RIP) (- = deficit)
1983	19.9	1.7	4.7	-3.0
1984	23.3	4.2	6.9	-2.7
1985	28.0	2.6	7.0	-4.4
1986	11.3	1.6	5.2	-3.6
1987	32.3	-1.0	4.5	-5.7
1988	53.0	0.9	5.7	-4.8
1989	83.1	-1.0	5.9	-6.9
1990	29.6	4.6	3.3	1.3
1991	27.2	2.8	2.8	0.0
1992	44.2	2.3	4.5	-2.2
1993	58.1	2.6	2.4	0.3
1994	43.8	5.1	3.8	1.3
1995	7.1	0.4	5.1	-4.8
1996	6.1	-0.1	3.8	-3.7

Source: Fundação Getúlio Vargas, *Conjuntura Econômica*, May 1997.

Table 4. Brazil, Unit Root Tests on Income Taxes, Sales Taxes (1965-1994), Government Consumption Expenditures (1965-1995), and Public Enterprises Investment (1980-1996)

	Income taxes/ GDP	Sales Taxes/ GDP	Government Consumption/ GDP	Public Enterprises' Investment/ GDP
Augmented Dickey-Fuller Test (equation includes intercept, change in lagged variable and trend)	-2.2365	-1.6858	-1.2540	-3.9658
1% critical value	-4.3226	-4.3226	-4.3082	-4.7315
5% critical value	-3.5796	-3.5796	-3.5731	-3.7611
Phillips-Perron Test (equation includes intercept)	-2.8305	-2.4995	0.2289	-0.8000
1% critical value	-3.6752	-3.6752	-3.6661	-3.9228
5% critical value	-2.9665	-2.9665	-2.9627	-3.0659

Table 5. Brazil, Johansen Cointegration Test Statistics for Taxes and Inflation, 1965-94

	Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value
Hypothesis: There is no cointegration between income taxes and inflation	0.241	11.25	15.41	20.04
Hypothesis: There is no cointegration between sales taxes and inflation	0.1104	6.026	15.41	20.04

Note: The log likelihood is 43.33. The lag interval is 1 to 1.

Table 6. Brazil, Johansen Cointegration Test for
Government Consumption Expenditures and Inflation, 1965-95

	Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value
Hypothesis: There is no cointegration	0.686	34.90	19.96	24.60
Hypothesis: At most one equation	0.044	1.30	9.24	12.97

Normalized Cointegrated Coefficients (One Cointegrating Equation)

Government Consumption Expenditures	Inflation	Constant
1.00	-0.0046 (0.0003)	-0.100

Note: Standard errors are in parentheses. The Log likelihood is 58.82. The lag interval is 1 to 1.

Table 7: Brazil, Granger Causality Tests for
Government Consumption Expenditures and Inflation, 1965-95

Null Hypothesis	Lags	Observations	F-Statistic	Probability
Inflation does not cause government consumption expenditures	1 (one year)	30	2.75	0.110
Government consumption expenditures do not cause inflation			0.44	0.510
Inflation does not cause government consumption expenditures	2 (two years)	29	1.59	0.220
Government consumption expenditures do not cause inflation			7.81	0.002

Table 8. Regression Analysis.
Dependent Variable: Ratio of Public Enterprises' Investment to GDP, 1980-96

Constant	3.39 (5.69)	0.74 (2.51)
Inflation	-0.07 (-1.89)	-0.03 (-4.18)
Public Enterprises' Investment (-1)		-0.60 (-4.401)
Dummy for period after 1985		0.80 (7.74)
Adjusted R-squared	0.14	0.87

Note: t-statistics in parentheses corrected by Newey-West standard errors and covariance.

Table 9. Brazil: Descriptive Statistics of Velocity and Inflation, 1949-95
(Number of observations = 47)

Measure	Velocity Levels (Income/M1)	Inflation Rate (Average percent per year)
Mean	11.0	259
Median	7.0	39
Minimum	4.5	7
Maximum	32.0	2,700

Source: Central Bank and author's calculations.

Table 10. Brazil: Unit Root Tests on Velocity and Inflation, 1949-1995
(Number of observations = 47)

	Velocity	Inflation	Critical Values
Augmented Dickey-Fuller Test (equation includes intercept and change in lagged variable)	-0.358	-3.332	-3.581 ¹ -2.927 ²
Phillips-Perron Test (equation includes intercept)	0.373	-2.721	-3.578 ¹ -2.926 ²
(equation includes intercept and trend)	-1.649	-3.319	-4.168 ¹ -3.509 ²

¹ 1 percent critical value.

² 5 percent critical value.

Table 11. Brazil: Johansen Cointegration Test Statistics for Velocity and Inflation, 1949-95

	Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value
Hypothesis: There is no cointegration	0.4977	33.03	19.96	24.60
Hypothesis: At most one equation	0.0444	2.04	9.24	12.97

Normalized Cointegrated Coefficients (One Cointegrating Equation)

Velocity	Inflation	Constant
1.0000	-2.279 (0.354)	-6.4946 (1.116)

Note: Standard errors are in parentheses. The log likelihood is -157.5117. The lag interval is 1 to 1.

Table 12. Brazil: Johansen Cointegration Test for Log (Velocity) and Inflation, 1949-95

	Eigenvalue	Likelihood ratio	5 Percent Critical Value	1 percent Critical Value
Hypothesis: There is no cointegration	0.3909	26.94	19.96	24.60
Hypothesis: At most one equation	0.0978	4.63	9.24	12.97

Normalized Cointegrated Coefficients (One Cointegrating Equation)

Log (Velocity)	Inflation	Constant
1.0000	-0.1813 (0.0370)	-1.842 (0.1319)

Note: Standard errors are in parentheses. The Log likelihood is -39.63252. The lag interval is 1 to 1.

Table 13. Results of Regression Analysis Using Instrumental Variables, 1949–95

Dependent Variable:	Log (Velocity)	Growth Rate of Velocity
Constant	0.178 (1.962)	0.043 (2.765)
Expected inflation	0.0113 (2.2825)	
Expected growth rate of inflation		0.0835 (3.948)
Log (velocity ₋₁)	0.924 (20.907)	
Adjusted R ²	0.96	0.30
Durbin-Watson	1.89	1.72

Note: t-statistics are in parentheses. Included observations after adjusting endpoints = 43. The instruments used for inflation include lagged inflation in four previous years, and four dummies: (i) period before and after the introduction of formal indexation in 1968, (ii) period before and after the oil shock in 1974, (iii) Cruzado Plan in 1986, and (iv) the Real Plan in 1994-1995.

REFERENCES

- Bacha, Edmar, 1994, "O Fisco e a Inflação: Uma Interpretação do Caso Brasileiro." *Revista de Economia Política* 14(1), pp. 5-17.
- Blejer, Mario and Adrienne Cheasty, 1993, "How to Measure the Fiscal Deficit," Washington, D.C.: International Monetary Fund.
- Bresciani-Turroni, Constantino, 1937, "The Economics of Inflation," translated by Millicent E. Sayers (London: Allen and Unwin).
- Cagan, Phillip, 1956, "The Monetary Dynamics of Hyperinflation." In Milton Friedman, editor, *Studies in the Quantity Theory of Money* (Chicago: The University of Chicago Press).
- Campelo Jr., Aloísio, 1997, "Por Que os Juros Não Caem." *Conjuntura Econômica* 51(7), pp. 35-6.
- Fischer, Stanley, 1994, "Modern Central Banking." In Forrest Capie, Charles Goodhart, Stanley Fischer, and Norbert Schnadt, editors, *The Future of Central Banking: the Tercentenary Symposium of the Bank of England* (New York, N.Y.: Cambridge University Press).
- Guardia, E.R., 1992, Orçamento Público e Política Fiscal: Aspectos Institucionais e a Experiência Recente. M.A. Dissertation, Universidade de Campinas, Sao Paulo.
- Instituto Brasileiro de Geografia e Estatística, 1997, Sistema Financeiro, Uma Análise a Partir das Contas Nacionais, 1990-1995. Rio de Janeiro: IBGE.
- Patinkin, Don, 1993, "Israel's Stabilization Program of 1985, Or Some Simple Truths of Monetary Theory." *Journal of Economic Perspectives* 7(2), pp. 103-28.
- Tanzi, Vito, 1978, "Inflation, Real Tax Revenue, and the Case for Inflationary Finance: Theory with an Application to Argentina." *IMF Staff Papers* 25 (3), 417-51.