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**SUSTAINABILITY OF FISCAL DEFICITS:
THE U.S. EXPERIENCE 1929-2004**

by

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ABSTRACT

Recurrent large fiscal deficits and accumulating public debt frequently ring alarm bells around the world on the sustainability of U.S. federal fiscal policy. The present-value borrowing constraint, which states that, for the fiscal policy to be sustainable the current debt stock should match the discounted sum of expected future primary surpluses, provides a framework for analysing fiscal sustainability. Incorporating rational expectations we extend the methodology developed by Hamilton and Flavin (1986) to test the sustainability hypothesis in a cointegrating framework that can accommodate both stationary and non-stationary variables. Our model predicts dynamically diverse episodes of the debt series extremely well. Our results support the hypothesis that the U.S. government is solvent despite the large increase in the debt stock in recent years.

Key Words: Fiscal Policy Sustainability, Present-value Borrowing Constraint, Rational Expectations, Cointegration.

JEL: E62; H62; H63.

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1. **INTRODUCTION**

The escalating fiscal deficit of the U.S. federal government has brought to surface the old fears of its sustainability. Any perceived unsustainability of the fiscal deficit combined with the current account deficit, which has reached staggering heights in recent years, may severely affect the reserve currency status of the U.S. dollar and may bring about a destabilizing effect on the world economy. Given this scenario it is worth examining how the past experience of fiscal operations shed light on the sustainability issue.

Fiscal deficit is nothing new to the U.S. Although the dynamics of each deficit-episode may differ, perhaps substantially, the government eventually has to face a borrowing constraint. If the Ponzi scheme[1] is ruled out, intertemporal budget operations of the government imply that the current debt stock must be matched by the present-value of expected primary surpluses (surplus net of interest payments). This condition, known as the present-value borrowing (PVB) constraint, holds when the fiscal policy is expected to generate sufficient net revenues in the future to repay the accumulated debt and interest payments. In a seminal paper, Hamilton and Flavin (hereafter HF) (1986) addressed this issue drawing evidence from the 1964-1980 period and reached a conclusion in support of the solvency of the U.S. government. The objective of our exercise is to extend the HF methodology and examine the issue over a much longer time span that covers dynamically very different deficit episodes.

In Section 2 we present the basic analytical framework and discuss some limitations of existing studies that have examined the issue of fiscal sustainability in the

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[1] The Ponzi scheme is a state where there are incentives for an economic agent to finance its excess expenses including interest payments on debt by issuing new debt.

U.S. within the framework of the PVB constraint. In Section 3 we use a rational expectations formulation to accommodate non-stationary behaviors in the debt process and present a more flexible model to test the PVB constraint. In Section 4 we examine the salient features of the debt and fiscal balance series that span over 75 years. In Section 5 we test the PVB constraint using data over this long time span that has recorded very different dynamics of the debt process. We find that our model captures all the important turning points of the debt stock very well. Overall the results emerge in support of the solvency, perhaps super-solvency, of the U.S. federal government in the long run.

2. THE ANALYTICAL FRAMEWORK AND PREVIOUS STUDIES

Following the work of HF we assume that the government issues only one kind of bond D_t, the aggregate debt, and its marginal cost is given by r, the real interest rate.[2] We further assume that the government's borrowing begins with a given initial condition at time t and ends in the period $t+N-1$ where N is an integer greater than one. Agents who lend to the government in each period believe that the government will run sufficient primary surpluses in the future, up to $t+N$, to offset its initial debt. The government's budget identity is given by:

$$D_t = (1+r)D_{t-1} - S_t \qquad (1)$$

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[2] As pointed out by Bohn (2006) an assumption that sets the interest rate to a positive constant is required to convert the budget identity to a budget constraint. As in Hamilton and Flavin (1986) the most common in the literature is to assume that r is a constant. The next common alternative is $E_t(r_{t+1}) = r$ (See, for example, Hansen, Roberts and Sargent (1991) and Roberts (1991)). This underlies the assumption that real interest is serially uncorrelated. However, if the conditional expectation is a random variable because of the effect of changing information over time one could still set the real interest rate to a constant by taking iterated expectations.

where $S_t = T_t - G_t$ is the primary surplus, T_t is government revenue and G_t is non-interest government expenditure. Writing equation (1) as

$$D_{t-1} = (1+r)^{-1} D_t + (1+r)^{-1} S_t \qquad (2)$$

and substituting recursively forward for N periods yield

$$D_t = (1+r)^{-(N-t)} D_N + \sum_{i=1}^{N} (1+r)^{-i} S_{t+i} \; . \qquad (3)$$

Taking expectation conditional on the information available up to t, the limiting value of (3) can be written as

$$D_t = A_t + S_t^* \qquad (4)$$

where $A_t = \lim_{N \to \infty} E_t[(1+r)^{-(N-t)} D_N]$, $S_t^* = \sum_{i=1}^{\infty} E_t[(1+r)^{-i} S_{t+i}]$.

In (4), the current debt stock is equal to the expected present-value of the debt stock in the limit (A_t) plus the discounted sum of the expected future primary surpluses (S_t^*). If the no-Ponzi-game (NPG) condition holds, i.e., A_t is a non-positive constant, then the debt stock at time t must be matched by the present-value of expected future primary surpluses. If the NPG condition holds in strict equality, $A_t = 0$, the government is solvent. If A_t is a negative constant, then the government is in a state of super-solvency. In general, the PVB constraint holds when the limiting value of the expected discounted debt is non-positive.

HF expressed model (4) in the following form for empirical testing:

$$D_t = A_0 (1+r)^t + S_t^*, \quad A_0 = \lim_{N \to \infty} E_t[(1+r)^{-N} D_N]. \qquad (5)$$

If A_0 is treated as a constant, then the PVB constraint holds if $A_0 \leq 0$. HF tested this condition in three ways. The first test resorts to examining the stationarity of D_t and S_t^* in (5). HF argued that stationarity of both these series necessarily implies that $A_0 = 0$. They found that D_t and S_t were stationary over the period 1964-1980 and concluded that $A_0 = 0$. Here they relied on the condition that stationarity of S_t implies stationarity of S_t^*. In the second and third tests HF assumed adaptive and partial-rational expectations respectively and regressed D_t on $(1+r)^t$ and current and lagged values of S_t. The estimated A_0 coefficient turned out to be negative and insignificantly different from zero and confirmed their former conclusion.

Although the HF procedure has led to many applications several questions arise in relation to the HF testing procedure. First, depending on the value of the real interest rate, the initial debt stock and the persistence of surpluses or deficits, the D_t series may behave as a locally stationary or non-stationary series (see (1)) and may not be fully informative of fiscal sustainability. Second, when the discount factor is close to unity (0.9889 in the HF study), the S_t^* process becomes virtually a unit root process unless the sample size is extremely large (perhaps 500 years or more). [3] So the use of current and lagged values of stationary S_t process does not capture the dynamics of the S_t^* process. Third, if D_t is stationary the correlation between D_t and $(1+r)^t$ tends towards zero as t becomes large. However, this is not guaranteed if D_t is non-stationary.

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[3] Engle and West (2004) have also pointed this out in relation to exchange rate expectations.

Wilcox (1989) offers a much simpler method for testing the PVB constraint. First he relaxes the assumption of fixed r and defines a variable discount factor by $q_t = \prod_{i=0}^{t-1}(1/1 + r_i)$, $q_0 = 1$. [4] He multiplies (1) through by q_t and discounts the variables from period t back to period zero and iterates the outcome forward for N periods and takes expectation to arrive at:

$$D_t' = A_t' + S_t', \quad A_t' = \lim_{N \to \infty} E_t D_{t+N}' \tag{6}$$

where $'$ indicates the discounted values using the variable discount rate q_t. Then Wilcox shifts the test of the NPG condition from A_t' to D_t' by showing that the path of A_t' is determined by the path of D_t': if D_t' is stationary, A_t' is constant, and if D_t' is non-stationary, then, A_t' is non-constant. Therefore, a zero-mean stationary D_t' series satisfies the PVB constraint. Using the HF sample, Wilcox computed D_t' series and found it to be non-stationary with a positive unconditional mean and therefore, concluded that the U.S. federal fiscal policy was unsustainable.

Wilcox's procedure is attractively simple. Many studies have used the method to evaluate fiscal sustainability in various countries (see, for example, Corsetti and Roubini 1991, Buiter and Patel 1992, Gerson and Nellor 1997, Uctum and Wickens 2000). However, Wilcox's procedure raises several concerns. First, Wilcox's method involves a backward formulation. A government standing at time t discounts its debt D_t to some initial year $t=0$ using an observed q_t. In reality a government faced with a debt stock D_t

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[4] If r is variable in (1), equation (4) becomes,

$$D_t = \lim_{N \to \infty} E_t \left[\prod_{i=1}^{N} 1/(1 + r_{t+i}) \right] D_{t+N} + \sum_{i=1}^{N} E_t \left[\prod_{i=1}^{N} 1/(1 + r_{t+i}) \right] S_{t+i}.$$

at time t does not discount this back to a year in the distant past to assess whether the discounted D_t in the limit is zero or not. The government has to look into the future and formulate policies to deal with the debt stock D_t. It should be noted that although (6), rather the expression in footnote 3, is derived from the accounting identity (1), as a behavioral relationship it is qualitatively different from (1) especially when expectations are involved. An important question to ask is, is it meaningful to derive the expected present-value of future surpluses or the discounted values of future debts using variable discount rates which are unknown? Governments and economic agents are more likely to engage in a scenario analysis by computing several present-values of projected surpluses by using a range of discount rates that are set to decline over time in a systematic way.

Second, Wilcox focused on A'_t of (6) and argued that D'_t series should have a zero-mean in the limit for the present-value constraint to hold. This limit value of A'_t approaching zero is true by construction. Since the discount factor has to approach zero in the limit, A'_t should approach zero unless the debt series itself explodes without limit. But what is important to note is that the expected limit value in (6) is zero regardless of the I(0) or I(1) nature of the D_t series. For instance, consider the case where D_t is I(1) and hence $\Delta D_t = a + u_t$, where u_t is a zero-mean I(0) process. Since D_t can be written as $D_t = D_0 + at + \sum_{i=0}^{t} u_i$ the limiting expected value of D'_t is

$$\lim_{N \to \infty} E_t \left[D_0 + aN + \sum_{i=0}^{N} u_{N-i} \right] / (1+r)^N = \lim_{N \to \infty} E_t \left[D_0 + aN \right] / (1+r)^N = 0$$

where the initial value, D_0, is assumed given and $r > 0$.

For fiscal sustainability what is important is how fast A_t' approaches zero. For instance, a huge debt burden over 25 years may be sufficient to cripple a government even though the discounted debt becomes zero after 200 years. Another point to note is that the constructed discounted debt series D_t involves a scaling effect. The level of debt is likely to increase with the size of the budget that in turn increases with the size of the economy. Wilcox's method may be better implemented if debt is taken as a ratio of GNP to remove the scaling effect.

Among other researchers on the topic, Trehan and Walsh (1988, 1991), Hakkio and Rush (1991) and Haug (1991) have tested the PVB constraint by testing cointegration between government revenue and expenditure inclusive of interest payments. Tanner and Liu (1994), Quintos (1995), Haug (1995), Ahmed and Rogers (1995), Martin (2000), Cipollini (2001) and Jha and Sharma (2004) have extended this procedure to allow for structural breaks. It should be noted however that cointegration between revenue and expenditure with a cointegrating vector (1, -1) is embedded in tests for the stationarity of the S_t series.

Although we do not intend to provide a complete literature survey, it is worth mentioning some other approaches that were designed to assess fiscal sustainability. Kremers (1989) argued that if a fiscal policy yields a stock of debt in real terms that grows asymptotically at an average rate smaller than the interest rate, the policy operates within the PVB constraint. However, government borrowing would not be restricted by the PVB constraint if an economy is dynamically inefficient (see Abel et al. 1989). For McCallum (1984), fiscal sustainability does not contradict the government's ability to run a permanent deficit inclusive of interest payments. A permanent primary deficit, however,

violates the PVB constraint and hence is not sustainable in the long run.[5] In a political-economic model, Velasco (2000) shows that due to the common property nature of government resources fiscal deficits emerge regardless of the intertemporal budget balance. Therefore, government debts tend to be excessively high in the long-run. Bohn (1998) suggested that fiscal policy is sustainable if the primary surplus positively responds to the changes in debt-income ratio as it provides direct evidence for corrective actions. Expanding further alone this line Bohn (2005) provides a criticism of the previous approaches and advocates estimating a policy reaction function. Based on this line of argument he concludes that the U.S. fiscal policy has historically been sustainable. Although this is an interesting alternative way of testing fiscal sustainability Bohn confounds the tax smoothing hypothesis and the sustainability hypothesis in his empirical model. Contrary to Bohn's argument that economic growth could render sustainability despite negative expected surplus, Giannitsarou and Scott (2006) re-emphasize the importance of primary surpluses. Using another line of approach Auerbach (1997) and Auerbach et al. (2003) compute a required tax hike (or a spending cut) for fiscal sustainability and conclude that the current US fiscal policies are quite far from satisfying the intertemporal budget constraint.

Some researchers have used regime-switching models to capture apparent non-linearities in the discounted D_t series (Bajo-Rubio et al. 2004, Davig 2005). It is important to emphasize that structural breaks and non-linearities in a single series does not necessarily amount to a breakdown in a causal relationship (see Hoover, 2001 for an excellent exposition of this point). An advantage of focusing on the full equation in (5) is

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[5] McCallum (1984) considered the theoretical validity of the monetarist hypothesis that 'a constant fiscal deficit can be maintained permanently if it is financed by the issue of bonds rather than money'. He showed that the monetarist claim is invalid if the deficit is defined exclusive of interest payments.

that it may remain intact by structural breaks and regime switches. It also takes care of the scaling effect on the level of D that we mentioned earlier and may perform better over a longer time span since it can accommodate non-stationary series in a cointegrating framework.

3. METHODOLOGY OF THE PRESENT STUDY

We test whether the PVB constraint holds or not directly as in the HF model (5). However, the discussion in the previous section shows that we need a more flexible model structure to account for non-stationary movements of the debt series D_t. We have already noted that when the discount rate is close to unity the expected present value of primary surplus, S_t^*, may behave like a unit root process in observed samples. If D_t also shares similar behavior it is still possible for the PVB constraint to hold if D_t and S_t^* cointegrate (locally) such that $A_0 \leq 0$.

Since S_t^* is unobserved we adapt the rational expectations formulation developed by Hansen and Sargent (1980) to relate S_t^* to observed variables (see also Sargent 1978, Wallis 1980, and Campbell and Shiller 1987). For this we assume that the policy makers form expectations on the discounted sum of future surpluses using all the relevant information available to them at time t as given below.

$$S_t^* = \sum_{k=0}^{\infty} \rho^k E_t S_{t+k} = \sum_{k=0}^{\infty} \rho^k E_t \left(Z_{t+k} + w_{t+k} \right) \tag{7}$$

where $\rho = 1/(1+r)$, $Z_t = a'X_t$, a is an ($n \times 1$) vector of constants and X is an ($n \times 1$) vector of relevant informational variables known both to the government and the public, and w_t is an unsystematic informational variable only known to the government with the

property $E_t w_{t+k} = 0$. The information set X_t may include both stationary and non-stationary variables and we assume that Z_t is stationary but it shares the same near unit-root behavior that S_t^* is likely to possess in observed samples.

Assuming that Z_t has the following infinite-order moving average representation $Z_t = \psi(L)e_t$ and using the Wiener-Kolmogorov prediction formula to get $E_t Z_{t+k} = \sum \psi_j L^{j-k} e_t$, $(j = k, k+1, ..., \infty)$ and then using the autoregressive representation $\phi(L)Z_t = e_t$ Hansen and Sargent (1980) derived the result:

$$\sum_{k=0}^{\infty} \rho^k E_t Z_{t+k} = \phi(\rho)^{-1} \left[1 + \sum_{j=1}^{p-1} \left(\sum_{k=j+1}^{p} \rho^{k-j} \phi_k \right) L^j \right] Z_t. \tag{8}$$

Since we are not interested in the non-linear parameter structure in this formulation we can write (8) as

$$\sum_{k=0}^{\infty} \rho^k E_t Z_{t+k} = \left[\lambda_0 + \sum_{j=1}^{p-1} \lambda_j L^j \right] Z_t. \tag{9}$$

By replacing Z_t with $a'X_t$ and redefining the parameters we write our model for testing the PVB constraint as

$$D_t = A_0 (1+r)^t + \beta_1' X_t + \beta_2' X_{t-1} + ... + \beta_{r-1}' X_{t-p+1} + \varepsilon_t \tag{10}$$

where ε_t is a well behaved disturbance term. Model (10) entails a couple of advantages over the previous formulations. First, it is grounded on a larger information set that policy makers and economic agents are likely to use at time t to make projections about future surpluses. Second, it may easily accommodate structural breaks or regime-shifts and non-stationary movements of D_t that do not violate the PVB constraint.

4. TRENDS OF DEFICIT AND DEBT

Following the comments by Eisner and Peiper (1984) and Eisner (1989) on the inappropriateness of gross debt and officially reported surplus as true measures of the fiscal position, we have made several adjustments to the officially reported data to obtain the net stock of public debt and the adjusted primary surpluses. The adjustments made here, to some extent, are similar to those made by Hamilton and Flavin (1986). The adjustment method is illustrated in Table 1.

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Insert Table 1, Figure 1 here

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Figure 1 plots the both unadjusted and adjusted data series. It is worth reporting some observations from these data series. Figure 1b shows that though there is a level difference, the time paths of both gross and net debt are quite similar. Figure 1a shows that though the adjusted primary balance is often higher than the unadjusted one, they also follow the same pattern over time. Between 1929 and 1942 the net debt stock was quite small (negative in some periods). As a result of wartime (WWII) high deficits, the debt stock rose to a staggering 124 percent of GDP in 1945. The overlap of the primary and overall fiscal balance until mid 1940s show that interest payments on the existing debt was not excessive. After the war, deficits declined quickly and surpluses emerged. As a result, the debt stock remained roughly constant until the early 1970s and the debt ratio fell significantly from its wartime high to about 30 percent of GDP in the 1970s. However, from the mid 1970s, the federal fiscal policy operations show a dramatic change giving rise to fiscal deficits and increasing debt and debt ratios. This fiscal

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erosion is known as the effect of the high spending policy of the U.S. government.[6]

Although these large deficits are reckoned to be an outcome of the high spending policy, it is apparent from the overall balance as opposed to the primary balance in Figure 1 that the main cause of the high deficits was the increase in interest payments. This was a period of slow economic growth, high unemployment and higher oil prices with unavoidable high government spending and interest bills. Large deficits and the increasing debt stock during the 1970s and 1980s forced policy makers to contain the budgetary operations to avoid further deterioration. Corrective measures, such as expenditure cuts and large tax hikes that were implemented in the early 1990s turned primary fiscal balance to a large surplus and slowed down the growth rate of debt. But these large surpluses plunged again since 2001 primarily due to a massive tax cut program.

5. EMPIRICAL RESULTS

The minimal variable set that we use to predict the discounted present-value of expected primary surplus (S_t^*) and thereby the stock of debt is: $X_t' = (T_t, G_t, M1_t, FA_t, U_t, r_t)$, where U is the unemployment rate and the other variables are in the usual notations. The first four are in real terms.[7] If $M1$ is replaced by H, the first four variables defined as (T, G, ΔH, ΔFA) are the direct determinants of the adjusted primary

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[6] Large deficits that occurred in the 1980s are often viewed as an outcome of increased spending. As Romer (2001, p. 550) noted, a desire to restrain the spending of future policy makers led the Reagan administration to follow high spending policies, and to incur large deficits.

[7] The annual data on interest bearing gross public debt, expenditure, interest payments on existing debt, base money stock, stocks of foreign liquid assets are obtained from the Federal Reserve Archival System for Economic Research (FRASER). Annual observations of GDP and implicit GDP deflator are from the National Income and Product Accounts (NIPA). Data on unemployment rate are from the U.S. Bureau of Labour Statistics.

balance (Table 1). We use *M1* in place of *H* and also the levels of *M1* and *FA* instead of their differences because of their better predictive performance in the model. The real interest rate r_t is the nominal interest rate minus the actual inflation rate in year *t*. The nominal interest rate is the average rate (average over the interest rates paid on various debt instruments) that approximates the total interest payments on the stock of public debt. The inflation rate is computed from the implicit GDP price deflator.

The ADF test for unit roots indicates that U_t and r_t are stationary and the others are I(1). However, given the low power of the ADF test against near-unit-root alternatives, it is difficult to ascertain whether these series are non-stationary due to unit roots or some other reasons. Despite this difficulty a residual based ADF test from a static regression of (10) (with *r* set to 0.01 and the sample period 1929-2004) strongly supports the stationarity of the residuals.[8] A non-linear LS estimate of *r* from model (10) that includes a constant term provides an estimate of *r*=0.01 which is not very different from the average real interest rate observed over the sample period. We then estimated the model over a range of *r* from 1% to 4% and observed that the parameter estimates remain highly invariant to the choice of *r*. We, therefore, proceed to present our results based on the non-linear estimate of the *r*.

Our primary focus is on the dynamic specification in (10). Figure 2 plots the actual and predicted values from (10) by setting *p=2*. The predicted values pick up the major turning points of the debt series remarkably well. We observe that by increasing *p* the model-fit could be improved and the residual autocorrelation could be reduced. To

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[8] A test procedure for cointegration that allows for different types of non-stationarity of the variables is yet to be developed. P.C.B. Phillips is currently looking into this subject matter (personal communications).

conserve degrees of freedom, however, we add the lagged dependent variable to the information set X.

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Insert Figure 2, Table 2 here

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Table 2 presents the results of two regressions, Model 1 with a constant term in (10) and Model 2 without. Both models fit the data very well as indicated by the diagnostic statistics reported at the bottom of Table 2. In Model 1 both the constant term and A_0 estimates are statistically insignificant. (To re-iterate, the PVB constraint requires the constant term to be zero and $A_0 \leq 0$.) Figure 3a and 3b plot the recursive estimates of the constant term and A_0. The constant term, though statistically insignificant, has remained mostly positive. A_0, on the other hand, has remained negative and statistically significant except towards the end of the sample period. The two estimates show a mirror-image behavior. Dropping the constant term leads to statistically significant negative estimates of A_0 as seen in Figure 3c. These estimates are also highly stable. The AIC also favors Model 2. Figure 3d shows the actual and fitted values from Model 2. The fit is impressive. We, therefore, base our analysis on the Model 2 estimates.

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Insert Figure 3

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The discussion in the previous paragraph shows that A_0 is statically different from zero and takes a very stable negative value. We observe that the negativeness of A_0 is robust to variations in the information set (e.g., replacing T with GDP and real interest rate with the nominal rate and inflation rate) though it may become statistically insignificant some times. This renders strong support for the PVB constraint hypothesis and the solvency, perhaps super-solvency, of the U.S. federal government. Hamilton and Falvin (1986) arrived at this conclusion from a period when the debt stock was stationary. Our results show that the apparent non-stationarity of the debt stock, observed during the last few decades, does not necessarily lead to the rejection of the solvency hypothesis.

It is worth examining how the variables in the information set bring about the above result. The high autoregressive coefficients of the lagged D_t terms indicates high persistence of the debt stock. Unlike private debt, it is not unusual for public debt to show such persistence. Given this persistence it would be informative to examine the time profile of the impulse response effects of the predictor variables on the debt stock. Figure 4 plots these impulse response effects over 50 years.

As expected, a dollar increase in taxes and government expenditure exerts their opposite effects on the debt stock, each effect steadily decreasing towards zero. The effects do not necessarily seem to be symmetric. Wald test on the restriction that the sum of tax coefficients in Model 2 is unity does not lead to a rejection of the restriction whereas the same test on the expenditure components leads to a rejection. It appears that debt created by an increase in government expenditure cannot be fully offset by an equal increase in taxes, after controlling for the interest effect.

Unlike *T* and *G* the expected effect of *M1* and *FA* on *D* is ambiguous. However, since *ΔM1* and *ΔFA* are expected to have a positive effect on the adjusted primary balance and a negative effect on net debt, purely from a technical point of view, the initial effect of *M1* and *FA* is expected to be negative. This is evident in Figure 4. Subsequently, however, a dollar increase in *M1* or *FA* tend to increase the debt stock though these effects taper off much faster than the *T* and *G* effects. A government could finance a certain amount of expenditure by seignorage, therefore, the immediate effect of *M1* on debt is negative. But a higher *M1*, which in turn increases the amount of financial assets of the economy, may increase the demand for government bonds leading to an increase in the government debt subsequently. On the other hand, for a government, the costs of financing deficit by drawing down *FA* may be higher than the interest cost of new debts. A government that runs down *FA* continually is vulnerable for criticisms purely on political grounds. Therefore, a government may not rely on financing deficit by running down *FA* frequently. In fact if the gains from holding *FA* are higher than the interest cost of debt, governments would tend to borrow more as *FA* increases.

We used the unemployment rate, as in many other studies (Barro 1979, Roubini and Sachs 1986) to capture the business cycle effects on the primary surplus and debt. We find *U* to be a better predictor of debt than the GDP growth rate. Higher unemployment rate is expected to increase the deficit and debt. This effect is reflected in Figure 4e. The last variable in the list is the real interest rate. Apart from the impact channeled through real money stock, the real interest rate has a significant impact on the fiscal balance in many ways. A high real rate results in increased interest payments on existing debt leading to large fiscal deficits and to further borrowings. As new

government borrowings crowd out the private economy, this will lead to lower tax revenue and increased primary deficit adding further pressure on debt. This effect is born out in Figure 4f.

6. CONCLUSION

In this paper we consider whether U.S. fiscal operations satisfy the PVB constraint using annual data over a longer time horizon stretching from 1929 to 2004. We argue that tests based on the full intertemporal budget equation are more desirable than tests based on debt or surplus series alone. By allowing for rational expectations on future surpluses we extend the Hamilton-Flavin model to accommodate non-stationary movements of the debt stock. This formulation leads us to replace the present value of expected future surpluses with a set of observed variables. This is a flexible framework that can accommodate both stationary and non-stationary variables and take care of any structural breaks and scaling effects present in the debt series.

Based on the current and lagged values of taxes, government expenditure, M1, government foreign financial assets, the unemployment rate, and the real interest rate as predictors of future surpluses, we find that our model predicts the net debt stock extremely well over very different fiscal episodes. The model provides highly stable recursive estimates on the main coefficient A_0 that tests the validity of the PVB constraint. The conclusion that emerges from the exercise is that U.S. federal budgetary policy does not violate the PVB constraint and the U.S. government is solvent, or super-solvent, in the long-run, despite the presence of an upward trend in the debt stock series since the 1980s.

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Table 1
Computation of Net Debt and Adjusted Primary Balance-2004

Series	U.S. Dollar Billions
Net Debt	
Interest Bearing Gross Federal Debt	7354.7
(-) Currency plus Deposits at Fed (High-Powered Money H)	- 744.0
(-) Stock of Gold, SDR, Reserve Position at IMF and Convertible Foreign Currencies (FA)	- 83.5
(=) Net Stock of Debt (at Current Prices)	6527.2
(÷) by Implicit GDP Price Deflator	÷ 1.082
(=) Real Net Stock of Debt (at 2000 Prices)	6031.4
Adjusted Primary Balance	
Government Revenue	1880.1
(-) Non-Interest Government Expenditure	- 2132.0
(=) Primary Balance	-251.9
(+) Seignorage (Change in H)	+ 37.3
(+) Change in FA	+ -2.5
(=) Adjusted Primary Balance (at Current Prices)	-217.1
(÷) by Implicit GDP Price Deflator	÷ 1.082
(=) Real Adjusted Primary Balance (at 2000 Prices)	-200.6

Note: The sum of H and FA (foreign liquid assets) is used as a proxy for the financial assets of the government.
Source: Authors' calculation based on FRASER and NIPA data.

Table 2
OLS Regression of Equation (10) (Dep. Var.: Net Debt)

Explanatory Variable	Model 1			Model 2		
	Est. Coef.	Sum[a]	F prob[b]	Est. Coef.	Sum[a]	F prob[b]
Constant	-262.74		0.556	---	---	---
$(1+r)^t$	-371.99		0.461	-646.63		0.001
T_t	-0.871			-0.832		
T_{t-1}	0.000	-0.934	0.000	-0.031	-0.867	0.000
T_{t-2}	-0.063			-0.004		
G_t	1.319			1.329		
G_{t-1}	0.123	1.334	0.000	0.120	1.356	0.000
G_{t-2}	-0.108			-0.093		
$M1_t$	0.277			0.369		
$M1_{t-1}$	-1.125	0.633	0.003	-1.238	0.724	0.000
$M1_{t-2}$	1.481			1.593		
FA_t	-2.516			-2.604		
FA_{t-1}	3.363	1.231	0.000	3.521	1.109	0.000
FA_{t-2}	0.384			0.192		
U_t	-5.521			-6.431		
U_{t-1}	6.225	16.019	0.005	6.269	16.476	0.000
U_{t-2}	15.315			16.638		
r_t	17.177			17.609		
r_{t-1}	3.877	26.529	0.000	4.617	27.438	0.000
r_{t-2}	5.475			5.212		
D_{t-1}	0.699			0.689		
D_{t-2}	0.215	0.914	0.000	0.213	0.902	0.000
Sigma	57.646			57.285		
R^2	0.999			---		
AIC	8.352			8.332		
AR F	1.800	(0.176)[c]		2.225	(0.119)	
ARCH F	0.069	(0.793)		0.029	(0.863)	
Hetero F	0.763	(0.735)		1.016	(0.532)	
Normality Chi^2	0.703	(0.703)		0.796	(0.672)	
RESET F	4.131	(0.047)		4.263	(0.044)	

Notes: (a) the sum of contemporaneous and lagged coefficients; (b) p-values for the F test on each variable; (c) values in parenthesis are p-values of diagnostic tests. Sample period 1929-2004, estimation period 1932-2004.
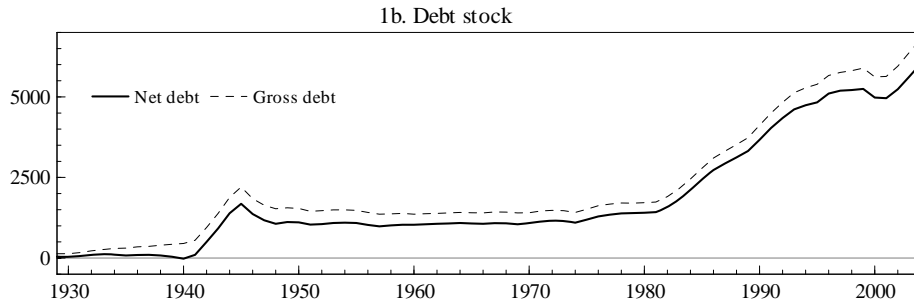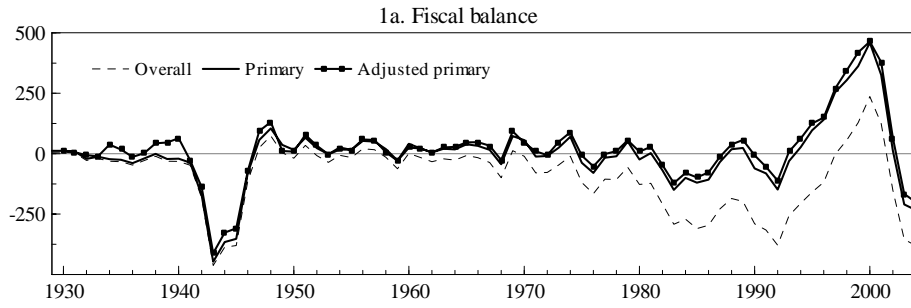
1a. Fiscal balance

1b. Debt stock

Figure 1: Federal government fiscal balance and debt stock (US$ billions)
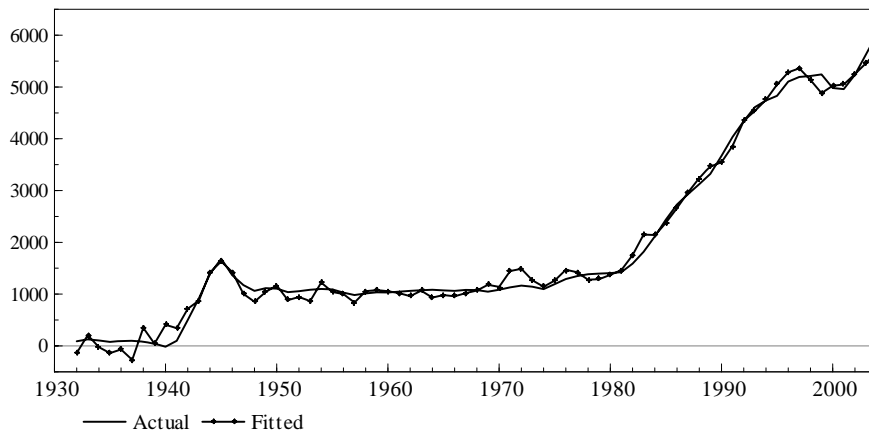
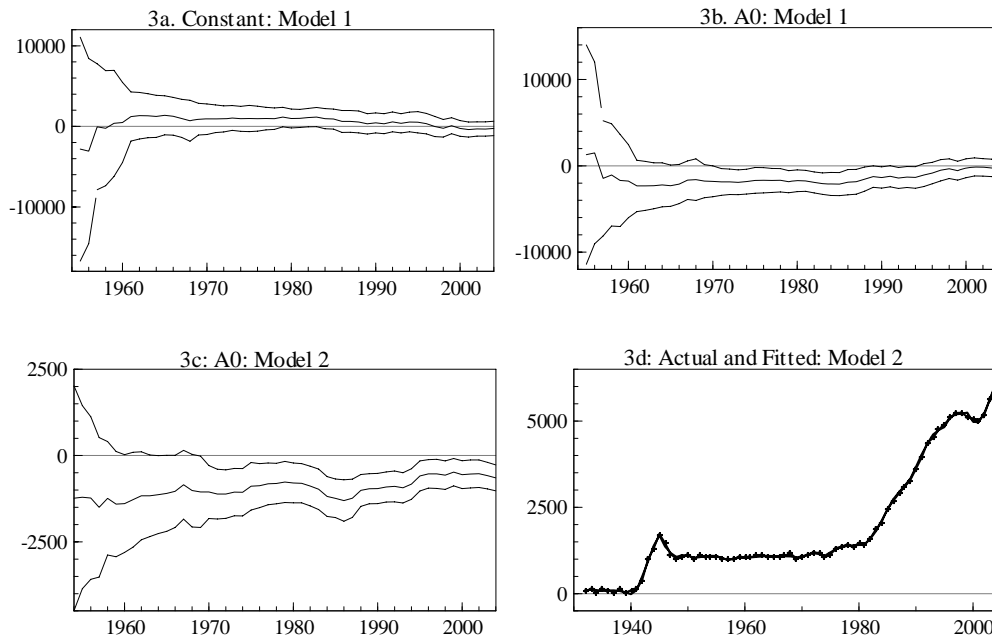Figure 2: Actual and fitted debt without the lagged dependent variable

Figure 3: Recursive estimates (with confidence intervals) and actual and fitted net debt
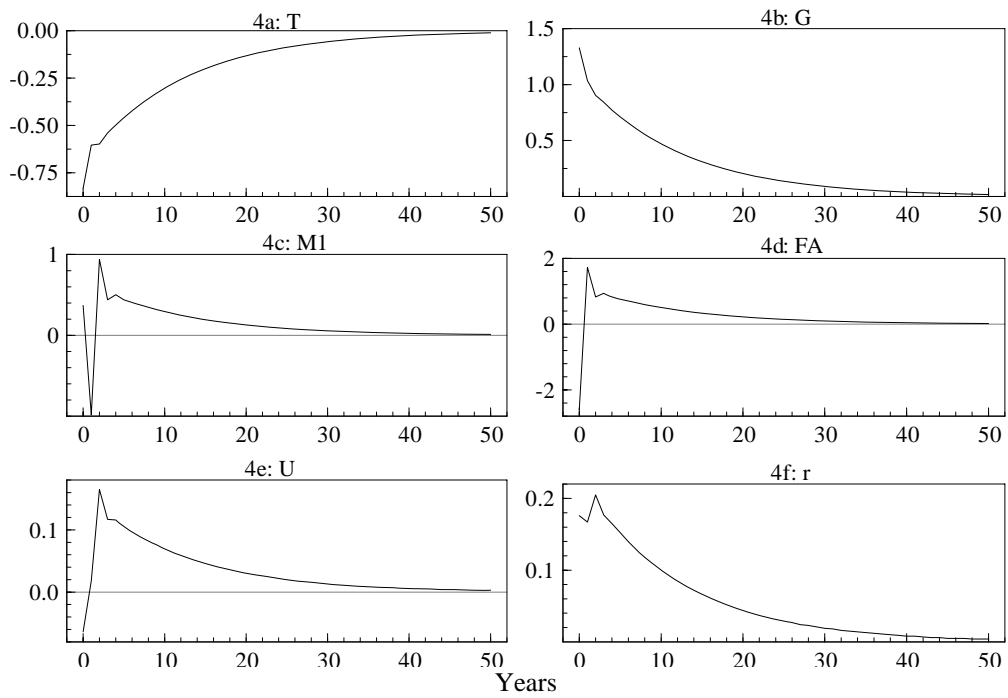
Figure 4. Impulse response effects of each variable on the debt stock