# IS THE PRICE LEVEL DETERMINED BY THE NEEDS OF FISCAL SOLVENCY?

Matthew B. Canzoneri
Robert E. Cumby
Behzad T. Diba

Working Paper **6471**

NBER WORKING PAPER SERIES

# IS THE PRICE LEVEL DETERMINED BY THE NEEDS OF FISCAL SOLVENCY?

Matthew B. Canzoneri
Robert E. Cumby
Behzad T. Diba

Working Paper 6471
http://www.nber.org/papers/w6471

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 1998

Helpful comments from John Cochrane, Eric Leeper, and seminar participants at MIT, the International Monetary Fund, and Georgetown University are acknowledged with thanks. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

of Fiscal Solvency?
Matthew B. Canzoneri, Robert E. Cumby
and Behzad T. Diba
NBER Working Paper No. 6471
March 1998
JEL Nos. E31, E42, E52

## ABSTRACT

A new theory of price determination suggests that if primary surpluses are independent of the level of debt, the price level has to "jump" to assure fiscal solvency. In this regime (which we call Fiscal Dominant), monetary policy has to work through seignorage to control the price level. If on the other hand primary surpluses are expected to respond to the level of debt in a way that assures fiscal solvency (a regime we call Money Dominant), then the price level is determined in more conventional ways. In this paper we develop testable restrictions that differentiate between the two regimes. Using post war data, we present what we think is overwhelming evidence that the United States is in a Money Dominant regime; even the post Reagan data (1980 to 1995) seem to support that contention.

Matthew B. Canzoneri
Department of Economics
Georgetown University
Washington, DC 20057
canzonem@gunet.georgetown.edu

Robert E. Cumby
Department of Economics
Georgetown University
Washington, DC 20057
and NBER
cumbyr@gunet.georgetown.edu

Behzad T. Diba
Department of Economics
Georgetown University
Washington, DC 20057
dibab@gunet.georgetown.edu

## I. INTRODUCTION

Woodford (1994, 1995, 1996) and Sims (1994, 1995) have recently emphasized the role of the government budget constraint in price determination.[1] If primary surpluses are determined independently of the level of debt, then the path of the money supply and the price level must satisfy the needs of fiscal solvency; we call this a *fiscal dominant* (FD) regime. If on the other hand primary surpluses respond to the level of debt in a way that assures fiscal solvency, then money and prices can be determined by the supply and demand for money; we call this a *money dominant* (MD) regime.[2] The question then is whether monetary or fiscal policy provides the nominal anchor for the economy.[3]

Woodford (1995) emphasize the FD regime, suggesting at one point that "it should be evident that (MD) regimes represent a highly special case." And indeed many, if not most, general equilibrium models are solved under that assumption.[4] The conventional wisdom, on the other hand, is that monetary policy provides the nominal anchor and most of the empirical models developed at policy making institutions are solved under the assumption of a MD regime.[5]

Clearly, both assumptions can not be right, and it is crucial in many modeling efforts to make the right choice. Consider first the theoretical (or methodological) issues that are at stake. We will show that the choice of regime limits the way in which monetary policy can be modeled.[6] For example, the price level will be over determined in a model in which the central bank tries to set the money supply in a FD regime, and the price level will be undetermined in a model in which the central bank tries to set the nominal interest rate in a MD regime. Furthermore, the choice of regime affects the way in which fixed exchange rate systems can be modeled. Canzoneri, Cumby and Diba (1997a) show that monetary policy alone can not peg the exchange rate in a FD regime. Instead, fiscal policy needs to insure solvency—in effect placing the economy in a money dominant regime—if a peg is to be viable.

Consider next the policy issues that are at stake. The reduced form for the price level depends in an important way on which regime is in place. In a FD regime, monetary policy has to work through seignorage and the government's budget constraint to control the price level; in a MD regime, monetary policy works through the familiar channels of aggregate demand management. Canzoneri and Diba's (1996) numerical calculations suggest that the central banks of most OECD countries would lose control of their price levels in a FD regime, because seignorage is such a small component of total revenue.[7] It is probably not reasonable to hold a central bank accountable for price stability in a FD regime, and this is one interpretation of the concern central banks have about the constraints placed upon them by loose fiscal policies.[8] If this interpretation of their concern is justified, then policy simulations should be based upon the assumption of a FD regime, which is not the usual practice.

All of this suggests that the modeler's choice of regime does not fall under the heading of "innocent assumptions". The choice should not be made lightly. But which assumption is right? In this paper, we approach the question in two ways. The proponents of the new theory of price determination focus much of their attention on FD regimes. This is understandable since FD regimes are the new element here, and they yield unconventional results for price determination and monetary policy. MD regimes embody the conventional macroeconomic wisdom. This focus can however give the (perhaps unintended) impression that FD regimes are somehow the natural choice to make, and that MD regimes are a very special case. So, the first thing we do is present the theory in a way that dispels this impression. We do this by showing that a wide class of fiscal policy rules leads to MD regimes. These rules can stringent, or they can be very lax: there is considerable latitude for countercyclical policy and/or political noise. After establishing the ex-ante plausibility of MD regimes, we go on to test the hypothesis that the United States has been in a FD regime. Using post war data, we try to distinguish between MD and FD regimes empirically.

It is more difficult than one might think to develop restrictions on the data that allow us to distinguish between the two regimes. For example, Figure 1 suggests that there has been a positive relationship between primary surpluses and government liabilities in the United States over the last forty five years. One might take this as prima facie evidence of a fiscal reaction function that could have led to a MD regime. However, we will show that there should also be a positive relationship between surpluses and liabilities in a FD regime, with the direction of causality going the other way. We have to look further than simple correlations between surpluses and debt to find our testable restrictions. Bohn (1995) argues that the surplus to GNP ratio responds positively to the debt to GNP ratio in the post war period (1948-1989) once temporary government spending and cyclical effects have been accounted for; if his use of these extra variables properly identifies the relationship he estimates as a policy reaction function, then his work offers evidence in favor of a MD regime. More generally, however, we may have to look further than fiscal reaction functions, even if they are well identified. To see why, suppose a fiscal retrenchment is expected to occur at some time well into the future. As we will show, such an expectation can result in a MD regime, but there may not be any evidence of it in our limited sample period. Developing an appropriate set of testable restrictions is one of the main contributions of the paper.

The rest of the paper is organized as follows. In section II, we review the new theory of price determination and illustrate the breadth of the class of fiscal policies that result in a MD regime. We also develop the restrictions that will allow us to distinguish between MD and FD regimes. Readers who are well acquainted with the theory may wish to skip to the last part of this section, where the restrictions are developed. In section III, we test these restrictions, and in section IV we discuss caveats about our conclusions and directions for future work.

It may be helpful to give our bottom line at the outset, so that the reader will know what to look for: we think the post war US data reject the hypothesis of a FD regime. We will present what we think is convincing evidence in favor of the MD regime, and therefore the conventional view of price determination. Kremers (1989) found some evidence for a switch in surplus policy after 1980, and so do we. However, if there is a new regime in place, we find no evidence that it is a FD regime.

## II. THEORETICAL CONSIDERATIONS

We begin this section with a review of the theory of price determination that was developed by Auernheimer and Contreras (1990), Leeper (1991), Woodford (1994, 1995) and Sims (1994, 1995). Once the basic theory is laid out, we present a Proposition that illustrates the breadth of the class of fiscal policy rules that lead to MD regimes. Then, we develop the restrictions that will allow us to distinguish between MD and FD regimes empirically.

The new theory of price determination revolves around the way in which the government's present value budget constraint gets satisfied. The reduced form for the price level will of course depend upon the way in which the rest of the economy is modeled, and that has been done in a variety of ways.[9] However, the defining features of MD and FD regimes can be explained in terms of the budget constraint alone. The theory is, in this sense, quite general.

In nominal terms, the government's budget constraint for period j can be written as

$$(1)\quad B_j = (T_j - G_j) + (M_{j+1} - M_j) + B_{j+1}/(1 + i_j),$$

where $M_j$ and $B_j$ are the stocks of base money and government debt at the beginning of period j, $T_j$ - $G_j$ is the primary surplus during period j, and $i_j$ is the interest rate for period j. The constraint says that the existing debt has to be paid off, monetized, or refinanced. It should be emphasized that we are assuming the government issues nominal liabilities (M and B); while the nominal values of these liabilities are fixed at the beginning of the period, their real values depend on the price level. We will see the importance of this assumption shortly.

We want to express the budget constraint in terms of total government liabilities, M + B, and to scale the fiscal variables on GDP. We do this to facilitate policy discussions and empirical applications. After some tedious algebra, the budget constraint becomes

$$(2)\quad \frac{M_j + B_j}{P_j y_j} = \left[\frac{T_j - G_j}{P_j y_j} + \left(\frac{M_{j+1}}{P_j y_j}\right)\left(\frac{i_j}{1 + i_j}\right)\right] + \left(\frac{y_{j+1}/y_j}{(1 + i_j)(P_j/P_{j+1})}\right)\left(\frac{M_{j+1} + B_{j+1}}{P_{j+1} y_{j+1}}\right).$$

(2) says that the ratio of total government liabilities to GDP has to be equal to the ratio of the primary surplus (now inclusive of central bank transfers) to GDP plus the discounted value of the ratio of next period's liabilities to GDP; the discount factor is the ratio of the real growth in GDP to the real interest rate. Finally, we want to simplify our notation by replacing (2) with

(3) $w_j = s_j + \alpha_j w_{j+1}$.

$w_j$ is the liabilities to GDP ratio, $s_j$ is the surplus to GDP ratio, and $\alpha_j$ is the discount factor. It should be kept in mind that $s_j$ includes central bank transfers (or seignorage).

We will follow Woodford's (1995) development of the theory and focus on the government's present value budget constraint.[10] Iterating equation (3) forward from the current period, t, and taking expectations on information available in period t, we obtain the present value constraint

(4) $$w_t = E_t \sum_{j=t}^{\infty} (\Pi_{k=t}^{j-1} \alpha_k) s_j \quad \Leftrightarrow \quad \lim_{T \to \infty} E_t (\Pi_{k=t}^{t+T-1} \alpha_k) w_{t+T} = 0.$$

where $\Pi_t^{t-1} \alpha_k \equiv 1$. The two expressions in (4) are equivalent ways of writing the constraint.

Following Hamilton and Flavin (1986), a growing literature has tried to test one or the other of these constraints empirically; this literature interprets the results as a test of government solvency.[11] By contrast, the new theory of price determination treats (4) as an equilibrium condition that must be satisfied.[12] In our empirical application, it is part of the maintained hypothesis. The fundamental question here is: how does (4) get satisfied, and how do we solve the model?

There are a number of possibilities. For example, there may be an endogenous fiscal policy that makes the sequence $\{s_j\}$ satisfy (4), no matter what values the discount factors, $\{\alpha_j\}$, or the initial liabilities to GDP ratio, $w_t$, take in equilibrium. Another possibility is that the sequence $\{s_j\}$ is independent of the level of the debt. Then, the discount factors, $\{\alpha_j\}$, and/or the initial liabilities to GDP ratio, $w_t$, have to fluctuate in equilibrium to satisfy (4). How can $w_t$ =

$(M_t + B_t)/P_t y_t$ move to satisfy (4)? Nominal liabilities are fixed at the beginning of the period, but a "jump" in nominal income can generate a change in the ratio. Here is where the assumption of nominal public sector liabilities is important. This would not be a theory of price determination without it; all of the onus of the adjustment to equilibrium in (4) would be on the discount factors or real income.

The MD and FD regimes can now be defined in terms of the present value constraint (4). If primary surpluses (or more precisely the surplus to GDP ratios) are determined independent of the level of the debt, then nominal income and/or discount factors must "jump" in equilibrium to satisfy (4). We call this a *FD regime*. If on the other hand primary surpluses are determined in such a way that (4) is always satisfied no matter what nominal income and discount factors are fed into it, then nominal income and the discount factors can be determined elsewhere in the model. We call this a *MD regime*. In summary, nominal income is determined by the needs of fiscal solvency in a FD regime; it can be determined in more conventional ways in a MD regime. Once we specify the way in which changes in nominal income are split between price and output, we have a theory of price determination. This last step is obviously model specific, and controversial. Fortunately, the restrictions we need for Section III do not require us to take a stand on these issues.

One must also fill out the model to see how the choice of regime limits the way in which monetary policy can be modeled. Consider a very simple example: let output and government purchases be fixed each period, and let there be a cash in advance constraint (so that $M_{j+1} = P_j \bar{y}$ in equilibrium). The consumer's Euler equation fixes the market discount factors, $\alpha_j$, at the household's discount factor, and an equilibrium sequence $\{M_{j+1}, P_j, s_j\}$ must satisfy the present value constraint, (4), and the cash in advance constraint. In a FD regime, the $s_j$ do not respond to the level of the debt, and $P_t$ has to "jump" to make $w_t$ satisfy (4). If the central bank tries to set $M_{t+1}$, $P_t$ will be over determined; $P_t$ can not (in general) satisfy both (4) and the cash in advance constraint. If on the other hand the central bank sets $i_t$, then there is no problem; (4) determines $P_t$, and the cash in advance constraint determines $M_{t+1}$. In a MD regime, things work out quite differently. The $s_j$ are determined in such a way that (4) is satisfied for any value of $P_t\bar{y}$ (or $w_t$) that is fed into it; (4) can not be used to determine $P_t$. Now, if the central bank sets $M_{t+1}$, $P_t$ is determined by the cash in advance constraint and there is no problem. If on the other hand, the central bank tries to set $i_t$, we have a new problem. The cash in advance constraint can not simultaneously determine $M_{t+1}$ and $P_t$. So, the FD regime limits us to considering interest rate rules, while the MD regime limits us to considering money supply rules. As explained in the introduction, none of these results are new; they hold in a wide class of models.

The MD regime might seem like a rather special case, but it turns out that many different fiscal policy rules lead to MD regimes. Moreover, these rules can be quite lax. The MD regime is not as implausible as it may at first appear. To illustrate this point, suppose that the sequence $\{s_j\}$ is expected to follow the rule

(5) $s_j = c_j w_j + \epsilon_j$,

where $c_j$ is a time varying response parameter and $\epsilon_j$ is a random variable. $\epsilon_j$ could represent political factors or economic conditions, such as unemployment. We have the following proposition:

<u>Proposition</u>: Assume that $\{c_j\}$, $\{\alpha_j\}$ and $\{\epsilon_j\}$ are deterministic sequences, that $\{\epsilon_j\}$ is bounded, and that the following conditions hold:

(C1) $\alpha_j \geq \alpha_* > 0$ for all j, and $\lim\sup \alpha_j < 1$

(C2) $0 \leq c_j \leq c^* < 1$ for all j,

(C3) $c_j \geq c_* > 0$ infinitely often,

where $c^*$, $c_*$ and $\alpha_*$ are constants; then, the flow budget constraint (3) and the fiscal rule (5) imply that the present value constraint (4) holds for any arbitrary value of $w_t$.

In other words, the fiscal rule (5) results in a MD regime if $\{\epsilon_j\}$ is bounded and conditions (C1), (C2) and (C3) hold. We prove this proposition in an appendix, and we extend it to a stochastic environment.

The intuition behind the proof is more transparent in the case where $c_j$ and $\alpha_j$ are constant ($c_j = c$ and $\alpha_j = \alpha$, for all j). If there is no stabilizing fiscal policy (because c = 0), then the flow budget constraint (3) is a dynamically unstable equation (since by assumption its root, $1/\alpha$, is greater than one); in this FD regime, $w_t$ has to jump to suppress this unstable root for (4) to hold in equilibrium.[13] Substituting (5) into (3), the root of the equation becomes $(1-c)/\alpha$. If the fiscal response coefficient, c, is sufficiently large to make $(1-c)/\alpha < 1$ -- which roughly corresponds to a fiscal response larger than the difference between the interest rate and the growth rate of GDP -- then the flow budget constraint is dynamically stable, and (4) holds for any initial condition, $w_t$.[14] It turns out however that the fiscal response does not have to be strong enough to make the flow budget constraint stable; all that is required by (4) is that the discounted value of $w_{t+T}$ go to zero as T goes to infinity. Any positive value of c implies that this is the case. Moreover, allowing for a time varying fiscal response, condition (C3) says that the requisite fiscal response may be arbitrarily small and infrequent.

We don't consider the above Proposition's assumptions about fiscal policy to be overly restrictive. It seems natural to assume that the ratio of the primary surplus to GDP, and thus $\{\epsilon_j\}$, is bounded and that an increase in debt does not cause a decrease in the primary surplus (so that $c_j \geq 0$ holds). The lower bound $\alpha_*$ on $\alpha_j$ and the upper bound $c^*$ on $c_j$ are plausible (and analytically convenient) assumptions. The growth rate of the economy can exceed the interest rate for finitely many periods without violating (C1). However, the condition lim sup $\alpha_j < 1$ is necessary for the government's present value budget to be well defined; without it the government could roll over debt indefinitely regardless of the value of $w_t$.

The only substantive assumption is that $c_j$ is bounded away from zero infinitely often. This will be the case unless the fiscal authority tries to rollover the interest due on debt indefinitely. In periods in which $c_j > 0$, $s_j$ is indeed moving to stabilize $w_j$. However, it need not do so each and every period. A stabilizing policy could be in effect every other year, or every third year, or every decade. Indeed, the required fiscal retrenchment need not occur in the next 100 years! All that is necessary is that the private sector expects that there will sooner or later be a retrenchment. In the meantime, fiscal policy can respond to economic or political conditions (as represented here by the random variable $\epsilon_j$).

With these insights, we are ready to develop the restrictions that will help us to differentiate between MD and FD regimes. This is not as straightforward as it may at first appear. Figure 1 illustrates the positive correlation between $s_t$ and $w_t$ in the post war data. This might be viewed as evidence in favor of a MD regime; primary surpluses responded to liabilities in the manner prescribed by (5) and produced a MD regime. However, there is an identification problem here; a FD regime would also have produced the positive correlation between $s_t$ and $w_t$, with causation going the other direction. To see why, consider the effect of a positive $s_t$ innovation in equation (4). In a FD regime, nominal income and/or expected future discounted surpluses must move to achieve fiscal balance. If an innovation in $s_t$ causes the RHS of (4) to rise, then nominal income must fall to raise the LHS of (4). Simple correlations between $s_t$ and $w_t$ are not very useful for our purposes.

This discussion does however suggest a way to differentiate between MD and FD regimes. Consider how a positive innovation in $s_t$ passes to $w_{t+1}$. In a MD regime, the surplus pays off some of the debt, and $w_{t+1}$ falls. In a FD regime, there are several possibilities. Consider first the case in which an innovation in $s_t$ is not correlated with the surpluses and discount factors that follow $s_t$ on the RHS of (4). In a FD regime, the value of $w_{t+1}$ can be found by shifting (4) forward one period. In the case we are considering, $w_{t+1}$ should not be affected by the innovation in $s_t$.[15] Consider next the case in which an innovation in $s_t$ is positively correlated with future surpluses and discount factors. In this case, $w_{t+1}$ should rise. In either of these cases, it should in principle be possible to differentiate between MD and FD regimes. For example, the impulse response function from a VAR in $s_t$ and $w_t$ would tell us how $w_{t+1}$ responds to an innovation in $s_t$. If $w_{t+1}$ falls, we have an MD regime; if it does not, we have a FD regime.

Unfortunately, there is also a third case to consider. Suppose innovations in $s_t$ are negatively correlated with future surpluses and discount factors. In this case, $w_{t+1}$ would fall in either a MD regime or a FD regime, and we have an identification problem. We will have to check for this possibility.

## III. TESTING FOR FISCAL DOMINANCE

In this section, we use annual data from 1951 - 1995 to determine whether the US has been in a MD regime (as most empirical policy analyses assume) or a FD regime. To do this, we use the data illustrated in Figure 2 to test the restrictions that were discussed at the end of the last section. *Liabilities/GDP* corresponds to $w_t$ in the last section; it is calculated by adding the net federal debt to the money base, both measured at the beginning of the fiscal year, and dividing by nominal GDP for the fiscal year.[16] *Surplus/GDP* corresponds to $s_t$.[17]

Before estimating the VAR, we test for stationarity. Both Phillips-Perron and augmented Dickey-Fuller tests reject a unit root in Surplus/GDP at the 1% significance level. The evidence on the stationarity of Liabilities/GDP is somewhat mixed. The Phillips-Perron test rejects a unit root at the 5% level. The augmented Dickey-Fuller test, on the other hand, does not reject a unit root at conventional levels.[18]

These results are consistent with those found in the literature. Kremers (1989), using data from the inter and post war periods (1923-1940, 1951-1985), found Augmented Dickey-Fuller tests reject a unit root in the debt to GDP ratio at about the 10% level. Bohn (1995), using a longer data set (1916-1989), found that ADF tests reject unit roots in the surplus to GNP ratio at the 1% level and in the debt to GNP ratio at about the 5% level. The general consensus from the literature seems to be that there is strong evidence that the surplus to GDP ratio is stationary while the evidence on the stationarity of the debt to GDP ratio is somewhat weaker.

We will adopt the stationarity of Surplus/GDP and Liabilities/GDP as a working hypothesis for two reasons. First, the results of the Phillips-Perron tests and the previous literature suggest both series are stationary. Second, the results for Surplus/GDP point unambiguously to stationarity and theory tells us that if Surplus/GDP is stationary then Liabilities/GDP, which is the expected present value of future surpluses, must also be stationary (provided the discount factor is constant).

Where might assuming stationarity create problems? The point estimates of the impulse response functions will still be valid. But the confidence intervals, which are calculated assuming the estimated parameters are asymptotically normal, may create problems. Fortunately, these problems do not prevent us from testing the main hypothesis of interest. The k-step ahead impulse response is calculated using only the first k lags in the estimated VAR. Sims, Stock, and Watson (1990) show that even if the VAR contains some I(1) variables, subsets of the estimated lag coefficients will be asymptotically normal. In particular, the k-step ahead impulse response coefficients will be asymptotically normal provided the VAR has more than k lags. Our main interest is in the effect of a shock to $s_t$ on $w_{t+1}$. As long as our estimated VARs have more than one lag, the standard errors for the impulse response at t+1 will be asymptotically valid, even if some of the variables are not stationary.

Next we estimate a VAR with two lags of Surplus/GDP and Liabilities/GDP (and a constant).[19] We tried other specifications: we added a deterministic trend; we used lags of one, three and four years; and we estimated the VAR in first differences. All of these VARs produced very similar results. Figure 3 shows the impulse response functions for an innovation in Surplus/GDP. Since the residuals in this VAR are highly (negatively) correlated, the ordering in the Cholesky decomposition may matter. For this reason, we show the results for both orderings. In the top panel, Surplus/GDP comes first. This ordering allows for a contemporaneous affect on Liabilities/GDP as is consistent with a FD regime (where nominal GDP has to jump to make the value of the existing debt equal to the expected present value of surpluses). In the bottom panel, Liabilities/GDP comes first. This ordering may make more sense in a MD regime (where GDP can be determined elsewhere in the model) because it does not allow for a contemporaneous affect on Liabilities/GDP. The dashed lines represent the two standard deviation bands obtained by a Monte Carlo simulation with 500 repetitions.

We are most interested in the response of Liabilities/GDP one period after the innovation in Surplus/GDP. As explained in Section II, the Surplus/GDP innovation pays off some of the debt in a MD regime, and Liabilities/GDP should fall in the next period. In a FD regime, there are three cases to consider. Recall that the value of next period's Liabilities/GDP can be found by moving equation (4) forward one period. If the innovation in Surplus/GDP is not correlated with the surpluses and discount factors that follow, then next period's Liabilities/GDP should not be affected by today's innovation; if the innovation in Surplus/GDP is positively correlated with future surpluses and discount factors, then next period's Liabilities/GDP should rise in response to today's innovation; and if the innovation in Surplus/GDP is negatively correlated with future surpluses and discount factors, next period's Liabilities/GDP should fall in response to today's innovation in Surplus/GDP. The existence of this last case creates a potential identification problem. We will have to investigate the possibility of a negative autocorrelation in the surplus process and the possibility of a negative correlation between the current surplus and future discount factors.

Figure 3 shows that the response of Liabilities/GDP in period 2 to an innovation in Surplus/ GDP in period 1 is negative and significant, regardless of the ordering used.[20] The response of Liabilities/GDP in period 3 is also negative and significant. This can be readily explained in terms of a MD regime. But it is also consistent with a FD regime in which the primary surplus is exogenous (or at least unrelated to liabilities) but exhibits negative autocorrelation.

Does the primary surplus respond to liabilities thereby yielding a MD regime or is Surplus/GDP exogenous but negatively autocorrelated? We begin answering this question by examining the autocorrelation function of Surplus/GDP, which is found in Table 1. The autocorrelations and the corresponding Q-statistics clearly indicate that there is significant positive autocorrelation in Surplus/GDP, at least at lags of up to 9 years. Next, we return to the joint dynamics of Surplus/GDP and Liabilities/GDP and look at the impulse response functions from the VAR. Figure 3 also shows that an innovation in Surplus/GDP in period 1 tends to produce a surplus in period 2, regardless of the ordering. (In a MD regime, this is consistent with the additional fall in period 3 Liabilities/GDP shown in Figure 3.) Beyond period 2, the impulse responses are negative and insignificant. These response functions are quite consistent with a MD regime—a deficit today means a higher debt next period, and in a MD regime that debt would have to be paid off at sometime in the future.

The difference between the positive autocorrelation we find when we look only at Surplus/GDP and the impulse responses that capture the feedback from Liabilities/GDP suggests that the surplus is not exogenous and is instead influenced by the level of existing liabilities. Bohn's (1995) fiscal reaction function (which was discussed in the introduction) is also consistent with this interpretation.

What do we conclude from all this? Apart from the feedback from Liabilities/GDP that a MD regime would predict, there appears to be very little evidence that innovations in Surplus/GDP are negatively correlated with future surpluses.

As Campbell and Shiller (1987) point out, if the discount factor is constant, the bivariate VAR includes all of the relevant information (because Liabilities/GDP is the expected present value of future Surplus/GDP). Of course, discount factors need not be constant so we also include the discount factor and consider a three-variable system. This allows us to determine whether the effect of an innovation to $s_t$ on $w_{t+1}$ is robust to conditioning on $\alpha$, the discount factor, and to investigate the effect of innovations to $s_t$ on future discount factors.[21] Figure 4 shows impulse response functions from a VAR with a constant and two lags. Once again the results are quite robust: adding a deterministic time trend, or using lag lengths of one, three or four, we get similar pictures. The VAR's residuals are highly correlated; we show what would seem to be the two relevant orderings. In the top panel, Surplus/GDP comes first (as may make more sense in a FD regime), followed by Liabilities/GDP and $\alpha$; in the bottom panel, Liabilities/GDP comes first (as may make more sense in a MD regime), followed by Surplus/GDP and $\alpha$. The dashed lines represent the two standard deviation bands obtained by a Monte Carlo simulation with 500 repetitions.

Our basic results are robust to conditioning on Alpha. The response of Liabilities/GDP in periods 2 and 3 to an innovation to Surplus/GDP in period 1 is again negative and significant. In addition, the response of Surplus/GDP to that same innovation shows some persistence, but as before it is short lived. The new information in Figure 4 is the response of $\alpha$ to an innovation in Surplus/GDP. The initial impact period 1 is negative, and it appears to be significant. However, we are interested in the correlation between innovations in Surplus/GDP and <u>future</u> discount factors. In Figure 4, the response of future discount factors is quite small and statistically insignificant.[22] Current innovations in Surplus/GDP appear to be uncorrelated with future discount factors.

In summary, we find that the post war US data strongly favors the MD regime over the

FD regime. The response of Liabilities/GDP one period after an innovation in Surplus/GDP is negative and significant. This is consistent with the MD regime (in which a surplus should pay off some the debt), and it is at odds with the FD regime, since we find no evidence that innovations in Surplus/ GDP are negatively correlated with future discount factors or future surpluses (apart form the feed-back from Liabilities/GDP that one would expected in a MD regime).

In the preceding analysis, we were implicitly assuming that there were no regime switches in the post war period. However, Figure 2 may cast some doubt on this assumption. Liabilities/GDP falls in the '50s, '60s and early '70s, it appears to level off in the late '70s, and it begins to rise again in the '80s and '90s. Kremers (1989) provides some formal evidence in support of this view; his statistical model predicts debt growth well from 1966 to 1981, but it significantly under predicts debt growth in subsequent years. Is it possible that the "Reagan Revolution" produced a regime switch that is hidden in our full sample results? Is it possible that the US has been in a FD regime since 1980?

Figure 2 also suggests that there may have been a break in the Surplus/GDP series. To obtain formal evidence in support of this view, we regressed Surplus/GDP on a constant and tested for structural breaks. These Chow tests are reported in Table 2. The tests do indicate a break, but they suggest that the "Revolution" might have preceded Reagan, beginning as early as 1975.

To see whether the US might now be in a FD regime, we reestimated our VARs using more recent sample periods. Figure 5 shows impulse response functions from a VAR for 1975-1995. The results are surprisingly strong given the short sample period. The VAR for 1980-1995 looks much the same. An innovation in Surplus/GDP makes Liabilities/GDP fall one period later, and the fall appears to be significant. Moreover, there is no evidence that the innovation in Surplus/GDP is negatively correlated with future discount factors.

We conclude that a "Revolution"—if one occurred, and whether it was inspired by Reagan or predated him—may indeed have produced a new fiscal regime, but we find no evidence that the United States has switched from a MD regime to a FD regime. Evidently, the financial markets anticipated a fiscal consolidation at some time in the future.

## VI. CONCLUDING COMMENTS

In this paper, we find that post war data are inconsistent with the hypothesis that the US has been operating in a FD regime. Our VARs show that the liabilities to GDP ratio falls one period after an innovation in the surplus to GDP ratio. This response is consistent with a MD regime, in which a surplus pays off part of the debt. It is inconsistent with a FD regime, unless innovations in the surplus to GDP ratio are negatively correlated with future surplus to GDP ratios or discount factors, and we find little or no evidence for such a correlation. We find some evidence of a change in fiscal regime that may have predated Reagan, but we find no evidence that the US switched to a FD regime. In summary, we find that the US has been in—and continues to be in—a MD regime.

In this paper, we used federal fiscal data for the entire post war period (1951-1995). Consolidated (federal, state and local) fiscal data are available from the OECD, but only for a relatively short period (1971-1995). In a companion piece, Canzoneri, Cumby and Diba (1997b), we find that the consolidated data for the United States produce results that are very similar to the ones we have just reported. Moreover, we find no convincing evidence in favor of the FD regime in any of the OECD countries we studied. However, the data sets are very short, and results for many of the countries were not very conclusive one way or the other. Further analysis of these countries may be warranted.

Our results do suggest that the empirical models developed at policy making institutions have been solved under the right assumptions. Or to put it in another way, our results provide support for more traditional views about price determination and monetary policy. The central bank can control the price level through demand management; the price level is not determined by the needs of fiscal solvency. Moreover, the traditional view of the "price indeterminacy problem" seems to be correct: the price level will not be pinned down when the central bank pegs the interest rate.

## Appendix

Recall from Equation (4) in the text, that the government's present value budget constraint holds if and only if

$$\text{(A1)} \quad \lim_{T \to +\infty} E_t\left(\prod_{k=t}^{T+t-1} \alpha_k\right) w_{t+T} = 0$$

is satisfied. In the FD regime, $w_t$ adjusts to satisfy (A1). In the MD regime, (A1) holds for all values of $w_t$. We show below that, under certain conditions, the fiscal rule of Equation (5) in the text is a sufficient condition for a MD regime. We first present the (more transparent) proof under perfect foresight, and then outline the extension allowing for uncertainty.

Using (5) and the flow budget constraint (3) in the text, the dynamics of $w_j$ are governed by

$$\text{(A2)} \quad w_{j+1} = \left[\frac{(1-c_j)}{\alpha_j}\right] w_j - z_j \ ,$$

where $z_j = \epsilon_j/\alpha_j$. Consider first the case where $\{c_j\}$, $\{\alpha_j\}$ and $\{\epsilon_j\}$ are deterministic sequences. We assume that $\{\epsilon_j\}$ is a bounded sequence and the following conditions hold:

(C1) $\alpha_j \geq \alpha_* > 0$ for all j, and $\limsup \alpha_j < 1$,

(C2) $0 \leq c_j \leq c^* < 1$ for all j,

(C3) $c_j \geq c_* > 0$ infinitely often,

where $c^*$ and $\alpha_*$ are constants—ensuring that $(1-c_j)/\alpha_j$ and $\alpha_j/(1-c_j)$ remain bounded for all j--and $c_*$ is an arbitrarily small positive constant. The condition $\limsup \alpha_j < 1$ implies that there exists $\alpha^* < 1$ and a positive integer J such that $\alpha_j \leq \alpha^*$ for all $j \geq J$. To simplify our notation, we replace

(C1) with

(C1') $0 < \alpha_* \leq \alpha_j \leq \alpha^* < 1$ for all j,

in the following proof. Working directly with (C1) instead of (C1') would only entail minor changes in (A6) and (A9) below, without changing the substance of the proof. The proof has three cases.

**Case 1:** lim sup $\{(1-c_j)/\alpha_j\} < 1$

In this case, the dynamics of $w_t$ are stable. Iterating (A2) from date T back to date t, we get

$$\text{(A3)}\quad w_T = \sum_{j=1}^{T-t} \phi_j z_{T-j} + \phi_{T-t+1} w_t ,$$

where $\phi_1 = 1$ and

$$\phi_{j+1} = \phi_j \left[ \frac{(1-c_{T-j})}{\alpha_{T-j}} \right], \quad \text{for } j = 1, 2, \ldots, T-t.$$

As T tends to +∞, the term $\phi_{T-t+1} w_t$ tends to zero for <u>any</u> given value of $w_t$, and we have

$$\text{(A4)}\quad \lim_{T\to+\infty} |w_T| \leq \sup|z_j| \sum_{j=1}^{+\infty} \phi_j .$$

The infinite series on the right-hand side converges by the "ratio test" [see, for example, Rudin (1976), Theorem 3.34] because

$$\text{(A5)} \quad \lim_{j\to+\infty} \sup \left|\frac{\phi_{j+1}}{\phi_j}\right| = \lim_{k\to+\infty} \sup \left[\frac{(1-c_k)}{\alpha_k}\right] < 1.$$

Thus, $w_{t+T}$ is bounded, and

$$\text{(A6)} \quad \lim_{T\to+\infty} (\prod_{k=t}^{T+t-1} \alpha_k)|w_{t+T}| \leq \lim_{T\to+\infty} (\alpha^*)^{T-1} |w_{t+T}| = 0.$$

**Case 2:** lim sup $\{(1-c_j)/\alpha_j\} = 1$

In this case, the right-hand side of (A3) does not converge as T tends to infinity, but (A6) still holds because the exponential function on its right hand side goes to zero faster than $|w_{t+T}|$ can grow.

**Case 3:** lim sup $\{(1-c_j)/\alpha_j\} > 1$

Iterating (A2) forward from date t to date t+T, and rearranging terms, we have

$$\text{(A7)} \quad (\prod_{k=t}^{T+t-1} \alpha_k)\, w_{t+T} = [\prod_{k=t}^{T+t-1} (1-c_k)][w_t - \sum_{i=0}^{T-1} \psi_i\, x_{t+i}] ,$$

where $x_{t+i} = \epsilon_{t+i}/(1-c_{t+i})$, $\psi_0 = 1$ and

$$\psi_{i+1} = \psi_i \left[\frac{\alpha_{t+i}}{(1-c_{t+i})}\right], \quad \text{for } i = 0, 1, 2, \ldots, T-2.$$

As T tends to $+\infty$ (assuming for now that the relevant limits exist), we get

$$\text{(A8)} \quad \lim_{T\to+\infty} (\prod_{k=t}^{T+t-1} \alpha_k)\, |w_{t+T}| \leq [\lim_{T\to+\infty} \prod_{k=t}^{T+t-1} (1-c_k)][|w_t| + \sup|x_i|\sum_{i=0}^{+\infty} \psi_i].$$

Since

$$\lim_{i\to+\infty} \sup \left|\frac{\psi_{i+1}}{\psi_i}\right| = \lim_{k\to+\infty} \sup \left[\frac{\alpha_k}{(1-c_k)}\right] < 1,$$

The infinite series on the right hand-side of (A8) converges and, therefore, the term in the second bracket is finite. The limit in the first bracket is zero by (C3), implying

$$\lim_{T\to+\infty} \left(\prod_{k=t}^{T+t-1} \alpha_k\right) w_{t+T} = 0.$$

## Stochastic Setup

Let $c_t$, $\alpha_t$, and $\epsilon_t$ be the first three components of a vector $\zeta_t$ generated by a first-order Markov process. The other components of $\zeta_t$ may include lags of the first three (capturing higher order dynamics) and other relevant random variables observed at or before date t. We assume that $\zeta_t \in Z$ for all t, where Z is a compact subset of a Euclidean space, that (C1') and (C2) hold with probability one, and that $\text{Prob}\{ c_{t+j} > c_* \mid \zeta_t = \zeta \} > 0$ for all $j > 0$, some $c_* > 0$, and all $\zeta \in Z$ (so that (C3) holds with probability one). Note that for any <u>fixed</u> $T > 0$, given the current state $\zeta_t = \zeta$, the random variable $w_{t+T}$ is a bounded function of $\{\zeta, \zeta_{t+1}, \ldots, \zeta_{T+t-1}\}$ and

$$E_t w_{t+T} = E\{ w_{t+T} \mid \zeta_t = \zeta \}$$

is well defined.

Given the state $\zeta_t = \zeta$ at date t, we can define the probability space $(\Omega, \mathscr{F}, P)$ so that each point $\omega \in \Omega$ corresponds to a sample path $\{\zeta, \zeta_{t+1}, \zeta_{t+2}, \ldots\}$. The σ-algebra $\mathscr{F}$ and the probability measure P can be defined so that for any random variable $f(\zeta, \zeta_{t+1}, \ldots, \zeta_{t+T})$,

$$E_t f(.) = \int_\Omega f(.)\,dP$$

whenever the expectation on the left-hand-side is well defined [see, for example, Stokey and Lucas (1989), Section 8.2].

For any given $\omega \in \Omega$, ignoring sets of measure zero where (C1'), (C2) and (C3) may fail to hold, the real sequence

$$[(\prod_{k=t}^{T+t-1} \alpha_k)\ w_{t+T}](\omega), \quad T = 1, 2, ...$$

converges to zero by one of the three cases above. So, the sequence of random variables

$$(\prod_{k=t}^{T+t-1} \alpha_k)\ w_{t+T}, \quad T = 1, 2, ...$$

converges to zero almost surely. Moreover, this sequence is bounded: (C1'), (C2) and (A7) imply

$$\text{(A9)} \quad (\prod_{k=t}^{T+t-1} \alpha_k)\ |w_{t+T}| \leq |w_t| + \left[\frac{\sup|\epsilon_i|}{1-\alpha^*}\right],$$

for all T > 0. Since P is a probability (finite) measure, the right-hand side of (A9) is P-integrable and, therefore, can serve as the dominating function for the Lebesgue Dominated Convergence Theorem [see, for example, Stokey and Lucas (1989), Theorem 7.10 ]. Thus, we have

$$\text{(A10)} \quad \begin{aligned} \lim_{T\to+\infty} E_t(\prod_{k=t}^{T+t-1} \alpha_k)w_{t+T} &= \lim_{T\to+\infty}\int_\Omega [(\prod_{k=t}^{T+t-1} \alpha_k)w_{t+T}]\,dP \\ &= \int_\Omega \lim_{T\to+\infty}[(\prod_{k=t}^{T+t-1} \alpha_k)w_{t+T}]\,dP = 0. \end{aligned}$$

Figure 1: Primary Surpluses and Liabilities, 1951 - 1995

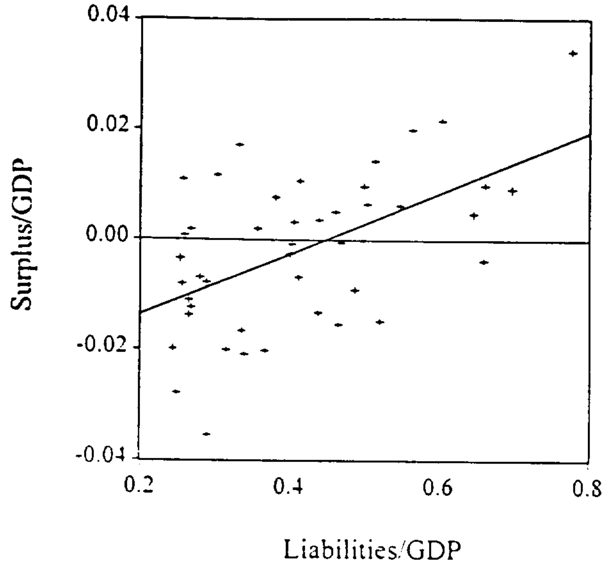
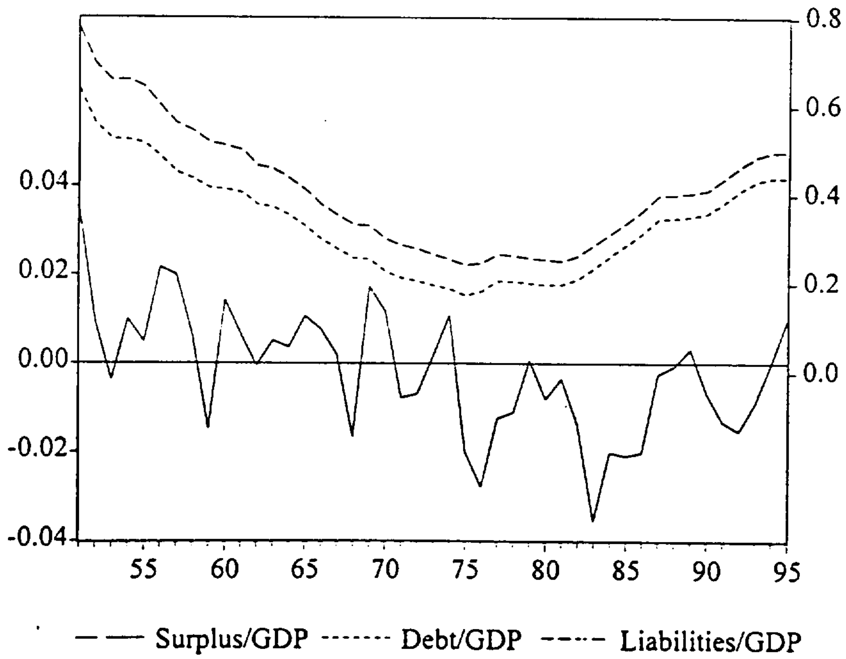



Figure 2: US Fiscal Data, 1951 - 1995

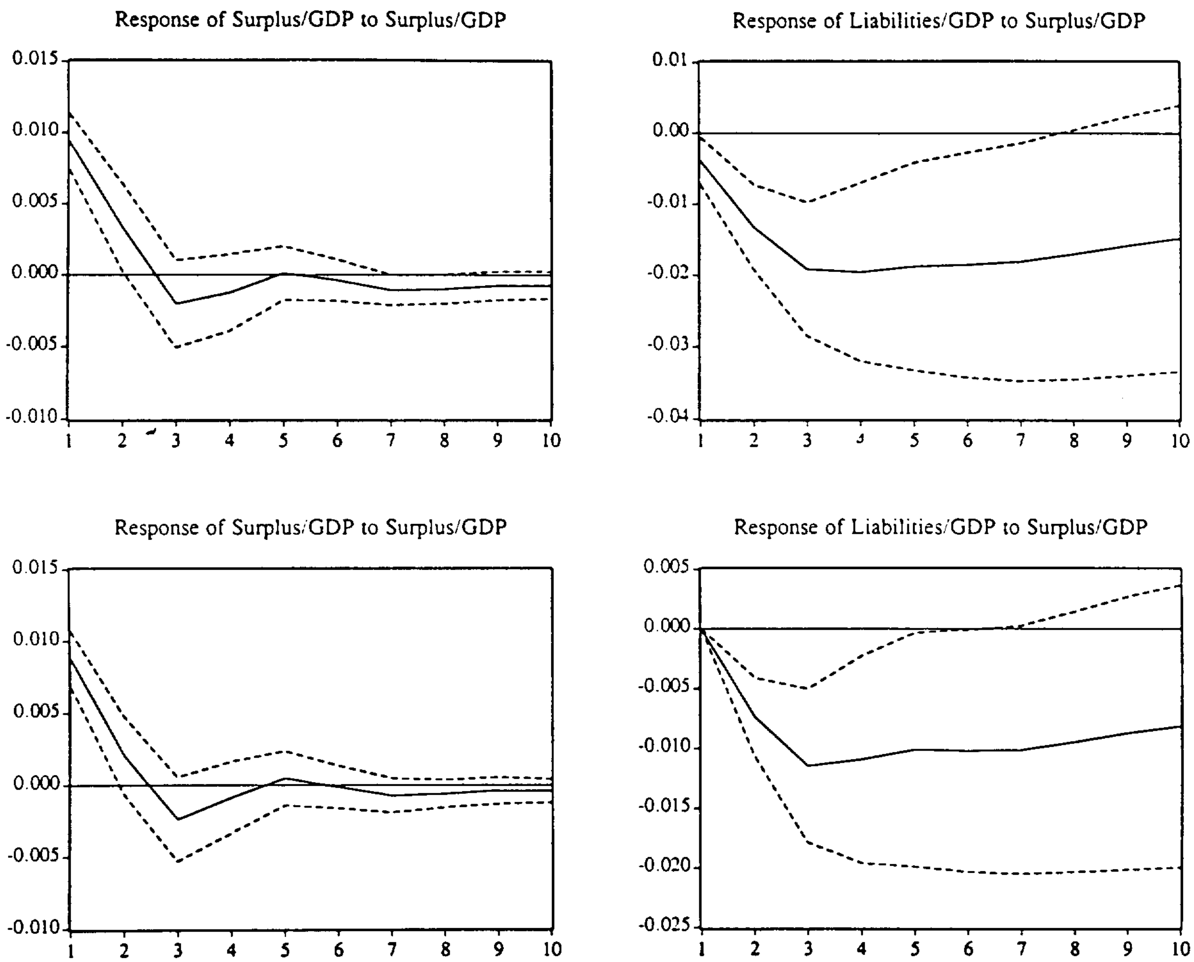



Note:

Scale for Surplus/GDP is on the left.

Scale for Debt/GDP and Liabilities/GDP is on the right.

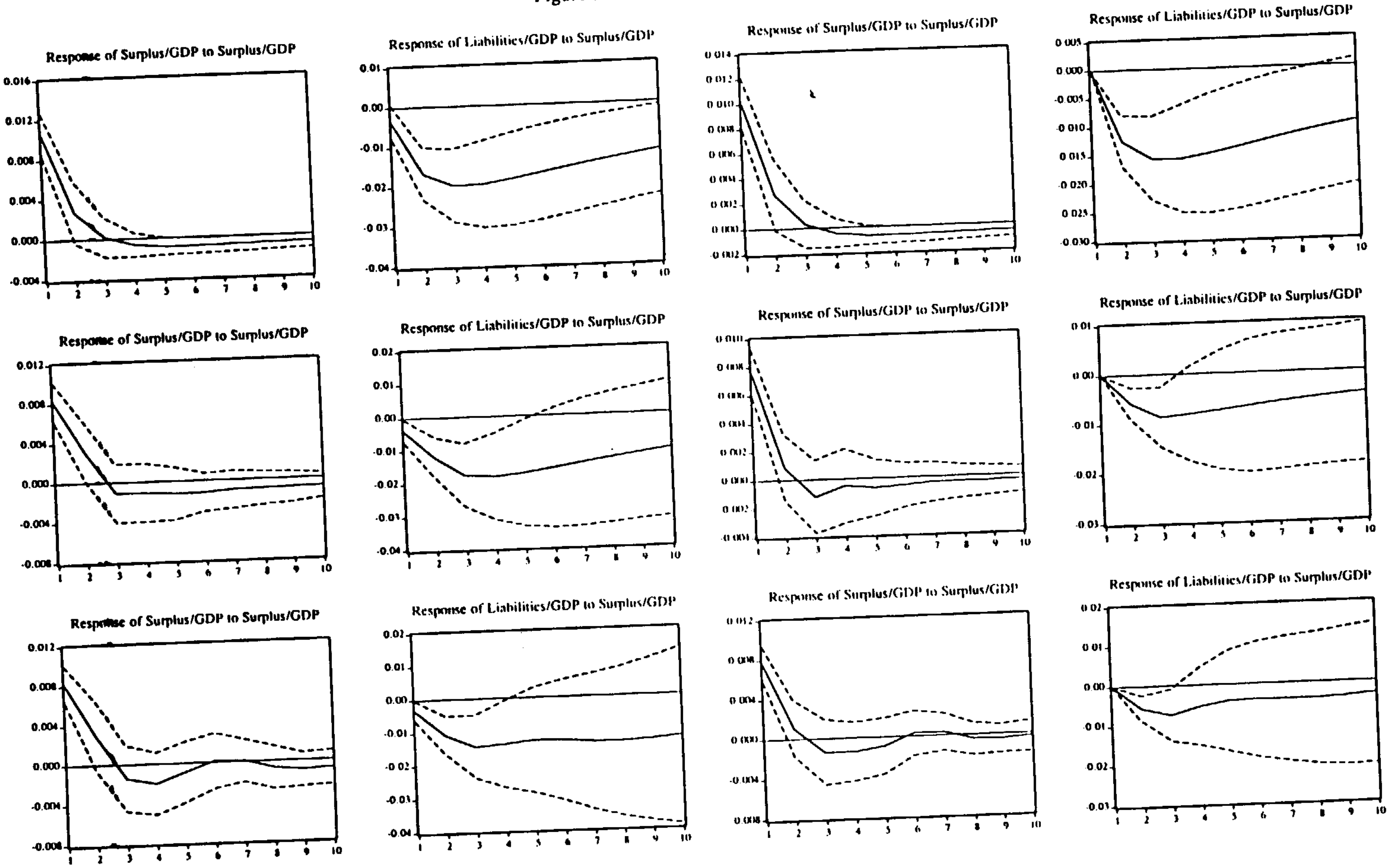
Figure 3: VAR in Surplus/GDP and Liabilities/GDP




Notes:

VAR has two lags and a constant
Sample Period: 1951 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Top panel ordering: Surplus/GDP, Liabilities/GDP
Bottom panel ordering: Liabilities/GDP, Surplus/GDP

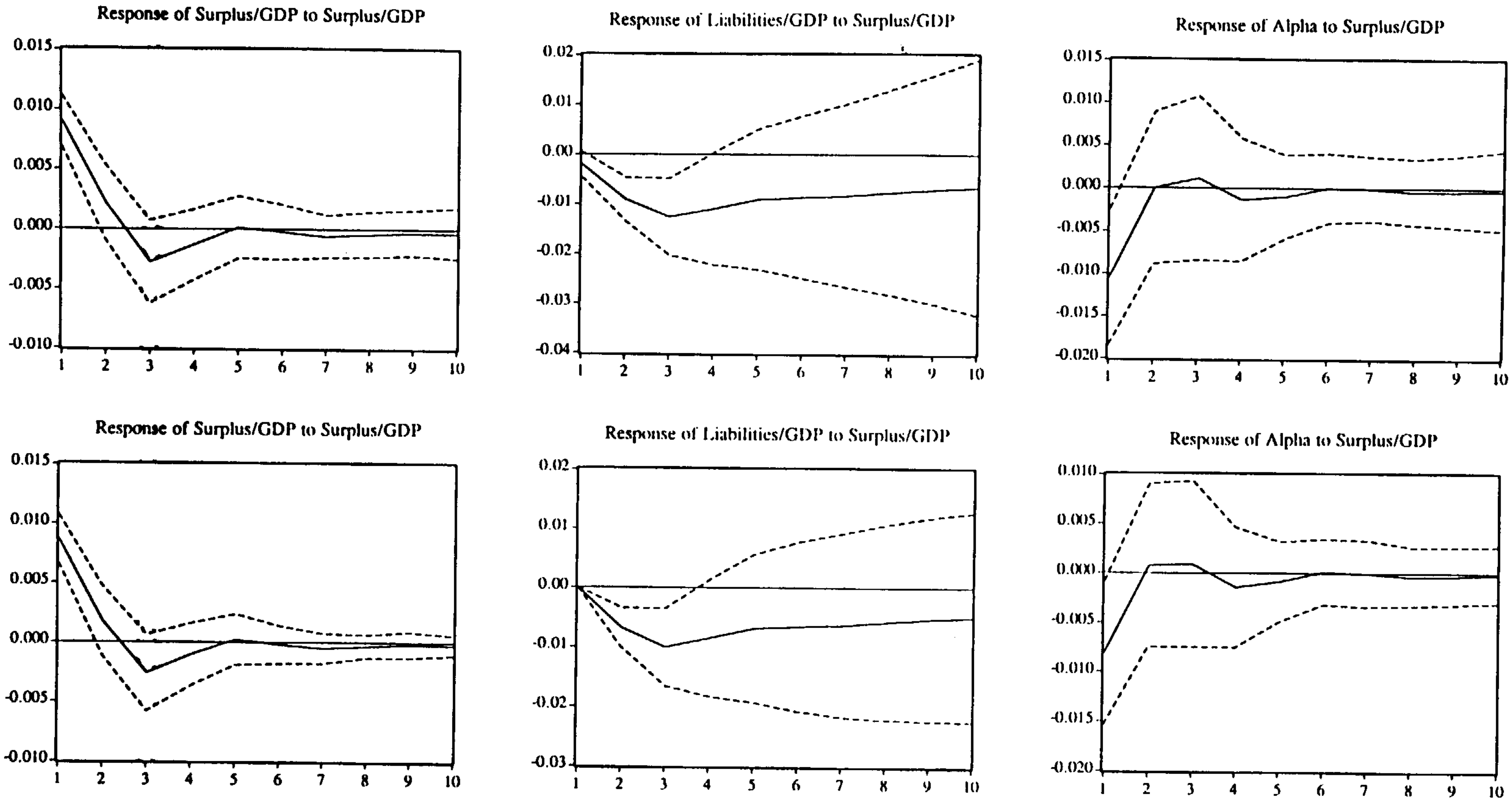
Figure 3a: VARs with other lag lengths




Notes:

VAR has two lags and a constant
Sample Period: 1951 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Column 1 & 2 ordering: Surplus/GDP, Liabilities/GDP
Column 3 & 4 ordering: Liabilities/GDP, Surplus/GDP
First Panel: VAR with 1 lag
Second Panel: VAR with 3 lags
Third Panel: VAR with 4 lags

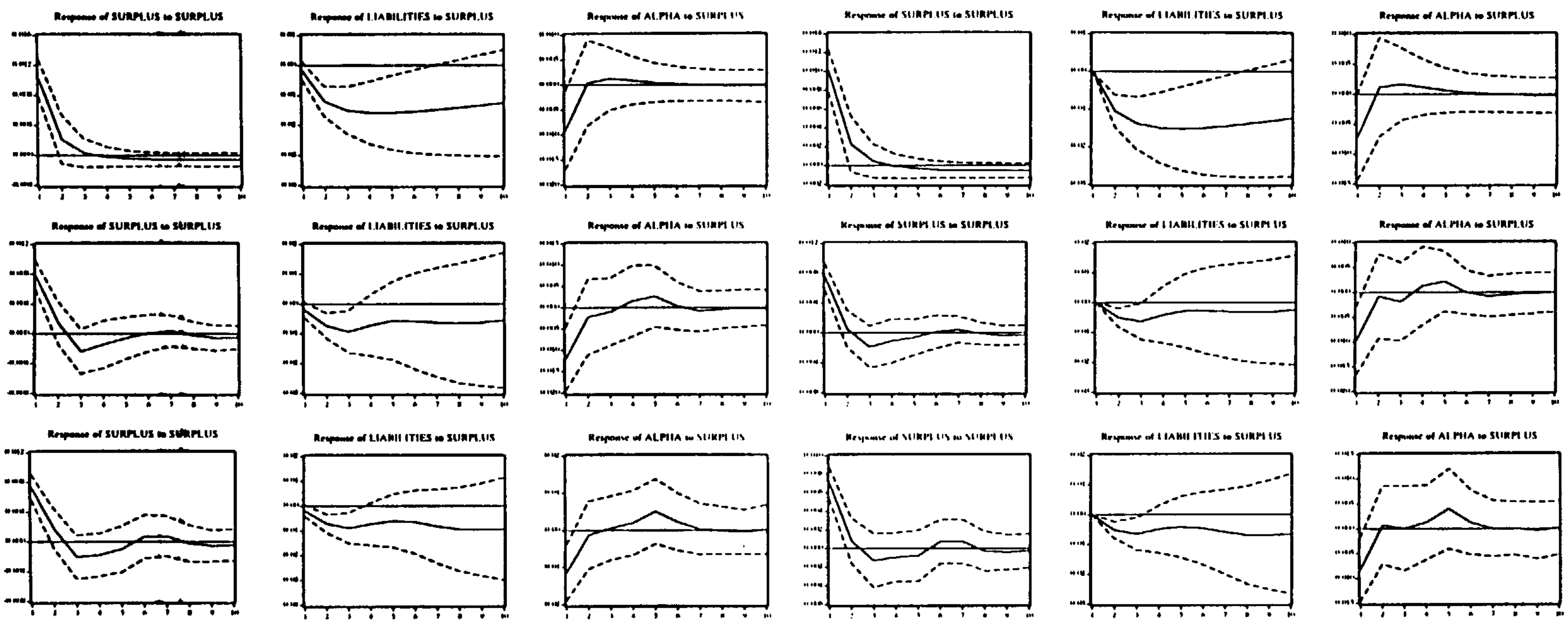
Figure 4: VAR in Surplus/GDP, Liabilities/GDP, and Alpha




Notes:

VAR has two lags and a constant
Sample Period: 1951 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Top panel ordering: Surplus/GDP, Liabilities/GDP, Alpha
Bottom panel ordering: Liabilities/GDP, Surplus/GDP, Alpha

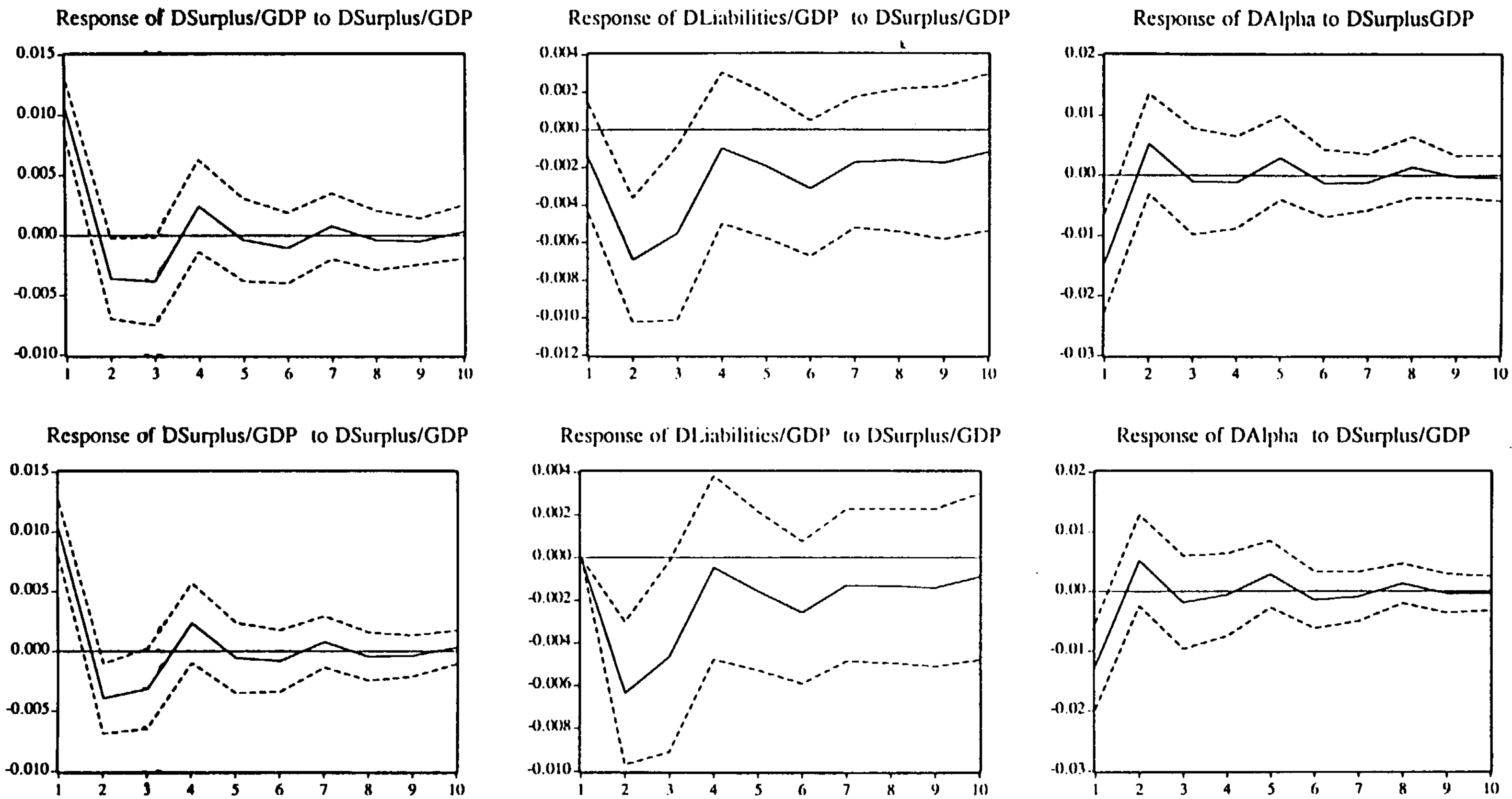
Figure 4a: VARs with other lag lengths




Notes:

VAR has two lags and a constant
Sample Period: 1951 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Column 1, 2 & 3 ordering: Surplus/GDP, Liabilities/GDP, Alpha
Column 4, 5 & 6 ordering: Liabilities/GDP, Surplus/GDP, Alpha
First panel: VAR with 1 lag
Second panel: VAR with 3 lags
Third panel: VAR with 4 lags

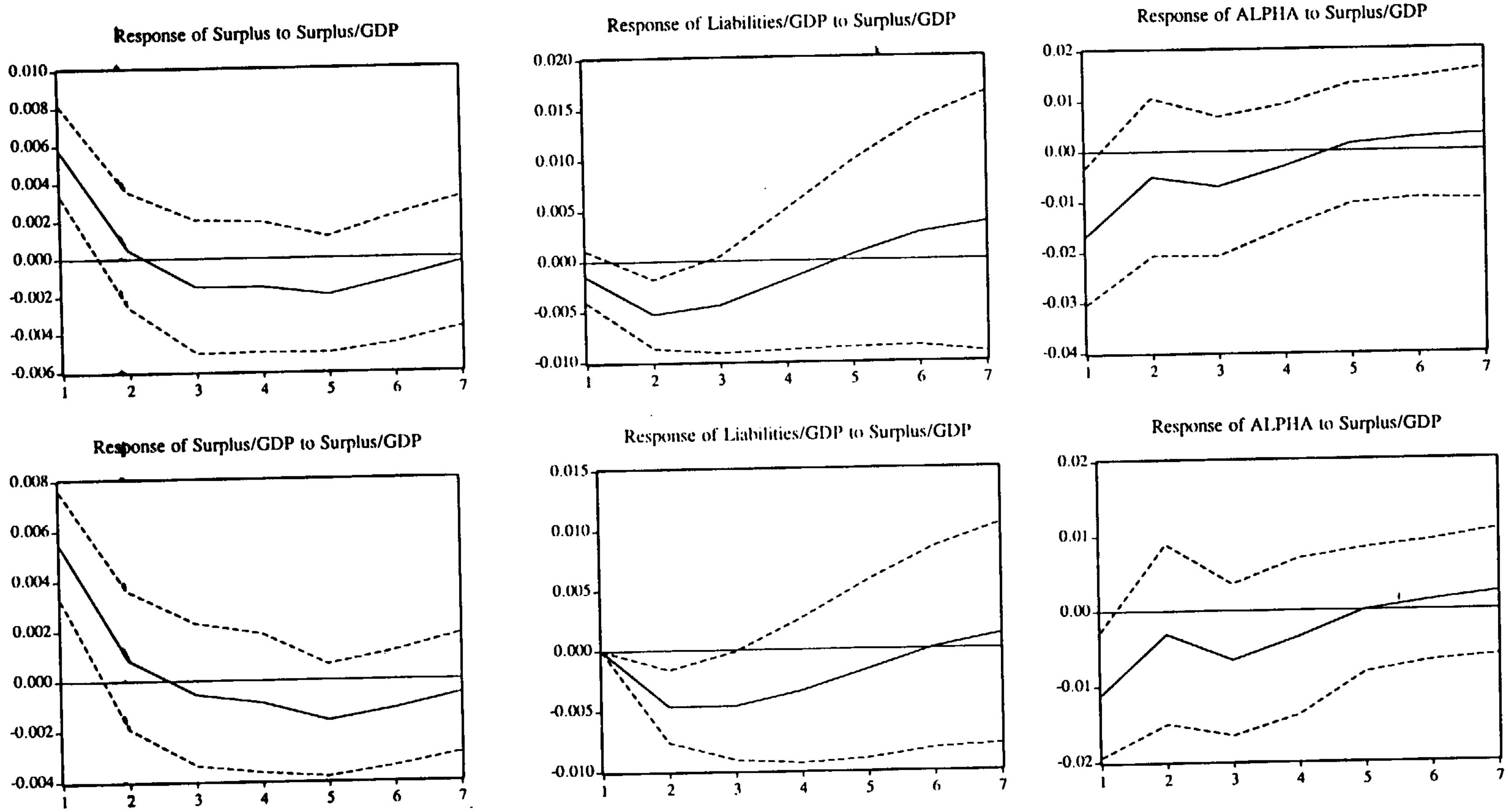
Figure 4b: VAR in first differences




Notes:

VAR has two lags and a constant
Sample Period: 1951 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Top panel ordering: Surplus/GDP, Liabilities/GDP, Alpha
Bottom panel ordering: Liabilities/GDP, Surplus/GDP, Alpha

Figure 5: VAR in Surplus/GDP, Liabilities/GDP, Alpha; 1975 - 1995




Notes:
VAR has two lags and a constant
Sample Period: 1975 - 1995
Response to a one S.D. impulse in Surplus/GDP
Two S.D. bands from Monte Carlo with 500 repetitions
Top panel ordering: Surplus/GDP, Liabilities/GDP, Alpha
Bottom panel ordering: Liabilities/GDP, Surplus/GDP, Alpha

Table 1: Correlogram of Surplus/GDP

| Autocorrelation | | AC | Q-Stat | Prob |
|---|---|---|---|---|
| | 1 | 0.452 | 9.8084 | 0.002 |
| | 2 | 0.173 | 11.274 | 0.004 |
| | 3 | 0.221 | 13.740 | 0.003 |
| | 4 | 0.252 | 17.022 | 0.002 |
| | 5 | 0.301 | 21.797 | 0.001 |
| | 6 | 0.231 | 24.698 | 0.000 |
| | 7 | 0.265 | 28.611 | 0.000 |
| | 8 | 0.266 | 32.652 | 0.000 |
| | 9 | 0.332 | 39.132 | 0.000 |
| | 10 | 0.114 | 39.914 | 0.000 |
| | 11 | -0.068 | 40.203 | 0.000 |
| | 12 | -0.035 | 40.284 | 0.000 |
| | 13 | 0.018 | 40.306 | 0.000 |
| | 14 | 0.024 | 40.344 | 0.000 |
| | 15 | 0.027 | 40.396 | 0.000 |

Table 2: Stability Tests for Regression of Surplus/GDP on a constant, 1951-1995

| | | | |
|---|---|---|---|
| Chow Breakpoint Test: 1980 | | | |
| F-statistic | 9.736322 | Probability | 0.003223 |
| Log likelihood ratio | 9.184695 | Probability | 0.002440 |
| Chow Breakpoint Test: 1975 | | | |
| F-statistic | 25.48643 | Probability | 0.000009 |
| Log likelihood ratio | 20.94460 | Probability | 0.000005 |

**REFERENCES:**


Ahmed, Shaghil and John Rogers, "Government Budget Deficits and Trade Deficits: Are Present Value Constraints Satisfied in Long-Term Data?" Journal of Monetary Economics, Vol. 36, November 1995, p. 351-374.

Auernheimer, Leonardo and Benjamin Contreras, "Control of the Interest Rate with a Government Budget Constraint: Determinacy of the Price Level, and Other Results," mimeo, 1990.

Barclays de Zoete Wedd, The Rate Reference Guide: U.S. Treasury Market, 1992-1995.

Bergin, Paul, "Fiscal Restrictions in a Currency Union: Further Lessons on the Interaction of Monetary and Fiscal Policies," mimeo, 1995.

Bohn, Henning, "On Testing the Sustainability of Government Deficits in a Stochastic Environment," mimeo, 1995.

Brayton, Flint and Peter Tinsley, "A Guide to FRB/US: A Macroeconometric Model of the United States," FEDS #66, Federal Reserve Board, 1996.

Campbell, John Y. and Robert J. Shiller, "Cointegration and Present Value Models," Journal of Political Economy, Vol. 95, October 1987, p. 1062-1088.

Canzoneri, Matthew and Behzad Diba, "Fiscal Constraints on Central Bank Independence and Price Stability," CEPR working paper #1463, 1996. (A Spanish version of this paper is published in La Politica Monetaria y La Inflacion en Espana, Bank of Spain, 1997.)

Canzoneri, Matthew, Robert Cumby, Behzad Diba, "Fiscal Discipline and Exchange Rate Regimes," mimeo, November, 1997a.

Canzoneri, Matthew, Robert Cumby, Behzad Diba, "Does Monetary or Fiscal Policy Provide a Nominal Anchor?: Evidence from the OECD Countries," mimeo, November, 1997b.

Daniel, Betty, "The Viability of a Fixed Exchange Rate Regime," mimeo, 1996.

Hall, Alastair, "Testing for a unit root in time series with pretest data-based model selection", Journal of Business and Economic Statistics, Vol. 12, October 1994, p. 461-470.

Hamilton, James and Marjorie Flavin, "On the Limitations of Government Borrowing: A Framework for Empirical Testing," American Economic Review, Vol. 76, No. 4, 1986, p. 808-819.

Kremers, Jeroen, "U.S. Federal indebtedness and the Conduct of Fiscal Policy," Journal of Monetary Economics, Vol. 23, No. 2, March 1989, p. 219-238.

Leeper, Eric, "Equilibria Under "Active" and "Passive" Monetary Policies," Journal of Monetary

Economics, 27, 1991, p. 129-147.

McCulloch, J. Huston and Heon-Chul Kwon, "U.S. Term Structure Data, 1947-1991," Ohio State University Working Paper No. 93-6.

Ng, Serena and Pierre Perron, "Unit root tests in ARMA models with data-dependent methods for the selection of the truncation lag", Journal of the American Statistical Association, Vol. 90, March 1995, p. 268-281.

Rudin, Walter, Principles of Real Analysis (Third Edition), McGraw-Hill, New York, 1976.

Sargent, Thomas, and Neil Wallace, "Some Unpleasant Monetarist Arithmetic", the Federal Reserve Bank of Minneapolis' Quarterly Review, Fall, 1981, p. 1-17.

Sargent, Thomas, Rational Expectations and Inflation, Harper and Row, New York, 1986.

________, Dynamic Macroeconomic Theory, Harvard University Press, Cambridge, 1987.

Schmitt-Grohe, Stephanie and Martin Uribe, "Price Level Determinacy and Monetary Policy under a Balanced Budget Requirement," mimeo, 1997.

Sims, Christopher, "A Simple Model for Study of the Price Level and the Interaction of Monetary and Fiscal Policy," Economic Theory, 4, 1994, p. 381-399.

________, "Econometric Implications of the Government Budget Constraint", mimeo, October 1995.

Sims, Christopher A., James H. Stock, and Mark W. Watson, "Inference in Linear Time Series Models with Some Unit Roots," Econometrica Vol. 58, January 1990, p. 113-144.

Stokey, Nancy and Robert Lucas, Recursive Methods in Economic Dynamics, Harvard University Press, 1989.

Woodford, Michael, "Monetary Policy and Price Level Determinacy in a Cash-in-Advance Economy, Economic Theory, 4, 1994, p. 345-380.

________, "Price Level Determinacy without Control of a Monetary Aggregate," Carnegie Rochester Conference Series on Public Policy, 1995.

________, "Control of the Public Debt: A Requirement for Price Stability?", mimeo, February, 1996.

**ENDNOTES:**

1. These papers were preceded by Auernheimer and Contreras (1990) and Leeper (1991). More recent work includes Bergin (1995) (who studies fiscal requirements for price stability in a monetary union), Daniel (1996) (who studies implications of fiscal policy rules for price and exchange rate determination), and Schmitt-Grohe and Uribe (1997) (who consider the implications of a balanced budget amendment for the choice of monetary policy rules).

2. This terminology originated with Canzoneri and Diba (1996). Woodford (1995) calls the regimes "Ricardian" (MD) and "non-Ricardian" (FD).

3. This literature is reminiscent of Sargent and Wallace's celebrated papers (Sargent and Wallace (1981) and Sargent (1986)) on "Unpleasant Monetarist Arithmetic." In our view, their "fiscal leadership" corresponds in spirit to our "fiscal dominant" regime; however, there is not a one to one relationship between the two notions. For example, even with "fiscal leadership" in setting taxation and spending, central bank transfers could in theory respond to the level of the debt in a way that satisfies the present value budget constraint and places the economy in a "money dominant" regime. It is interesting to note that Sargent and Wallace (1981) speculated that the US and other major industrial countries have exhibited "fiscal leadership" for some time now.

4. See, for example, Sargent (1987, Chapter 7), which provides a very explicit example of how the FD regime is assumed when solving an OLG model.

5. For example, the Federal Reserve Board's new model -- FRB/US -- assumes an endogenous tax policy that appears to ensure that the budget constraint is always satisfied. Brayton and Tinsley (1996) provide a guide to FRB/US. Endogenizing tax policy seems to be the favored approach to assuring a MD regime in this class of policy models.

6. These results are not new, and our review of them will be brief. More detailed discussions appear in Auernheimer and Contreras (1990), Leeper (1991), Sims (1994) and Woodford (1995).

7. Canzoneri and Diba estimate that a country like Spain or Italy would have to raise their interest rates by over 700 basis points to offset the effect of a 1% shock in their primary surplus to GDP ratios. A policy change of this magnitude would probably not be feasible.

8. The fiscal criteria written into the Maastricht Treaty can also be rationalized in this way. For example, Canzoneri and Diba (1996) show that the 3% deficit rule would insure a MD regime. See also Woodford (1996).

9. It should be emphasized that this approach to price determination is not limited to models with flexible prices. Prices can be "sticky" or even "fixed." See Woodford (1995, 1996) for examples.

10. Our formulation of the analysis differs from Woodford's (1995) only in that (for empirical purposes) we deflate liabilities by GDP instead of the price level. This difference only entails algebraic manipulation of Woodford's setup; his arguments extend directly to our formulation.