WP/02/5

IMF Working Paper

Fiscal Sustainability and Monetary versus Fiscal Dominance: Evidence from Brazil, 1991–2000

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INTERNATIONAL MONETARY FUND

WP/02/5

IMF Working Paper

IMF Institute and Western Hemisphere Department

Fiscal Sustainability and Monetary versus Fiscal Dominance: Evidence from Brazil, 1991–2000

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January 2002

Abstract

Under a monetary dominant (MD) regime, the primary surplus adjusts to limit debt growth, permitting monetary policy to be conducted independently of fiscal financing requirements. In Brazil, some evidence favors an MD regime for 1995–97, but not for the decade of the 1990s as a whole. While fiscal adjustments of 1999 yielded a primary surplus of about 3 percent of GDP, consistent with solvency, a credible MD regime would require further adjustments of the primary surplus if debt increases, growth falls, or interest rates rise.

JEL Classification Numbers: E6, H6, O5.

Keywords: Intertemporal solvency, monetary and fiscal dominance, fiscal theory of the price level, vector autoregression.

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I. INTRODUCTION

All governments face an intertemporal constraint: the current real value of its net liabilities by definition equals the present discounted value of future primary surpluses (tax revenues minus non-interest expenditures). If this constraint can be satisfied without a change in either policy or the price level, current fiscal policy is said to be sustainable. If the government adjusts the primary deficit to limit debt accumulation, the central bank is not forced to inflate away the debt. Such a regime has been called *monetary dominant (MD)* or *Ricardian*. By contrast, under a *fiscal dominant (FD) or non-Ricardian* regime, primary deficits are set independently of real liabilities.[2]

This paper attempts to empirically distinguish between these two regimes, using data from Brazil in the 1990s. In principle, Brazil should be a good case to study such issues: faced with high deficits, inflation, and dramatic policy shifts, Brazil's government met its intertemporal budget constraint in different ways in recent years.[3] And, the choice of fiscal regime is crucial to policy makers in countries like Brazil, since a monetary dominant regime is presumably necessary for either a managed exchange rate regime (like Brazil's crawling peg from 1995 through 1999) or for a more independent monetary policy (like the more recent inflation targeting program).[4]

However, there is some debate as to *how* we might distinguish between monetary and fiscal dominant regimes. This paper develops two basic approaches: a backward-looking approach and a forward-looking approach. Both approaches extend recent work regarding the fiscal regime for the U.S.

First, the *backward-looking* approach follows Bohn (1998): does the government cut its primary deficit when liabilities rise? If so, there should be a short-run negative relationship between the primary deficit and liabilities. Also, does the primary deficit reflect recent interest rate movements? If so, there should be a negative relationship between the primary deficit and real interest payments.[5]

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[2] The distinction between FD and MD regimes is due to Sargent and Wallace (1981).

[3] For example, adjustments to the primary surplus helped limit the real value of Brazilian debt between the mid-1970s and the mid-1980s. Then, as revenue collection and expenditure reduction became more difficult, real government debt was instead reduced by inflation and incomplete indexation. Evidence on this issue is provided in Tanner (1994, 1995); see also Loyo (1999). Then, in the early 1990s, some evidence suggests that inflation was used to limit the primary deficit (see Cardoso, 1998).

[4] For discussions of fiscal policy and fixed or managed exchange rate regimes, see Savastano (1992), Velasco and Tornell (1998), and Daniel (2000).

[5] The test is also "backward looking" since today's real interest payments apply to *yesterday's* outstanding debt stock.

As a related issue, we also discuss the magnitude of the response: by *how much* the primary deficit adjusts. Unless the adjustment is sufficiently large, undiscounted debt may build up, even while the government remains solvent. Such a buildup of undiscounted debt may provide an incentive to inflate away the debt or otherwise default, as McCallum (1984) and others have pointed out.

Second, the *forward-looking* approach follows Canzoneri, Cumby, and Diba (2000) but also uses work by Campbell (1987): do current reductions in the primary deficit help pay down the debt (reduce future liabilities and/or interest payments), as implied by an MD (but not FD) regime? If so, shocks to the current primary deficit and future liabilities should be positively correlated.[6]

These tests provide little evidence of an MD regime for most of the 1991–2000 period. Rather, most estimates suggest that the response of primary deficits to liabilities is statistically insignificant, as expected under an FD regime. However, some evidence does favor an MD regime during one specific period, namely 1995–97. Such evidence is found only in time-varying estimates of the backward looking test. Shortly after the *Real* plan begins, estimates of the response parameter—primary deficits to liabilities —becomes negative and significant. This finding may reflect the temporary surge in tax revenues that came after stabilization. However, when the Asian crisis begins, estimates of this response parameter once again become statistically equal to zero.

As is well known, both fiscal imbalances and a difficult external environment ultimately contributed to the collapse of Brazil's moving peg in early 1999. After the floating of the *Real*, the fiscal adjustment yielded a substantial primary surplus (over 3 percent of GDP). Nonetheless, a monetary dominant regime—as defined in this paper—would require additional adjustments of the primary surplus if interest rates or GDP growth rates change.[7]

The paper is organized as follows. Section II introduces budget identities, the intertemporal solvency condition, and data. Section III discusses fiscal policy rules and how to implement a monetary dominant (MD) regime. Section IV presents backward-looking estimates of the relationship between the change in the consolidated primary deficit and the change in liabilities (the real operational deficit). And, incorporating variable real interest rates, the relationship between the primary deficit and real interest payments is also estimated. Section V presents analogous tests with a forward looking (vector autoregression) approach. Section VI presents a summary and some conclusions.

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[6] This hypothesis is tested with a vector autoregression (VAR) framework. A VAR is desirable in this context because there is an important drawback to the single equation test: prices may not be exogenous. Specifically, prices may rise (and the real value of liabilities may fall accordingly) in anticipation of future primary deficits. As discussed in the text, this hypothesis is related to the fiscal theory of the price level (FTPL). Recent discussions of the FTPL are cited in the text.

[7] Formally, the model presented in this paper is formulated in real terms, not as a percent of GDP. This is done to facilitate analysis with monthly data. However, the model can easily be reformulated in terms of GDP, and the policy implications are largely the same.

 Corrected: 3/5/02

II. Intertemporal Solvency and Debt Accumulation

In any country, the government's budget one-period budget constraint is:

$$(1) \qquad [B_t + M_t]/P_t = [T_{t+1} + S_{t+1} - G_{t+1} + (M_{t+1} + B_{t+1})/P_{t+1}]/(1+r)$$

where G_t and T_t are real government expenditures and revenues, P_t is the price level, B_t is interest bearing debt held by the public (foreign and domestic), M_t is the monetary base (government debt held by the central bank), and where $S_{t+1} = i\, M_t/P_{t+1}$ is the foregone interest payments on the public's money holdings that accrue to the government (seigniorage), where i is the nominal interest rate, and r is the real interest rate ($r = [(1+i)P_{t-1}/P_t]-1)$.[8] Initially, the real interest rate is assumed to be constant, but later this assumption will be modified.

Net public sector liabilities are presented in Table 1, in nominal terms $B_t + M_t$, real terms ($LIAB_t = [B_t + M_t]/P_t$), and as a percent of GDP, for Brazil's consolidated public sector (the central government, state and municipal governments, and public enterprises) in current and constant *Reais* and as a fraction of GDP.[9] Table 2 presents the corresponding flow data: the primary deficit (PDEF), real interest payments (RIP = r *LIAB) and the real operational deficit ($ODEF_t = LIAB_t - LIAB_{t-1}$). Charts 1 and 2 show monthly real debt, primary deficit and real interest payments. The tables and the charts both show that total net public sector debt falls between 1991 and 1994, but rises thereafter, both in constant *Reais* and as a percent of GDP. Substituting equation (1) forward over an infinite horizon, using the identities $LIAB_t = (M_t + B_t)/P_t$ and $PDEF_t = [G_t - T_t - S_t]$ yields the intertemporal budget constraint:

$$(2) \qquad LIAB_0 = -E\{\sum_{t=1}^{\infty} PDEF_t/(1+r)^{t-1} + \lim_{t\to\infty} LIAB_t/(1+r)^{t-1}\}$$

where E{ } is the expectations operator. The transversality condition is:

$$(3) \qquad \lim_{t\to\infty} LIAB_t/(1+r)^{t-1} = 0.$$

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[8] Note that $[iM_{t-1}/P_t]/(1+r) \equiv i/(1+i)M_{t-1}/P_{t-1}$; the latter term is also a commonly used definition of seigniorage.

[9] As mentioned above, this paper examines fiscal data of the consolidated public sector in Brazil between 1991 and 2000. Other papers, including Tanner (1994,1995), Rocha (1997), and Rossi (1997) examine the *gross* internal debt of the Brazilian federal government. While such data cover a longer period, they are not comparable with the data examined here, which are available only from 1991 onward. (Note also that, for the period discussed by Loyo (1999), only gross debt data are available.)

Equations (2) and (3) thus summarize intertemporal solvency. More precisely, equation (3) says that the *discounted* value of government liabilities approaches zero over an infinite horizon. Expressions (2) and (3), as identities, are *not* directly testable. However, it is possible to ask whether (3) would be satisfied if the relevant fiscal variables G, T, M, B, and P were to continue their historically observed relationships into the indefinite future. If so, (3) is satisfied and fiscal policy is said to be *sustainable*. By contrast, if fiscal policy is not sustainable, an adjustment to one or more fiscal variables will be required at some future date.[10]

One test for sustainability, suggested by Trehan and Walsh (1991) and others, is for the *stationarity* of the real operational deficit. Results of this test in Appendix II suggest that the Brazil's real operational deficit is stationary for the period 1991–2000, indicating long-run sustainability.

However, some recent literature, including Cochrane (1999), Christiano and Fitzgerald (2000), and Woodford (2001), have suggested that (2) and (3) should be interpreted as equilibrium conditions.[11] That is, since (3) holds in equilibrium, (2) implies that all current information about future primary surpluses is contained in current real government liabilities $LIAB_0$. Thus, if the market forecasts a one unit fall in discounted primary surpluses, $LIAB_0$ must also fall today, through price level increases. This ideas is known as the *fiscal theory of the price level* (FTPL).

Of course, for some purposes, evolution of the *undiscounted* debt is important as well. As McCallum (1984), Hakkio and Rush (1991) and others suggest, growing debt in undiscounted terms provides an incentive for the government to inflate away the debt or otherwise default. And, as Calvo (1978) suggests, the government may be unable to credibly rule out a default through surprise inflation (a time consistency problem).

III. The Fiscal Rule, or How To Implement a Monetary Dominant Regime

Closely related to fiscal sustainability is the issue of the *fiscal rule*: what variable adjusts to restrain government debt? Potentially, the primary deficit ($PDEF = G - T^*$), may respond to changes in the real value of liabilities, through changes in G and/or T^*, thus satisfying (3). In this case, monetary policy is not subordinated to fiscal financing requirements. For this reason, such a regime has been called "monetary dominant (MD)" or "Ricardian" (see Canzoneri, Cumby, and Diba (2000)).

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[10] Points similar to these are found in other papers, including Hamilton and Flavin (1986) and Wilcox (1989).

[11] We are indebted to Shigeru Iwata for discussions on this topic.

Table 1. Brazil: Public Debt Stocks, Millions of Current *Reais* (B_t)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Millions of Current *Reais*										
Nominal Liabilities Unadjusted	56	678	17,715	153,163	208,460	269,193	308,426	385,870	516,579	563,163
Accumulated Adjustments	-	-	-	-	-	14,481	-2,049	3,211	5,349	-6,045
Privatizations	-	-	-	-	-	-1,144	-17,790	-30,650	-39,623	-59,562
Arrears Recognition	-	-	-	-	-	15,625	15,741	33,862	44,972	53,517
Nominal Liabilities, Adjusted	56	678	17,715	153,163	208,460	254,712	310,475	382,658	511,230	128,572
Millions of Constant *Reais*										
Liabilities (LIAB) Unadjusted	193,984	185,025	162,492	167,369	198,050	234,167	250,484	307,684	343,513	341,966
Accumulated Adjustments	-	-	-	-	-	12,597	-1,664	2,561	3,557	-3,671
Privatizations	-	-	-	-	-	-995	-14,448	-24,440	-26,349	-36,167
Arrears Recognition	-	-	-	-	-	13,592	12,784	27,001	29,905	32,497
Liabilities (LIAB) Adjusted	193,984	185,025	162,492	167,369	198,050	221,570	252,148	305,123	339,956	345,637
Deflator (May - Jun 95=100)	0.03	0.37	10.90	91.51	105.26	114.96	123.13	125.41	150.38	164.68
Percent of GDP										
Liabilities (LIAB) Unadjusted	37.9	37.2	33.0	29.2	30.5	33.3	34.6	42.4	47.0	49.2
Accumulated Adjustments	-	-	-	-	-	1.8	-0.2	0.4	0.5	-0.5
Privatizations	-	-	-	-	-	-0.1	-2.0	-3.4	-3.6	-5.2
Arrears Recognition	-	-	-	-	-	1.9	1.8	3.7	4.1	4.7
Liabilities (LIAB) Adjusted	37.9	37.2	33.0	29.2	30.5	31.5	34.8	42.0	46.5	11.2
GDP 1/ 2/	148.0	1,823.8	53,617	525,027	683,401	809,332	891,801	910,595	1,100,212	1,144,220

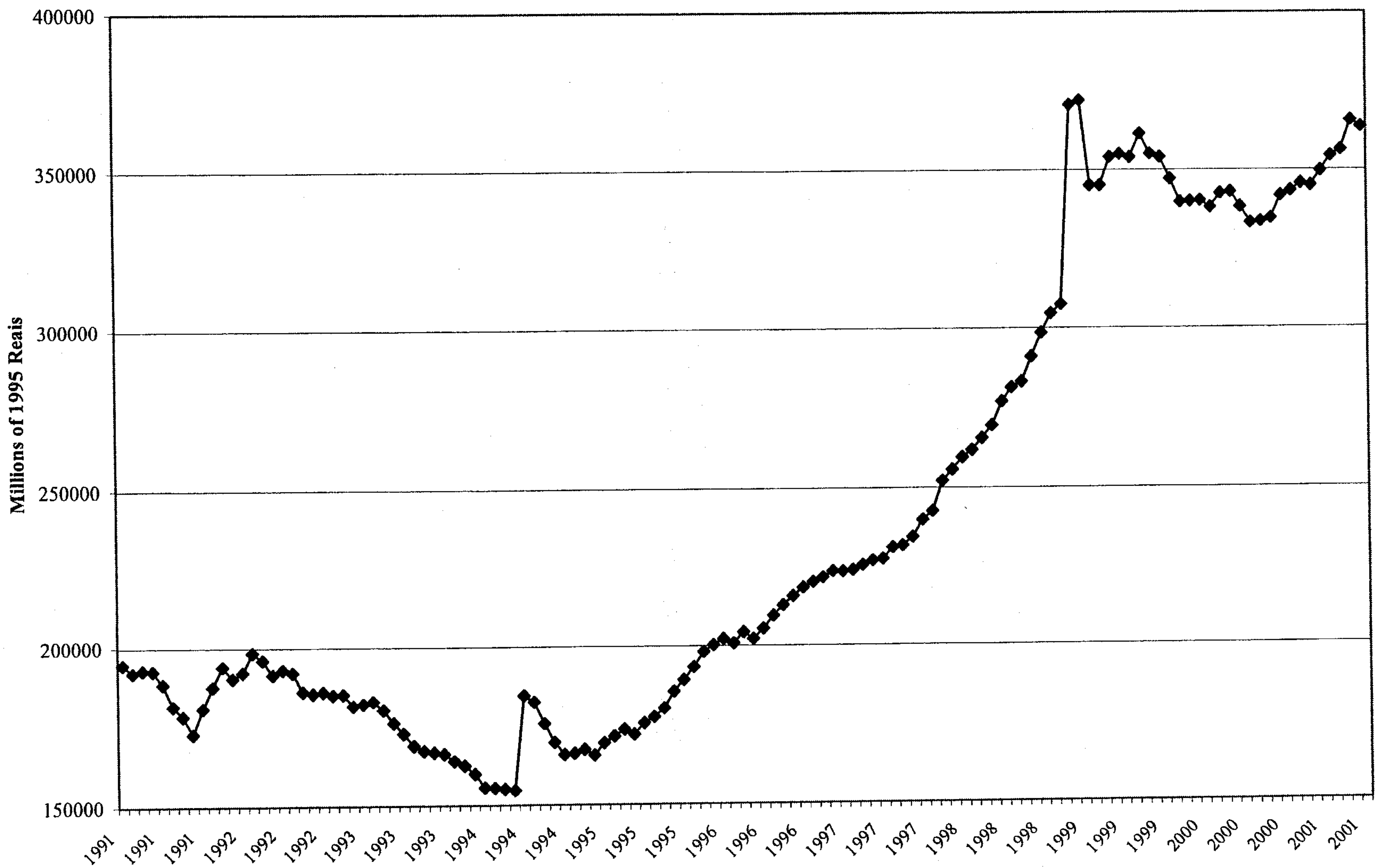
Source for all data: Central Bank of Brazil.
1/ Deflator is general price index (IGPDI)
2/ GDP calculated with end year prices.

Table 2. Brazil: Alternative Concepts of the Public Deficit

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Millions of Constant *Reais*										
Operational Deficit (ODEF) Unadjusted	-65,373	-8,959	-22,532	4,876	30,681	36,117	16,316	57,201	35,829	-1,547
Adjustments to Flow	-	-	-	-	-	12,597	-14,261	4,225	996	-7,227
Privatizations	-	-	-	-	-	-995	-13,453	-9,992	-1,909	-9,819
Arrears Recognition	-	-	-	-	-	13,592	-808	14,217	2,905	2,591
Operational Deficit (ODEF) Adjusted	-65,373	-8,959	-22,532	4,876	30,681	23,520	30,578	52,976	34,833	5,681
Primary Deficit (PDEF) 2/	-14,662	-11,329	-13,260	-28,127	-2,315	622	7,088	-98	-22,890	-24,574
Real Interest Payments (RIP)	-50,712	2,370	-9,273	33,004	32,996	22,897	23,490	53,074	57,723	30,255
In percent of GDP										
Operational Deficit (ODEF) Unadjusted	-12.8	-1.8	-4.6	0.8	4.7	5.1	2.3	7.9	4.9	-0.2
Adjustments to Flow	-	-	-	-	-	1.8	-2.0	0.6	0.1	-1.0
Privatizations	-	-	-	-	-	-0.1	-1.9	-1.4	-0.3	-1.4
Arrears Recognition	-	-	-	-	-	1.9	-0.1	2.0	0.4	0.4
Operational Deficit (ODEF) Adjusted	-12.8	-1.8	-4.6	0.8	4.7	3.3	4.2	7.3	4.8	0.8
Primary Deficit (PDEF)	-2.9	-2.3	-2.7	-4.9	-0.4	0.1	1.0	0.0	-3.1	-3.5
Real Interest Payments (RIP)	-9.9	0.5	-1.9	5.8	5.1	3.3	3.2	7.3	7.9	4.4
Memo: GDP	148	1,824	53,617	525,027	683,401	809,332	891,801	910,595	1,100,212	1,144,220
Memo: Implicit Real Interest Rate	-	1.2	-5.0	20.3	19.7	11.6	10.6	21.0	18.9	8.9

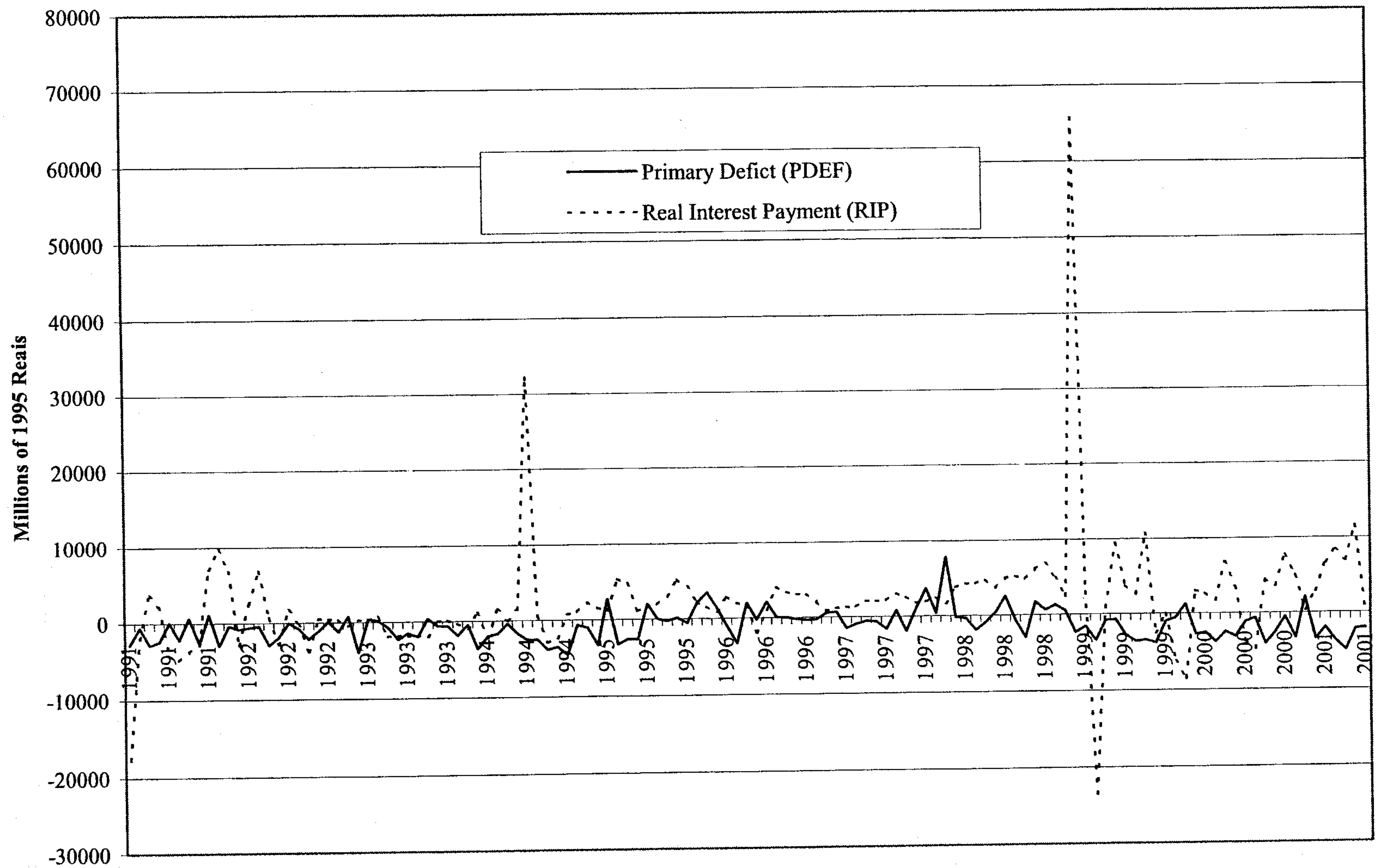
Source: See Table 1.
Note: To calculate *annual flows* as a percent of GDP, real monthly flows from January to December are summed; this sum is then multiplied by the *December* price level and then divided by the above GDP figure based on *December* prices. This procedure may yield annual flows in percent of GDP different from other published figures.

Figure 1. Brazil: Real Net Public Debt



Source: Central Bank of Brazil

Figure 2. Brazil: Real Primary Deficit and Interest Payments



Source: Central Bank of Brazil

Alternatively, if there is no such response, the primary deficit is set independently of either liabilities or real interest payments. In this case, monetary policy is determined by fiscal needs, under a "fiscal dominant" (FD) (or non-Ricardian) regime. And, an MD regime is required for monetary policy to be conducted independently.

Whether an economy operates under an MD or FD regime depends on the authority's *fiscal rule* (or reaction function). Several recent authors, including Woodford (2001) have suggested that, to restrain inflation, a fiscal rule is required (in addition to a monetary rule).[12] Such a rule conditions current fiscal behavior on past debt:

(4) $$PDEF_t = \kappa + \beta\, LIAB_{t-1}.$$

In equation (4), κ is assumed to be an *exogenous* component of the primary deficit, corresponding to non-discretionary components of the budget, while β summarizes the authorities' adjustment of the primary deficit to past liabilities.

Regardless of the value of κ, an infinitesimal adjustment of the primary surplus to increased liabilities ($\beta < 0$) is sufficient to maintain intertemporal solvency (3). To see this, note first that *undiscounted* liabilities evolve according to:

(4') $$\lim_{t \to \infty} LIAB_t = LIAB_0 Z^t + \kappa\{1+Z+Z^2+Z^3+Z^4+\ldots.\}$$

where $Z = (1+r+\beta)$. Thus, if $\beta < 0$, $Z < (1+r)$ and hence (3) holds (an MD regime).[13]

However, there are several cases—specific combinations of κ and β—also of interest to policy makers. These cases are summarized in Table 3. As the table shows, whether the *undiscounted* value of liabilities explodes, stays constant, or tends to zero depends critically on the values of κ and β.[14] For example, as previously mentioned, policy makers may want to limit debt accumulation in undiscounted terms. Doing so requires a more stringent fiscal policy than the minimum required to ensure solvency.

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[12] For a discussion of the interaction of monetary and fiscal rules, see also Benhabib, Schmitt-Grohe, and Uribe (2001).

[13] In present value terms, the right-hand side of (5') reduces to $[LIAB_0 Z^t + \kappa/(1-Z)]/(1+r)^t$.

[14] Note that the model implicitly assumes that the government can freely borrow at the market interest rates. However, if there are borrowing constraints (including rollover risk), a build-up of undiscounted debt may also be a concern for the public sector.

Consider the simple rule often recommended to policy makers: keep undiscounted public liabilities constant. This is similar to rules proposed by Blanchard et. al. (1990) and Talvi and Végh (2000), but they write their policy in terms of GDP.[15]

This rule is also sufficient to keep the government solvent. In terms of equation (4), such a policy implies $\kappa = 0$ and $\beta = -r$.

A less stringent rule would be $\kappa = 0$ and $0 > \beta > -r$. This rule satisfies solvency, as mentioned above, but nonetheless permits the undiscounted debt to grow boundlessly according to $LIAB_t = LIAB_0 \{(1+r+\beta)]^t$. If $\beta = -r$, undiscounted liabilities remain constant; if $\beta < -r$, undiscounted liabilities shrink.

Of course, cases with a constant (nondiscretionary) component of the primary deficit ($\kappa > 0$) present more challenges for policy makers. One such case, previously discussed by McCallum (1984) is that of a constant primary deficit and no feedback ($\kappa > 0$, $\beta = 0$). In this case, (3) is not satisfied. Rather, undiscounted liabilities evolve according to $LIAB_t = LIAB_0 (1+r)^t + \kappa(1+r)/r$. Thus, as $t \rightarrow \infty$, the discounted value of liabilities $LIAB_t/(1+r)^t$ does not approach zero.

However, as mentioned above, even if $\kappa > 0$, $\beta < 0$ is nonetheless sufficient to satisfy (3). If $0 > \beta > -r$, the undiscounted debt grows boundlessly according to $LIAB_t = [(1+r+\beta)]^t \{LIAB_0 + \kappa/(r+\beta)\}$. However, (3) is satisfied: over an infinite horizon, the expression $[(1+r+\beta)]^t/(1+r)^t * \{LIAB_0 + \kappa/(r+\beta)\}$ tends to zero. In another special case, if $\kappa > 0$ but $\beta = -r$, the operational deficit is constant. Once again, (3) is satisfied, but the *undiscounted* debt grows over time according to $LIAB_t = LIAB_0 + t\kappa$. Finally, if $\beta < -r$, the undiscounted debt shrinks to a constant: as $t \rightarrow \infty$, $\lim LIAB_t = \kappa /(r+\beta)\}$. In this case (3) is satisfied.

The case of $\beta = \kappa = 0$ implies an FD regime if the initial outstanding stock of liabilities is positive ($LIAB_0 > 0$). Related to (4), according to the fiscal theory of the price level (FTPL), as mentioned above, continual adjustments in the price level, rather than the primary deficit, force equation (3) (intertemporal balance) to hold at any point in time (since real liabilities $LIAB_t$ equal nominal liabilities deflated by the price level $(M_t+B_t)/P_t$).[16] The FTPL cannot hold under an MD regime. Rather, for the FTPL to hold, an FD regime is necessary (but not sufficient).[17]

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[15] The analysis may be written in terms of GDP. For example, as $t \rightarrow \infty$, $\lim LIAB_t = LIAB_0(\theta+\beta)^t + \kappa[1+ (\theta+\beta) + (\theta+\beta)^2 + (\theta+\beta)^3 + ...]$, where $\theta = (1+r)/(1+\gamma)$, γ = real GDP growth. In this case, solvency requires that $\beta < -\gamma\theta$. To maintain a constant debt-to-GDP ratio, $\beta = -\theta$.

[16] As Woodford (1995) notes, the price level adjusts through a wealth effect: private agents sell their (excess) government assets in return for goods, and goods prices hence rise.

[17] For more discussion on rules like these, see Christiano and Fitzgerald (2000).

Table 3. Implications of Fiscal Rule for Debt Accumulation and Intertemporal Solvency

(4) $$PDEF_t = \kappa + \beta\, LIAB_{t-1}.$$

Tendency of undiscounted debt over infinite horizon; satisfaction of intertemporal solvency (3)

Value of κ: Value of β:	$\kappa = 0$	$\kappa > 0$
$\beta = 0$	Undiscounted debt **grows boundlessly** at rate (1+r) each period. Intertemporal solvency (3) **not satisfied.**	Undiscounted debt **grows boundlessly** by $(1+r)LIAB_{t-1} + \kappa$ each period. Intertemporal solvency (3) **not satisfied.**
$0 > \beta > -r$	Undiscounted debt **grows boundlessly** at rate $[(1+r+\beta)] > 1$: Intertemporal solvency (3) **satisfied** since $(1+r+\beta) < (1+r)$	Undiscounted debt **grows boundlessly**: $LIAB_t = [(1+r+\beta)]^t \{LIAB_0 + k/(r+\beta)\}$ Intertemporal solvency (3) **satisfied**: $\lim LIAB_t/(1+r)^t = t \to \infty$ $\lim_{t \to \infty} [(1+r+\beta)]^t/(1+r)^t \{LIAB_0 + \kappa/(r+\beta)\}$
$\beta = -r$	Undiscounted debt **constant at initial value** $LIAB_0$. Intertemporal solvency (3) **satisfied** since $(1+r+\beta) < (1+r)$	Undiscounted debt **grows boundlessly** by κ each period ($LIAB_t = LIAB_0 + t\kappa$). Intertemporal solvency (3) **satisfied**: $\lim_{t \to \infty} LIAB_t/(1+r)^t = \{LIAB_0 + t\kappa\}/(1+r)^t = 0$
$-r > \beta > -1$	Undiscounted debt **approaches zero** at rate since $(1+r+\beta) < 1$. ($LIAB_t = LIAB_0 [(1+r+\beta)]^t$). Intertemporal solvency (3) **satisfied.**	Undiscounted debt **approaches constant** $\kappa/(r+\beta)$ Intertemporal solvency (3) **satisfied**: $\lim_{t \to \infty} LIAB_t/(1+r)^t = \lim_{t \to \infty} \kappa / \{r+\beta)/(1+r)^t = 0$
$\beta = -1$	Undiscounted debt approaches **zero** Intertemporal solvency (3) **satisfied.**	Undiscounted debt approaches **constant**: $\kappa/(1-r)$. Intertemporal solvency (3) **satisfied.**

In this case, (3) will not be satisfied unless additional inflation occurs. Moreover, according FTPL, rational agents will recognize that the present value of future primary surpluses will be insufficient to cover liabilities. Accordingly, they reduce their bond holdings, forcing the government to monetize the debt and hence bid up today's price level.

IV. Empirical Estimates: A Backward-Looking Approach

Several questions naturally arise from equation (4). For example, does the Brazilian government adjust the primary deficit to ensure long-term solvency ($\beta < 0$)? Does the fiscal authority react vigorously enough to also limit the undiscounted debt? This section presents several ways to address these questions. In Section IV.A, presents an initial implementation of equation (4) assuming a fixed interest rate. In Section IV.B the model is modified to include variable real interest rates.

A. Primary Deficits and Liabilities

As a first step, it is tempting to implement equation (4) as an empirical reaction function. However, before doing so, several important issues must be dealt with. First, equation (4) must be expressed in first differences, since the real primary deficit (PDEF) is stationary but real liabilities (LIAB) is nonstationary. [18] Hence, consider the modified reaction function:

(5) $$\Delta PDEF_t = k + b\ ODEF_{t-1} + error_t$$

Unfortunately, as the discussion in the previous section suggests, while equation (5) can in some cases rule out a MD regime, it cannot distinguish between MD and FD regimes. For example, under a MD regime, the primary deficit responds to changes in liabilities (the real operational deficit). By contrast, under an FD regime, if the FTPL also holds, the price level jumps and the real value of liabilities falls in anticipation of future primary deficits. In either case, b would be negative. However, even if price level doesn't jump in anticipation of future primary deficits, *b will be zero or positive under an FD regime*. Therefore, an MD regime is ruled out if b is either not different from zero or significantly positive.

To incorporate policy shifts during the period under study, estimates of (5) are presented for both the entire 1991:1–2000:12 period and six subperiods: 1991:1–1994:6 (pre-*Real*), 1994:7–2000:12 (entire post –*Real*), 1994:7–1998:12 (post-*Real*, pre-devaluation), 1995:7–7–1997:12 (post-*Real*, pre-Asia Crisis), 1997:12–2000:12 (post Asia Crisis), and the 1999:4–2000:12 period (post-devaluation).[19]

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[18] That is, estimates below reflect *short-term* relationships between PDEF and ODEF, not long-run (or cointegrating) relationships. Stationarity tests are available from the authors.

[19] Also, estimates for *rolling* 18 month periods, beginning with the period 1991:1–1992:6 and ending with the period 1999:6–2000:12, yielded similar results. These estimates are available from the authors.

According to estimates in Table 4, the null hypothesis of b = 0—that ΔPDEF does not respond to ODEF—cannot be rejected at the conventional 90 percent level for either the entire period or 5 subperiods: 1994:7–2000:12 (entire post –*Real*); 1994:7–1998:12 (post-*Real*, pre-devaluation); 1997:12–2000:12 (post Asia crisis); and 1999:4–2000:12 period (post-devaluation).

However, results for two of these periods were 'borderline': for the 1994:7–1998:12 period (post-*Real*, pre-devaluation) the null was rejected at the 87 percent level; for the 1999:4–2000:12 period (post-devaluation) the null could be rejected at the 89 percent level.

The null of b = 0 was rejected in 2 subperiods: 1991:1–1994:6 (pre-*Real*); and 1995:7–1997:12 (post-*Real,* pre-Asia). During the former period, the constant component (k) was statistically insignificant, while in the latter period k was significant and positive, reflecting substantial deficits during the period.

Clearly, economic conditions were very different in these two periods: inflation was much higher in the former than in the latter. The 1991:1–1994:6 (pre-*Real*) finding has alternative interpretations. According to some, during this period the fiscal authority balanced the budget by under-indexing non-interest expenditures.[20] Alternatively, this finding may be consistent with the FTPL: under a FD regime, if the FTPL also holds, the price level jumps and the real value of liabilities falls in anticipation of higher primary deficits in the future.

During the 1995:7–1997:12 period (post-*Real*, pre-Asia Crisis), inflation is low, primary deficits are increasing and real interest payments are falling. For this period, the point estimate of b is about –0.6. Thus, during this period, while the undiscounted debt was growing, the response of the primary deficit to changes in liabilities ensured intertemporal solvency under an MD regime.[21] Note that the finding of b < 0 may also reflect the impact of the *Real* plan on tax revenues: as the plan immediately slashed inflation, boosting output and thus tax collections.

B. Extension: Primary Deficits and Real Interest Payments

It is natural to also consider variable real interest rates. Several factors help explain real interest rate movements during the sample. For example, in the pre-*Real* (high inflation) period, ex-post real interest rates were low, and in some years negative. Immediately after the *Real* Plan, as inflation plummeted, real interest rates (and payments) rose.

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[20] We are indebted to Claudio Paiva for emphasizing this point in conversation. Also, Cardoso (1998) develops a similar theme.

[21] Recall from the previous section that for $\kappa > 0$ and $\beta < -r$, the undiscounted debt converges to $\kappa/(r+\beta)$). Note also that, between 1995 and 1997, the debt/GDP ratio grew moderately, from 30 to about 34 percent.

Table 4. Equation (5) Response of $\Delta PDEF_t$ to $ODEF_{t-1}$ (b)

(Standard Errors in Parentheses)

(5) $$\Delta PDEF_t = k + b\ ODEF_{t-1} + error_t$$

Period:	K	b	R^2 adj	D.F.
1991:1–2000:12	48.70	-0.03	0.01	116
	(175.44)	(0.02)		
1991:1–1994:6	-162.00	$-0.11^{\dagger}$	0.07	38
	(236.50)	(0.05)		
1994:7–2000:12	82.85	-0.02	0.00	76
	(245.58)	(0.03)		
1994:7–1998:12	308.26	-0.10	0.02	52
	(367.16)	(0.07)		
1995:7–1997:12	$1515.83^{\ddagger}$	$-0.59^{\ddagger}$	0.14	28
	(667.29)	(0.24)		
1997:12–2000:12	34.86	-0.01	-0.02	35
	(348.31)	(0.03)		
1999:4–2000:12	-42.43	-0.07	0.08	19
	(312.65)	(0.04)		

Note: †, ‡ Indicate rejection of null hypothesis that coefficient is zero at 90 percent and 95 percent levels, respectively.

Table 5. Equation (7) Response of $PDEF_t$ to RIP_{t-1} (b^*)

(Standard Errors in Parentheses)

(7) $$PDEF_t = k^* + b^*\ RIP_t + error_t$$

Period:	k^*	b^*	R^2 adj	D.F.
1991:1 - 2000:12	$-939.85^{\ddagger}$	0.00	-0.01	117
	(152.91)	(0.02)		
1991:1 - 1994:6	$-1238.98^{\ddagger}$	-0.02	0.00	39
	(158.79)	(0.03)		
1994:7 - 2000:12	$-779.77^{\ddagger}$	0.00	-0.01	76
	(220.63)	(0.03)		
1994:7 - 1998:12	$-776.28^{\ddagger}$	0.21	0.03	52
	(410.54)	(0.13)		
1995:7 - 1997:12	382.93	-0.02	-0.04	28
	(609.13)	(0.25)		
1997:12 - 2000:12	$-1148.48^{\ddagger}$	0.00	-0.03	35
	(316.42)	(0.03)		
1999:4 - 2000:12	$-1970.07^{\ddagger}$	-0.04	-0.03	19
	(255.33)	(0.05)		

Note: †, ‡ Indicate rejection of null hypothesis that coefficient is zero at 90 percent and 95 percent levels, respectively.

This increase was, however, temporary: real interest rates subsequently fell from about 20 percent in 1995 to under 11 percent by early 1997. As mentioned before, the primary deficit grew dramatically during this period (see Table 3).[22] However, when the Asian crisis began, real interest rates once again rose.[23]

During the post-*Real* period, the government might have been reaping benefits of stabilization: low real interest rates permitted the government to borrow more. Certain reforms and fiscal adjustments became less urgent than they would have otherwise been.

To formally test this proposition, the framework may be modified to estimate the response of the primary deficit to *real interest payments*. At a theoretical level, consider the following modification of (4) (similar to a rule proposed by Wilcox (1986)): [24]

$$\text{(6)} \qquad PDEF_t = \kappa^* + \beta^* r_t \, LIAB_{t-1} = \kappa^* + \beta^* RIP_t$$

Over time, liabilities evolve according to $LIAB_0 Z^{*t} + \kappa\{1+Z^* + Z^{*2} + Z^{*3} + \ldots\}$, where $Z^* = (1+r(1+\beta^*))$. The analogy between β and β^* is easily seen. In all cases, (3) is satisfied so long as $\beta^* < 0$. However, in some cases, the undiscounted debt explodes. For $\kappa = 0$, if $0 > \beta^* > -1$, the undiscounted debt explodes, while for $\beta^* = -1$ (the "Blanchard-Talvi-Végh" rule) or $\beta^* < -1$ the undiscounted debt vanishes. For $\kappa > 0$, if $0 > \beta^* > -1$, the undiscounted debt also explodes, while for $\beta^* = -1$ or $\beta^* < -1$ the undiscounted debt converges to a constant.

Next, consider an empirical counterpart to (7):

$$\text{(7)} \qquad PDEF_t = k^* + b^* \, RIP_t + error_t$$

Like equation (5), this equation may be thought of as a backward looking test, since today's real interest rates apply to *yesterday's* outstanding debt stock.[25] Nonetheless, as RIP_t equals r_t times $LIAB_{t-1}$, this test incorporates the *most recent* real interest rate, thus permitting a test of whether the authorities attempted to "reap the benefits of stabilization."

However, while this hypothesis may be appealing, the evidence does not support it. Rather, according to estimates in Table 5, PDEF is not linked to changes in RIP. The null hypothesis of

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[22] In this regard, if governments need to tighten their fiscal with high interest rates, one might also argue symetrically that governments should be able to "reap the benefits of stabilization" with a larger primary deficit. However, the government must apply the policy symmetrically.

[23] Also, in early 1995, the central bank temporarily raised interest rates to shore up the *Real* against external pressures related to the Mexican crisis.

[24] This analysis assumes that r_t equals a constant mean plus a serially uncorrelated error.

[25] Also, if the authority follows the Blanchard-Talvi-Végh rule, b^*_1 should equal minus unity.

$b^* = 0$ (no reaction of PDEF to RIP) cannot be rejected at the conventional 90 percent level for either the entire period or any of the subperiods.

V. A Forward-Looking, Vector Autoregression Approach

Equations (5) and (7) are simple and intuitive. However, there are drawbacks to using a one-equation framework. As discussed above, such a framework cannot distinguish between *ex-post* adjustments of primary deficits to liabilities (consistent with an MD regime) and *ex-ante* adjustments of liabilities to primary deficits (consistent with an FD regime and the FTPL).

It may be more fruitful to analyze fiscal adjustment in a *forward-looking* manner. As a simple illustration, note that under an MD regime (as defined above) *current* reductions in the primary deficit help reduce future liabilities. If so, we should observe a *positive* relationship between *current* innovations to the primary deficit today and liabilities in the future. In this section, vector autoregression (VAR) framework that incorporates such issues is developed.

A. Primary Deficits and Liabilities

To develop the VAR framework, several steps are required. First, recall that (2) and (3) imply that the current value of liabilities $LIAB_0$ equals (-1 times) the expected present value of future primary deficits $PDEF_t$. Second, multiply both sides of equation (2) by the real interest rate, r. Third, add the current primary deficit $PDEF_1$ from both sides of equation (2), and note that $ODEF_t \equiv rLIAB_{t-1} + PDEF_t \equiv LIAB_t - LIAB_{t-1}$. Then, after manipulation (2) is re-written as:

$$(2') \qquad ODEF_1 = rLIAB_0 + PDEF_1 = -E\{\sum_{t=1}^{\infty} \Delta PDEF_t/(1+r)^{t-1}\}$$

Equation (2') has a clear interpretation: today's operational deficit is equal to (-1 * times) the sum of discounted *changes* in the primary deficit. In fact, equation (2') is similar to Campbell's (1987) version of the permanent income hypothesis. Furthermore, following Campbell's logic, the VAR implied by theory is:

$$(8) \qquad \mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + ... + \mathbf{v}_t$$

where $\mathbf{X} = [\Delta PDEF, ODEF]$, $\mathbf{a}_i$ is a vector of coefficients, and $\mathbf{v}_t = (v_{PDEF}, v_{LIAB})$ is a vector of error terms.[26] Expression (8) is similar to a VAR system developed by Canzoneri, Cumby and Diba (2000). In standard fashion, assume that each element of the error vector $\mathbf{v}_t$ is in turn

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[26] The analogy between Campbell's (1987) formulation of the permanent income hypothesis (PIH) can be seen in several steps. First, according to the PIH, consumption equals r/(1+r) times the present value of labor income. Next, savings (S), which equals income (Y) minus consumption (C), also equals (-1 times) the sum of discounted *changes* in income ΔY. Thus, the vector of variables for the VAR is [S, ΔY].

composed of "own" error terms $\mathbf{w}_t = (w_{PDEFt}, w_{LIABt})$ and contemporaneous correlations with "other" errors:

(9) $$\mathbf{v}_t = \mathbf{B}\,\mathbf{w}_t$$

where **B** is a 3 x 3 matrix whose diagonal elements ("own correlations") equal one and whose nonzero off-diagonal elements reflect contemporaneous correlations among the error terms. Also, (9) yields impulse response functions (IRF's) that summarize the effects of current *innovations* w_t on values of **X**.

Like any VAR framework, system (8) estimates relationships of time-series causality (or following Maddala 1992, p. 537, "precedence") that run in both directions. Table 6 summarizes the economic interpretations of these time-series relationships.

Table 6. Summary of Interpretation, System (8), **X** =[ODEF, ΔPDEF] or **X** =[RIP, PDEF]

Current primary deficit ($PDEF_t$)* ➔ future liabilities (RIP_{t+i} or $ODEF_{t+i}$)	
Positive	Government pays down future debt, consistent with MD regime.
Zero	Primary deficit exogenous, consistent with FD regime.
Negative	Government anticipates future interest bill or other obligations, consistent with MD regime.
Current liabilities (RIP_t or $ODEF_t$)* ➔ future primary deficit ($PDEF_{t+i}$)	
Positive	Unstable policy, consistent with FD regime; or interest rates anticipate future primary deficits.
Zero	Primary deficit exogenous, consistent with FD regime.
Negative	Government pays down past debt, consistent with MD regime; or price level anticipates future primary deficits, consistent with FD regime and FTPL.

* Innovations.

First, consider temporal relationships that run *from* the current operational deficit ($ODEF_t$) *to* future primary deficits ($\Delta PDEF_{t+i}$). Like equation (5) a *negative* relationship may either indicate that primary deficits compensate for changes in liabilities ($ODEF_t$) to help limit debt accumulation (consistent with an MD regime) or that the price level (and hence the operational deficit) anticipate future primary deficits (consistent with an FD regime and the FTPL).

By contrast, a *positive* relationship indicates that primary deficits respond to liabilities in an unstable fashion (consistent with an FD regime) or that real interest rates (and hence ODEF) respond positively to anticipated future primary deficits (reflecting higher risk).[27] If there is no relationship, the primary deficit is exogenous (an FD regime).

Second, consider relationships in (8) that run *from* the current primary deficit ($\Delta PDEF_t$) *to* future operational deficits ($ODEF_{t+i}$). Under an MD regime, current *innovations* to the primary deficit w_{PDEFt} should be positively related to future government debt and hence ODEF: when the government reduces the primary deficit, it pays down the debt and hence reduces future operational deficits.

But, if real interest rates vary, a negative relationship between shocks to the primary deficit w_{PDEFt} and future operational deficits (ODEF) might reflect a response by the government lower (higher) expected future interest payments by borrowing more (less)—running higher (lower) primary deficits today. By contrast, under an FD regime, w_{PDEFt} would be uncorrelated with future ODEF.[28]

In Table 7 exclusion (Granger causality) tests and impulse response functions (IRF's) are summarized for system (8), estimated with 1 and 2 lags, for both the entire 1991:1–2000:12 period and the selected subsamples.[29]

Like estimates of equation (5), for both the entire sample and (with few exceptions) the selected subsamples, there is little evidence of a statistically significant relationship between the changes in the primary deficit (ΔPDEF) and the operational deficit (ODEF).

As Table 7 shows, the null hypothesis that current ODEF does not explain future ΔPDEF is rejected only for the 1999:04–2000:12 period, and only for the 1-lag model. The IRF, while insignificant, is negative, reflecting the substantial fiscal adjustment that took place after the devaluation of the Real in early 1999.

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[27] Such a relationship was directly tested using fiscal variables and interest *rates* but was not evident.

[28] An exception, as CCD note, occurs if w_{PDEF} is negatively correlated with future PDEF. In this case, w_{PDEFt} may be positively related with future ODEF even under an FD regime.

[29] Both Akaike and Schwarz criteria were minimized at either one or two lags. Several other lag lengths were estimated, but qualitative results were similar to those presented here.

Table 7. Summary of Results, System (8)

$$\mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + \ldots + \mathbf{v}_t \quad (8)$$

$$\mathbf{X} = [\text{ODEF}, \Delta\text{PDEF}]$$

	1 Lag Model				2 Lag Model			
	$\Delta PDEF_t$ ➔ $ODEF_{t+i}$		$ODEF_t$ ➔ $\Delta PDEF_{t+i}$		$\Delta PDEF_t$ ➔ $ODEF_{t+i}$		$ODEF_t$ ➔ $\Delta PDEF_{t+i}$	
	F-Stat	IRF	F-Stat	IRF	F-Stat	IRF	F-Stat	IRF
1991:1–2000:12	2.76 (0.10)	N.S.	0.57 (0.45)	N.S.	2.19 (0.12)	N.S.	1.00 (0.37)	N.S.
1991:1–1994:6	1.21 (0.28)	N.S.	0.72 (0.40)	N.S.	1.64 (0.21)	N.S.	0.96 (0.39)	N.S.
1994:7–2000:12	2.10 (0.15)	N.S.	0.33 (0.57)	N.S.	1.48 (0.24)	N.S.	0.90 (0.41)	N.S.
1994:7–1998:12	0.68 (0.41)	N.S.	2.08 (0.16)	N.S.	0.61 (0.55)	N.S.	1.95 (0.15)	NEG
1995:7–1997:12	9.02 (0.01)	NEG	1.36 (0.25)	NEG	1.35 (0.28)	N.S.	1.13 (0.34)	NEG
1997:12–2000:12	1.94 (0.17)	N.S.	0.00 (0.97)	N.S.	1.36 (0.28)	N.S.	0.20 (0.82)	N.S.
1999:04–2000:12	0.41 (0.54)	N.S.	4.97 (0.05)	N.S.	1.36 (0.28)	N.S.	0.20 (0.82)	N.S.

F-Stat: Test for hypothesis that lagged variable does not help explain contemporaneous variable in system (8). IRF: impulse response function. NS: Not significant. NEG: negative and significant. P-values in parentheses.

In the other direction, the null hypothesis that current ΔPDEF does not explain future ODEF is rejected only for the 1995:7–1997:12 period, but only for the 1-lag model. In this case only, the corresponding IRF is significant. The relationship is *negative*: an increase in today's primary deficit is associated with a future reduction in liabilities. As suggested above this finding may represent an optimizing (albeit implicit) decision by the government: with a falling (ex-post) real interest rate on public debt between 1995 and 1997, budgetary reforms may have been perceived to be less urgent than otherwise.

B. Extension: Primary Deficits and Real Interest Payments

Like the backward-looking analysis, a modified VAR can also capture the relationship between primary deficits and real interest payments. The vector in (8) is now defined as **X** = [PDEF, RIP]. Implications from Table 6 continue to hold.

In Table 8, exclusion (Granger causality) tests and impulse response functions (IRF's) are summarized for the modified system (8), estimated with 1 and 2 lags, for both the entire 1991:1–2000:12 period and the selected subsamples.

Like the previous estimates there is little evidence of a statistically significant relationship between the primary deficit (PDEF) and real interest payments (RIP), for either the entire sample or, with few exceptions, the selected subsamples. And, as before, the evidence that does favor such a relationship is not robust to alternative specifications.

The null hypothesis that current real interest payments do not explain future primary deficits is rejected only for the 1999:04–2000:12 period. The IRF, significant only for the 2-lag model, is negative. This finding reflects the fiscal adjustment that occurring after the *Real* floated in early 1999.

In the other direction, the null hypothesis that current PDEF does not explain future RIP is rejected only for the 1994:7–1998:12 period, in both the 1-and 2-lag models (with a significant IRF). The relationship is *positive*: an increase in today's primary deficit is associated with a future increase in liabilities (through some combination of changes in r and LIAB). This finding may reflect anticipated changes in the real interest rate. As mentioned above, the government may respond to an expected drop in real interest rates by increasing the primary deficit today. In this case, we might see a negative relationship between shocks to the primary deficit w_{PDEFt} and real interest payments (RIP), even if the corresponding relationship between the primary and the operational deficit is not evident.

VI. Summary, Conclusions, and Policy Implications

This paper examines several questions related to intertemporal solvency and fiscal adjustment in Brazil for the period 1991–2000, using monthly fiscal data. Is the recent fiscal regime in Brazil better characterized as "fiscal dominant" or "monetary dominant"? To limit debt accumulation, does the primary deficit adjust to changes in liabilities or real interest payments?

In Brazil, for most of the 1991–2000 period, the answer to these questions was generally "no." What evidence there is of a monetary dominant regime—and this evidence should be viewed with cautiously—is concentrated in the period from 1995 to 1997: after the Real plan but before the Asian crisis. Notably, what appeared to be an MD regime became an FD regime when the global market crises began.

Results in this paper relate to recent developments in Brazil. A substantial fiscal adjustment in Brazil began in 1999 (following the devaluation of the *Real*). At that time, the primary surplus rose to over 3 percent of GDP, consistent with intertemporal solvency and sufficient to reduce the debt-to-GDP ratio.

In the most recent period covered by this paper, notwithstanding the substantial fiscal adjustment, there is little evidence favoring a monetary dominant regime (a statistically significant relationship between primary deficits and liabilities). Of course, this finding may simply reflect insufficient data. For example, in mid-2001, a period not covered in this paper, as GDP growth fell and real interest rates rose, yet another fiscal adjustment took place. Adjusting on a continual basis—as implied by a fiscal rule—avoids the need for larger, more costly adjustments in the future. In this regard, it is hoped that this paper will stimulate more research into the implementation of fiscal rules.

Table 8. Summary of Results, Modified System (8)

$$\mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + \dots + \mathbf{v}_t \qquad (8)$$

$$\mathbf{X} = [\text{RIP, PDEF}]$$

	1 Lag Model				2 Lag Model			
	$PDEF_t$ →	RIP_{t+i}	RIP_t →	$PDEF_{t+i}$	$PDEF_t$ →	RIP_{t+i}	RIP_t →	$PDEF_{t+i}$
	F-Stat	IRF	F-Stat	IRF	F-Stat	IRF	F-Stat	IRF
1991:1 - 2000:12	0.09	N.S.	0.03	N.S.	2.27	N.S.	0.11	N.S.
	(0.77)		(0.87)		(0.11)		(0.90)	
1991:1 - 1994:6	0.00	N.S.	0.12	N.S.	0.83	N.S.	0.73	N.S.
	(0.95)		(0.73)		(0.45)		(0.49)	
1994:7 - 2000:12	0.00	N.S.	0.07	N.S.	1.24	N.S.	0.25	N.S.
	(0.97)		(0.79)		(0.30)		(0.78)	
1994:7 - 1998:12	7.19	POS	0.18	N.S.	5.84	POS	0.43	N.S.
	(0.01)		(0.67)		(0.01)		(0.65)	
1995:7 - 1997:12	0.42	N.S.	0.16	N.S.	2.55	NS	0.72	N.S.
	(0.52)		(0.69)		(0.10)		(0.50)	
1997:12 - 2000:12	0.05	N.S.	0.01	N.S.	0.94	N.S.	0.09	N.S.
	(0.83)		(0.94)		(0.40)		(0.91)	
1999:04 - 2000:12	0.02	N.S.	10.44	N.S.	1.75	N.S.	24.46	NEG
	(0.90)		(0.01)		(0.23)		(0.00)	

F-Stat: Test for hypothesis that lagged variable does not help explain contemporaneous variable in modified system (8). IRF: impulse response function. NS: Not significant. NEG: negative and significant. POS: Positive and significant. P-values in parentheses.

DATA DEFINITIONS

Brazil's consolidated public sector includes the central government (the federal government, central bank, and social security system for private sector workers; INSS), state and municipal governments, and public enterprises at all 3 levels of government. Net public liabilities, presented in Table 1, include debt (B) and the monetary base (M).[30]

Privatizations that began in 1996 reduce public debt figures, both through direct proceeds and indirectly through the transfer of liabilities to the private sector. The net recorded impacts of these transactions is called $PRIV_t$. By contrast, other factors at this time that increased the debt include explicit recognition of both past arrears and other unsecuritized debts, and recapitalization of federal banks. These factors are contained in the variable called ARR_t.

As discussed below, estimates in this paper use data that are adjusted for these factors from 1996 onward. To obtain the adjusted measures, consider first unadjusted liabilities in current *Reais* $(B^U_t + M_t)$; that include these factors are:

(A.I.1) $$(B^U_t + M_t) = (B^U_{t-1}(1+i) + M_{t-1}) + G_t - T_t - PRIV_t + ARR_t$$

Equation (A.I.1) says that today's unadjusted liabilities equals the previous period's liabilities plus the (flow) current deficit (the primary deficit plus interest payments) minus debt operations associated with privatization ($PRIV_t$) plus, explicit recognition of arrears and other discrete adjustments to the debt stock (ARR_t).

For example, in 1998, the expanded operational deficit $ODEF_t$, 2.2 percent of GDP, reflects *reductions* of public sector debt due both to privatization ($PRIV_t$ = -1.9 percent of GDP) and arrears recognition (-.1 percent of GDP). Accordingly, the adjusted (or restricted) operational deficit is $ODEF(adjusted)_t$ approaches 4 percent of GDP.

In economic terms, PRIV is an incomplete measure: it includes the reduction in gross liabilities but not the gross assets (discounted flow of revenues). Also inclusion of arrears (ARR) may introduce a bias since those obligations, while unrecognized, had nonetheless previously existed. Thus, for estimations, the appropriate definition of the primary deficit is, adjusted for privatizations and arrears, is: $PDEF_t = G_t - T_t + PRIV_t + ARR_t + S_t$. Real interest payments are defined as $RIP_t = ODEF_t - PDEF_t$.

[30] In Brazil, while most debt is exchanged in the market (securitized), some debt is not marketable (contractual).

STATIONARITY TESTS, REAL OPERATIONAL DEFICIT

If fiscal variables were to behave indefinitely as they had in the past, would (3) be satisfied? To address this question, tests have been developed by several authors, including Hamilton and Flavin (1986), Wilcox (1991), Trehan and Walsh (1991), Bohn (1991), Hakkio and Rush (1991), and others. Here, we follow Trehan and Walsh (1991) test whether real operational deficit $ODEF_t = LIAB_t - LIAB_{t-1}$ is *stationary* about a constant.[31] Trehan and Walsh's test is similar to that of Hakkio and Rush (1991) (see also Tanner and Liu (1994)), namely a test for the one-to-one cointegration of interest-inclusive government expenditures $GG_t = G_t + RIP_t$ and T^*_t, where $RIP_t = r_t * LIAB_{t-1}$ and $T^*_t = T_t + S_t$. Note that both tests permit a variable real interest rate.[32] However, the Hakkio-Rush test requires that both GG_t and T^*_t be nonstationary. By contrast, the Trehan-Walsh does not require these assumptions. For this test, the Augmented Dickey Fuller (ADF) equation is:

$$\Delta ODEF_t = a_0 + a_1\, ODEF_{t-1} + \sum_{j=1}^{J} a_j\, \Delta ODEF_{t-j} + error_t \qquad \text{(A.II.1)}$$

The null hypothesis of nonstationarity implies that $a_1 = 0$. The related Zt and $Z\alpha$ tests, due to Phillips (1987) and Phillips and Perron (1988) are also presented. All tests are applied to the entire 1991–2000 period and three subperiods, namely Pre-*Real* (1991:1–1994:6), Post-*Real* (1994:7–2000:12), and Post-Tequila (1995:7–2000:12). Results, presented in Table 9, suggest that for the entire sample, as well as all three subperiods, most results suggest that ODEF is stationary: with the exception of the ADF statistics for the pre-*Real* period, for all three statistics and all periods, the null hypothesis of the nonstationarity of ODEF is rejected at the 90 percent level or better.[33]

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[31] These tests are related to McCallum's (1984) demonstration that, over an infinite horizon, constant interest inclusive deficit is consistent with intertemporal solvency. To see this, suppose that the government runs a constant operational deficit of k dollars each period. With a constant real interest rate, the right hand side of equation (3) is written as:

$$\lim_{t\to\infty} = [LIAB_0 + tk]/(1+r)^t$$

which converges to zero. Intuitively, if the interest inclusive deficit is a constant, the *undiscounted* value of obligations converges to a constant and hence the *discounted* value of the debt converges to zero over an infinite horizon.

[32] By contrast, a similar test proposed by Bohn (1991), for the cointegration of G, T^*, LIAB with a vector of coefficients [1, -1, r] requires a constant real interest rate.

[33] The authors also implemented the stationarity test due to Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992). Unlike the ADF test, the null hypothesis of the KPSS test is stationarity. Nonetheless, similar results were obtained.

Table 1. Stationarity Tests, Real Operational Deficit (ODEF)

(A.II.1) $$\Delta ODEF_t = a_0 + a_1\, ODEF_{t-1} + \sum_{j=1}^{J} a_j\, \Delta ODEF_{t-j} + error_t$$

	ADF(1)	ADF(2)	Zt(1)	Zt(1)	Zα(1)	Zα(1)
Whole Period (1991:1–2000:2)	-8.77**	-6.14**	-9.88**	-9.86**	-103.44**	-96.40**
Pre-Real (1991:1–994:6)	-1.95	-1.17	-3.27**	-3.33**	-26.68**	-27.42**
Post-Real (1994:7–2000:2)	-7.34**	-4.98**	-8.00**	-7.96**	-70.34**	-64.36**
Post-Tequila (1995:7–2000:2)	-7.00**	-4.64**	-7.60**	-7.59**	-61.66**	-56.11**

Notes: Null hypothesis is a_1=0. ADF(x), Zt(x) and Zα(x) are the Augmented Dickey Fuller (Equation (5)) test, Phillip's Zt and Zα tests (See Phillips (1987) and Phillips and Perron (1988), respectively, where x is the number of augmented terms included in the test. The 95 and 99 percent critical values for the ADF(x) and Zt tests are -3.00 and -3.75, respectively. The 90 and 95 percent critical values for the Zα test are -8.0 and -13.6, respectively. *, ** represents rejection of the null hypothesis of nonstationary process at 90,95 percent levels. Critical values are from Fuller (1976, pp. 371–73).

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