Chapter Title: The Behavior of United States Deficits

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6   The Behavior of United States Deficits

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Much recent attention has focused on the large values of actual and projected federal deficits. To evaluate this discussion we must know whether these deficits represent a shift in the structure of the government's fiscal policy or are just the usual reaction to other influences, such as recession, inflation, and government spending. A related, but broader, question is whether the process that generates deficits in the post–World War II period differs systematically from that in place earlier—say, during the interwar period 1920–40. For example, has there been a change in the average deficit or in the magnitude of the countercyclical response of deficits?

I begin by describing the tax-smoothing theory of deficits that I developed earlier. Then I estimate this model on United States data since 1920. Basically, the results are consistent with an unchanged structure of deficits since that time. Specifically, the recent deficits and the near-term projections of deficits reflect mainly the usual responses to recession and, it turns out, to anticipated inflation.

6.1   The Tax-Smoothing Model of Deficits

I analyze the determination of deficits within the framework of the tax-smoothing model that I developed in an earlier paper (Barro 1979).[1]

1. Some related work is Kydland and Prescott 1980 and Lucas and Stokey 1983. The general idea of the implications of tax smoothing for the behavior of deficits appears also in Pigou 1928, chap. 6.

In this approach the government faces the exogenous, deterministic stream of real expenditures other than interest payments, as given by $g(t)$. The base of real taxable income is the deterministic amount $y(t)$, which generally depends on the path of tax rates. I think of $y(t)$ as a fixed fraction of the economy's real GNP for period t. Let $\tau(t)$ be the average tax rate at date t, so that the amount of real income tax revenue is $\tau(t)y(t)$. Then, if the real interest rate is the constant r and the initial real public debt is $b(0)$, the government's budget constraint in terms of present values is[2]

$$(1) \qquad \int_0^\infty \tau(t)y(t)e^{-rt}dt \ = \ \int_0^\infty g(t)e^{-rt}dt \ + \ b(0).$$

In the present formulation I do not separate the revenue from money creation from the government's other revenues. Rather, I think of inflationary finance as a tax on the holdings of money. Then, in order to focus on taxes in one period versus those in another, I combine the inflation tax with the variety of other levies (on income, sales, property, etc.) that apply at the same date. In particular, there seems to be no reason to give special treatment to the inflation tax.[3]

Suppose that the allocative effects from taxation depend on the "average marginal tax rate," $\tau^m(t)$, for each period. That is, the time path of average marginal tax rates, $\tau^m(1)$, $\tau^m(2)$, . . . , influences people's incentives to work, produce, and consume in the various periods. Here I take a Ramsey-like optimal taxation perspective in order to formulate a testable positive theory of the government's choices of tax rates over time.[4] In particular, if each period is similar in terms of elasticities of labor supply, and so on, then the Ramsey formulation dictates roughly equal tax rates, $\tau^m(t)$, for each period.[5] More generally, this approach would allow the tax rate to depend on time-varying features of the economy such as war or peace and boom or recession. But to bring out the main implications of the approach, I assume to begin with that the government plans for equal average marginal tax rates, $\tau^m(t)$, in each period. Then I examine later some perturbations from this path of uniform taxation.

2. This formulation assumes that the real interest rate exceeds the economy's steady-state growth rate. For a discussion, see McCallum 1984.

3. Anticipated inflation amounts to a form of excise tax. But unanticipated inflation entails a capital levy, which has different implications for the excess burden of taxation (see, for example, Barro 1983). However, changes in other kinds of taxes can also imply capital levies.

4. For discussions of Ramsey taxation, see Atkinson and Stiglitz 1980, chap. 12, and Ramsey 1927.

5. Kydland and Prescott 1980, 185–86, suggest that this rule will be close to optimal if intertemporal substitution effects are strong.

I assume that the average marginal tax rate for any period bears a stable relation to that period's average tax rate, $\tau(t)$—that is,

$$(2) \qquad \tau^m(t) = f[\tau(t)],$$

where the function f is invariant over time. In this case the stabilization of average marginal tax rates entails stabilization of average tax rates. If τ denotes the constant value of the average tax rate, then the government's intertemporal budget constraint in equation (1) implies that this tax rate is

$$(3) \qquad \tau = [\int_0^\infty g(t)e^{-rt}dt + b(0)]/\int_0^\infty y(t)e^{-rt}dt.$$

Suppose that real government spending, $g(t)$, and the real tax base, $y(t)$, are fluctuating around trend values that grow at the common rate n. That is, the time paths, $g^*(t) = g^*(0)e^{nt}$ and $y^*(t) = y^*(0)e^{nt}$, have the same present values as the respective actual time paths, $g(t)$ and $y(t)$.[6] Then the current "normal" values, $g^*(0)$ and $y^*(0)$, satisfy the conditions

$$(4) \qquad \begin{aligned} g^*(0) &= (r - n)\int_0^\infty g(t)e^{-rt}dt, \\ y^*(0) &= (r - n)\int_0^\infty y(t)e^{-rt}dt. \end{aligned}$$

Dropping the time subscripts and substituting back into equation (3) yields the formula for the (stabilized) average tax rate,

$$(5) \qquad \tau = [g^* + (r - n)b]/y^*.$$

Hence the tax rate equals the ratio of normal real spending to normal real income, where normal real spending includes the real interest payments on the outstanding public debt, rb, less the amount financed by the usual growth of the real debt, nb. I discuss this last item further below.

The current deficit—which I think of as the change in the real quantity of interest-bearing public debt, db/dt—is given at any date by

$$db/dt = g + rb - \tau y = g + rb - y[g^* + (r - n)b]/y^*.$$

After rearranging terms, this expression becomes

$$(6) \qquad db/dt = (1 - y/y^*)[g^* + (r - n)b] + g - g^* + nb.$$

The first term on the right side of equation (6) indicates that the real debt rises when output is below "normal"—that is, when $y/y^* < 1$.

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6. These assumptions rule out any drift in the ratio, g/y. In the long run this drift would be subject to the bounds, $0 < g/y < 1$.

Effectively, tax revenues fall in proportion to the fall in output (in order for the average tax rate not to change). Hence, the amount of revenue lost is the proportional shortfall of output $(1 - y/y^*)$ multiplied by the normal amount of real government spending (and revenues), $g^* + (r - n)b$. Note that, when tax rates are stabilized over time, the coefficient of the cyclical variable, $(1 - y/y^*)[g^* + (r - n)b]$, is unity in equation (6). Alternatively, if the government were to set relatively low tax rates during recessions, then it would have to engineer a more dramatic countercyclical response of deficits. In this case the coefficient of the cyclical variable would be greater than one. In any case, the present analysis does not distinguish the automatic cyclical response of tax revenues under a given tax law (which people sometimes try to filter out in the construction of a "full-employment deficit") from that effected through "discretionary" fiscal policy. For example, under a proportional income tax, average tax rates tend automatically to be stabilized over the business cycle, whereas under a graduated rate setup the average tax rate tends to be below normal during recessions and above normal for booms. Thus a well-designed tax system may make it unnecessary to change the tax laws frequently in order to achieve the desired cyclical pattern of tax rates. If the analysis included adjustment costs for altering the tax laws, then it would be possible to study the optimal design of these laws. But for the present analysis I assume that some combination of automatic response within the tax system plus discretionary changes in the laws achieves the desired behavior of deficits.

The second term on the right side of equation (6), $g - g^*$, indicates that the real debt rises by the amount of temporarily high real government spending. Thereby the government avoids abnormally high tax rates during periods when its expenditures are unusually high. Empirically, my measure of temporary spending focuses on the unusually high levels of military spending during wartime. Thus the unitary coefficient on the $(g - g^*)$ variable in equation (6) reflects the government's desire to equalize tax rates during wartime and peacetime periods. Alternatively, if the tax rates were above normal during wars, then the coefficient on the $(g - g^*)$ variable would be less than one.

Finally, other things equal, the last term in equation (6) says that the real debt grows at the rate n, which is the trend growth rate of the economy. If the debt did not grow along with the economy, then interest payments would fall over time relative to GNP, which would be inconsistent with stabilizing the average tax rate.

Note that the present formulation deals with the conventional concept of the funded real public debt, b. Sometimes people suggest adding the implicit debt that corresponds to the anticipated present value of social social security benefits or of other government obligations. In

fact, the pertinent variable for the government's decisions on taxes is g^* (plus the amount, $(r - n)b$), which is the anticipated flow of normal real spending. Aside from differences in the degree of uncertainty attached to various categories of expenditures, it is clear that future social security benefits play no special role—rather, they enter the analysis in a manner analogous to future defense spending, and so forth. However, the debt could be redefined if desired to include either the present value of social security benefits or of other expenditures. This change in definition would not alter the central economic problem, which concerns the government's choice of tax rates at different dates. But different concepts of deficits would behave in different manners.

Suppose, for example, that people expect a bulge in social security benefits to occur five years from now and to last for ten years. On this count, current spending g would be below the normal flow g^*, which calls for a surplus ($db/dt < 0$) in equation (6). Correspondingly, the government raises taxes currently in order to prepare for the eventual bulge in spending. However, if the debt included the present value of social security benefits, then the rise over time in this present value (as the bulge in spending approaches) would offset the surplus in the funded debt. That is, the broader concept of public debt—which included social security—would not tend to decline over time. But no matter how one defines the debt, the important point is that the prediction for tax rates is identical. Namely, the expectation of a bulge in future spending calls for a rise in current tax rates. (Unfortunately, I have not yet isolated this type of effect empirically for prospective government spending, whether for social security or for other types of spending.)

Dividing through in equation (6) by the level of real debt, b, the results can be written in terms of the proportionate growth rate of the real debt:

(7) $(1/b)db/dt = (1 - y/y^*)(g^*/b + r - n) + (g - g^*)/b + n.$

Empirically, the term $r - n$ is small relative to g^*/b. (That is, normal real spending g^* is large relative to real interest payments, rb, less the growth term, nb.) Hence I neglect the term $r - n$ in the subsequent analysis. Then it is appropriate to measure g^* as the normal amount of real government expenditures exclusive of interest payments.

When the time paths $g(t)$ and $y(t)$ are uncertain, the values g^* and y^* are also uncertain. I interpret these magnitudes in equation (7) as corresponding to anticipated present values of real government spending and GNP, assuming a known value of the real interest rate r. Possibly some further results could be obtained by modeling explicitly the uncertainty for future government spending and private endowments.[7]

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7. See Lucas and Stokey 1983 for a treatment of uncertainty.

The main point is that new information about the long-run values of spending, g^*, and income, y^*, lead to corresponding changes in the average tax rate, τ, as shown in equation (5). Thus the tax rate adjusts for surprise changes in spending and income, but the sign or magnitude of the necessary adjustments cannot be predicted in advance. In other words, the tax rate follows a martingale. However, some predictable changes in tax rates may appear if—as mentioned before—the tax rate depends on the state of the economy. For example, if tax rates were lower than normal during recessions, then predictable increases in tax rates would occur along with the (predictable) ends of recessions. Similarly, if tax rates were higher than normal during wars, then predictable declines in tax rates would show up at the (predictable) ends of wars. Thus, the martingale property for tax rates is not central to the approach followed in this paper.[8]

Another property of the theory is that it prescribes no target value for the level of public debt or for the ratio of debt to income. A higher initial value of debt is "undesirable" in the sense that it requires a higher tax rate at each date (equation 5), which then entails a larger excess burden from taxation. But (with default ruled out) it is not worthwhile for the government systematically to run surpluses in order to pay off the debt.[9] Such a policy implies temporarily high tax rates, which violates the tax-smoothing criterion. Thus, given the right-side variables in equation (7), there is no independent effect on the growth rate of debt from the starting value of the debt/income ratio. (This conclusion would still follow even if the government varied the tax rate with the business cycle or with conditions of war and peace.)

The argument above is consistent with the marked tendency of the ratio of public debt to GNP to fall during peacetime, nonrecession years. (See Barro 1984, chap. 15, for the long-term evidence on this behavior from the United States and the United Kingdom.) The variable g^* incorporates a country's propensity to experience infrequent but possibly large wars. Therefore temporary spending, $g - g^*$, is negative rather than zero during the typical peacetime year. Hence the debt/income ratio tends to fall during peacetime and to rise sharply during the infrequent large wars.

If the price level follows a known path, then equation (7) describes the time path of the real debt. Hence, the nominal debt—denoted by

8. In a previous study (Barro 1981a) I accepted the random walk hypothesis for average tax rates, although the statistical tests were not very powerful. Subsequently I have rejected the random walk hypothesis for some revised systems. Sahasakul 1983 finds evidence that average marginal tax rates are lower than normal during recessions and higher than normal during wars.

9. If an increase in the debt/income ratio raises the required real interest rate payable on public debt (perhaps because of an increasing probability of the government's default), then there would be a force that deters the government from amassing very high debt/income ratios.

B—grows at the rate of inflation, π, plus the amount shown on the right side of equation (7). That is (neglecting the term, $r - n$, in equation 7),

(8) $(1/B)dB/dt = n + \pi + (1 - y/y^*)(g^*/b) + (g - g^*)/b.$

Note that the inflation rate, π, has a one-to-one effect on the growth rate of the nominal debt.

A one-time surprise jump in the price level would shift the real debt, *b*, by a discrete amount in the opposite direction. Then, except for the shift in *b* on the right side of equation (8), there would be no alteration to the subsequent path of growth rates of the debt—in particular, there is no tendency to adjust the nominal debt in order to compensate for the unexpected inflation (and thereby to restore some target value of the real debt). It follows in equation (8) that the variable π should be replaced by the expected rate of inflation, π^e. (In the presence of indexed public debt, the actual rate of inflation would be appropriate.) The main point is that the planned growth rate of the real debt, $(1/B)$ $(dB/dt) - \pi^e$, depends on the real variables (other than π) that appear on the right side of equation (8). Hence, the government's deficit policy is specified in real terms, rather than being subject to some form of money illusion.

Given the expected real interest rate *r*, a higher value of anticipated inflation shows up as a higher nominal interest rate. Hence the previous result says that the government finances the (expected) inflation part of its nominal interest payments by issuing new nominal debt rather than by levying taxes. Although this interpretation is suggestive, it turns out that the results do not depend on a one-to-one relation between expected inflation and nominal interest rates. Any discrepancy here appears as a different value for the expected real interest rate. But a different level for the real interest rate does not affect the growth rate of the debt in equation (8) (assuming a given real growth rate, *n*, and neglecting the effect from the $r - n$ term in equation 7). A permanently higher real interest rate induces a once-and-for-all adjustment of the tax rate (equation 5), but no response of the deficit. On the other hand, if the expected real interest were temporarily high or low, then the deficit would adjust accordingly. Thus far I have not investigated this possibility empirically.

When the debt is long term there are also changes in the real market value from changes in long-term nominal interest rates. A one-time jump in the nominal interest rate shifts the current market value of the debt by a discrete amount in the opposite direction. For example, Butkiewicz (1983) shows that the market value of the debt (B^m) can be well approximated empirically from the par value (B^p) by using the formula

(9) $B^m \simeq B^p(1 + hc)/(1 + hR),$

where c is the average coupon rate on the outstanding bonds, R is the overall market yield, and h is the average maturity of the bonds. For given values of c and h, the effect of a change in market yield on the market value of debt is approximately

$$(10) \qquad dB^m/B^m \simeq -dR \cdot h/(1 + hR).$$

Equations (7) and (8) describe the paths of the market value of the real and nominal debt, respectively, subsequent to the initial discrete shift in market value at the moment of the one-time shift in yield. In particular, this discrete shift affects subsequent growth rates of the debt only through the change in b on the right side of the equations (and by any change in expected inflation that accompanies the shift in the long-term nominal interest rate). As with a surprise change in the price level, there is no tendency to return to a normal real market value of the debt. But in order to explain the overall movements in the market value of the debt, it is necessary to include an additional variable—such as that shown in equation (10)—in order to measure the effect of surprise changes in interest rates. In practice, I assume that all changes in the yield on government bonds, R, are unanticipated.

When considering the public debt, most researchers deal with the par value rather than the market value. (However, some reliable estimates of market value are now available for the post–World War II period, as discussed below.) A surprise jump in nominal interest rates has no immediate effect on the debt when measured at par value. But as the old debt matures the government effectively replaces it with new debt, which bears, say, a higher coupon. (I assume that all debt is issued at par.) Thus, if nothing else changes the government would face a rising path of real interest payments—that is, current real payments would be low relative to the average of anticipated future real payments. As with any path of rising real expenditures, the government's policy of tax smoothing requires a rise in the current tax rate, which means a smaller current deficit. In other words, a surprise increase in nominal interest rates leads to a gradual reduction over time in the real debt when measured at par value. In fact, if there are no further surprises in interest rates (and the debt has finite maturity), then the real par value gradually approaches the real market value, which fell in a discrete fashion at the moment of the one-time shift in interest rates.

Using equation (9), the effect on the par value of the debt from a change in the average coupon rate is

$$(11) \qquad dB^p/B^p \simeq -dc \cdot h/(1 + hc).$$

Suppose that the retirement of old debt means that the coupon rate, c, approaches the market yield, R, gradually, with the speed of adjustment depending inversely on the average maturity, h—that is,

$$dc/dt = (1/h)(R - c).$$

Then, using equation (11), the effect on the par value of the debt is

(12) $$(1/B^p)dB^p/dt = -(R - c)/(1 + hc).$$

I add the right-side variable (unsuccessfully) to some of the equations that I estimate below. (I have data on R, c, and h only for the period since 1946.)

6.2 Setup of the Empirical Analysis

The equation that I estimate with annual United States data over subsamples of the period 1920–82 takes the form

(13) $$\log(B_t/B_{t-1}) = a_0 + a_1\pi_t^e + a_2 YVAR_t$$
$$+ a_3 GVAR_t + a_4 RVAR_t + u_t,$$

where u_t is an error term with the usual properties and the other variables are as follows:

B: end-of-calendar year (par or market) value of the United States government's interest-bearing public debt, exclusive of holdings at federal agencies and trust funds or the Federal Reserve. Market value figures are based on Seater (1981) and Butkiewicz (1983).

π_t^e: expected rate of inflation (for the CPI),[10] generated as a forecasting relation based on the following: two annual lags of inflation, π_{t-1} and π_{t-2}; two annual lags of monetary growth (based on annual averages of M1), μ_{t-1} and μ_{t-1}; and the interest rate on four- to six-month commercial paper at the end of the previous year, RC_{t-1}.[11] That is, the equation for inflation is

(14) $$\pi_t = b_0 + b_1\pi_{t-1} + b_2\pi_{t-2} + b_3 \mu_{t-1}$$
$$+ b_4\mu_{t-2} + b_5 RC_{t-1} + \text{error term.}$$

10. These inflation rates are January-to-January values, using the consumer price index less shelter since 1947. For 1943–47, the data are strongly affected by price controls. Instead of using the reported price levels, I substituted values based on the extrapolation of an estimated price-level equation from some previous research (Barro 1981c, 157). This adjustment shifts the inflation rates as follows: from 2.9% to 25.8% for 1943, from 2.3% to 13.0% for 1944, from 2.2% to 3.2% for 1945, from 16.7% to −4.8% for 1946, and from 10.2% to −2.9% for 1947. This procedure affects the subsequent results mainly for the samples that include the World War II years. (There are also some effects of lagged inflation rates on the estimates for 1948–49.)

11. Theoretically, the annual average of π_t^e would matter, which means that some updating of expectations for current-period information comes into play. The present procedure excludes current-period information (and thereby avoids some econometric problems). I used the commercial paper rate, rather than, say, a one-year treasury bill rate, in order to have a consistent variable for the full sample. The difference between a four- to six-month maturity and a one-year maturity would not be of major significance for the results.

This equation for inflation is estimated jointly with the debt equation (13).

The behavior of inflation in the post–World War II period differs markedly from that before the war. First, there is positive persistence in inflation rates from year to year, which is not true earlier; second, lagged monetary growth is a positive predictor of inflation, which also does not apply earlier; and third, the variance of the inflation rate— conditioned on information from the previous year—is much smaller now than before. Some experimentation indicated that the main break in the structure of the inflation equation occurred around the Korean War—possibly with the accords between the Fed and the Treasury, which relieved the Fed from strict stabilization of interest rates. In any event, I estimate separate coefficients of the inflation equation (14) for the period up to 1953 and for the recent period, 1954–82. (It turns out that, in order to maximize the overall value of the likelihood function, it would be slightly preferable to break the sample at 1955/56. But I have retained the break at 1953/54, which has some rationale a priori.) Note that in equation (13) the hypothesized coefficient of the π^e variable is $a_1 = 1$.

Returning to the specification of variables in equation (13),

$$\text{YVAR}_t \equiv (1 - y_t/y_t^*) \cdot (g_t^*/\bar{b}_t),$$

$$\text{GVAR}_t \equiv (g_t - g_t^*)/\bar{b}_t,$$

where $\bar{b}_t$ is a geometric average of the year-end values, B_t and B_{t-1}, divided by the GNP deflator for year t.[12]

I base the measure of temporary real federal spending, $g_t - g_t^*$, on the variable I used previously (Barro 1981b) to explain fluctuations in real GNP. In that approach I isolated mainly the temporary parts of military spending that accompanied wars. Shifts in the ratio of federal nondefense expenditures to GNP and shifts during peacetime in the ratio of military spending to GNP were treated as predominantly permanent (in the sense that the ratios followed random walks). Sahasakul (1983) finds additional components of temporary real federal spending from the following: (1) a drift since the 1930s in the ratio of federal transfers to GNP; (2) the tendency since the 1930s of real federal transfers to move countercyclically; and (3) the tendency of wars to crowd out the nonmilitary components of federal spending. However, these influences do not introduce variables that are independent of those that

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12. The forms of the *YVAR* and *GVAR* variables in equation (13) arise as an approximation for discrete-time data to the continuous-time formulation in equation (8). The approximation seems to be satisfactory except for the very large values of $(g_t - g_t^*)/\bar{b}_t$ that arise at the start of World War I.

I include anyway in the equation to explain the growth rate of debt. Mainly, there are implications for the interpretations of coefficients—for example, the variable $GVAR$ will measure the impact of temporary wartime spending net of the typical transitory decline in the other components of real federal spending during wartime. Recall that the tax-smoothing model predicts that the coefficient of $GVAR_t$ in equation (13) is $a_3 = 1$. But the crowding out of other federal spending during wars implies $a_3 < 1$. In addition, if tax rates are somewhat above normal during wartime, then the coefficient a_3 would be reduced further below one.

For the cyclical variable $YVAR$ in equation (13), I need a measure of the temporary shortfall of output, $(1 - y_t/y_t^*)$. In my previous study (Barro 1979), I used the deviation of current real GNP, which measured y_t, from trend real GNP, which measured y_t^*.[13] I again report results with this construct, although it deals incorrectly with permanent shifts to the level of output. In these cases the variable indicates a permanent departure of output from normal. The results improve if I use instead the unemployment rate, U_t, to proxy for the shortfall in output, $(1 - y_t/y_t^*)$. As long as the unemployment rate is stationary in levels, this variable will work satisfactorily even when there are permanent shifts to the level of output.

My main results use the total unemployment rate (including the military in the labor force).[14] Then I assume a stable relation between percentage shortfalls in output and the departure of the unemployment rate from a fixed natural rate:

$$(15) \qquad (1 - y_t/y_t^*) = \lambda(U_t - .054).$$

I take the natural unemployment rate in this formulation to be 5.4%, which is the median rate over the sample 1890–1982. (The value 5.4% is also close to the median and mean over the period 1948–82.) For the post–World War II period (for which data are available), I obtain similar results if I use instead the prime-age male unemployment rate, U_t^m. Some people argue that this variable is more stable over long periods than the overall unemployment rate. Note that in equation (15) the parameter λ is an Okun's law type of coefficient, which is likely to lie between two and three.

As a general statement it would be preferable to construct normal output, y_t^*, as an explicit time series representation for "permanent income." (My measure for $g_t - g_t^*$ does take this approach, although

13. For trend real GNP, the growth rate was 3.4% per year since 1946 and before 1914. From 1915 to 1945, the two trend lines were connected, implying an average growth rate of 2.5% per year.

14. I also adjust the values from 1933 to 1943 as suggested by Darby 1976 to include New Deal workers as employed.

only for military spending.) But I have thus far been unsuccessful along these lines in the construction of the variable y_t^*.

The variable $YVAR_t$ depends also on normal real federal spending, g_t^*. I use here Sahasakul's (1983) concept of normal real federal spending, which combines normal military spending (which entered above into the construction of the $GVAR$ variable) with measures of normal real federal spending for transfers and nondefense purchases. In this context the results are relatively insensitive to the precise measure of g_t^*, as long as the variable picks up the longer-term movements in the size of the federal government. But when making comparisons over long periods, it is important to recall that the growth rate of the debt in equation (13) depends on the $YVAR$ variable, which equals the percentage shortfall in output, $(1 - y_t/y_t^*)$, multiplied by the ratio $g_t^*/\bar{b}_t$. For example, in 1982 this last variable is 0.83, while in 1933 it is 0.17. Hence—because of the high value of normal real federal spending in recent years—a one-percentage-point shortfall in output has five times as much effect on the growth rate of debt as it would have in 1933 (where the percentage shortfall in output was much larger).[15]

The tax-smoothing model suggests that the coefficient of $YVAR_t$ in equation (13) would be $a_2 = 1$. However, the countercyclical behavior of transfers and any tendency to lower tax rates during recessions lead to $a_2 > 1$. When the unemployment rate proxies for the shortfall in output (equation 15), the estimated coefficient on $YVAR_t$ is also multiplied by the Okun's law coefficient, λ.

The variable $RVAR_t$ in equation (13) accounts for the effects of changes in interest rates. With the debt measured at par value, the interest rate variable (available since 1946) is $RVAR_t = (\bar{R}_t - \bar{c}_t)/(1 + \bar{h}_t \bar{c}_t)$, where R is the yield, h is average maturity, c is the average coupon rate, and overbars signify averages over the year. When the debt is measured at market value (available accurately since 1941), the interest rate variable is $RVAR_t = \bar{h}_t(R_t - R_{t-1})/(1 + \bar{h}_t\bar{R}_t)$. In both cases the hypothesized coefficient in equation (13) is $a_4 = -1$.

6.3 Empirical Results

Table 6.1 shows joint, maximum-likelihood estimates for the debt equation (13) and the inflation equation (14). For the debt equations in this table, the $RVAR$ variable is omitted and the $YVAR$ variable is based on the overall unemployment rate. The first six sets of results refer to the sample 1920–40, 1948–82, which excludes the years associated

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15. The ratio of the real deficit to real GNP, $(db/dt)/y_t$, depends on g_t^*/y_t. This last variable is .21 in 1982 and .06 in 1933.

with World War II. The inflation equations report separate coefficients for the two subperiods 1920–40, 48–53 and 1954–82. Also, the observations in the inflation equation for the first subperiod, 1920–40/48–53, are weighted by .40 in order to correct for heteroskedasticity (that is, for a higher error variance in the earlier sample).

For set 1 in table 6.1, the coefficients of the inflation equation in the earlier subperiod are insignificant except for *negative* effects of the lagged interest rate (coefficient of -1.2; $SE = 0.2$) and of the second lag of monetary growth (-0.29; $SE = 0.09$). The first effect probably reflects the tendency for (real) interest rates to be high during financial crises, which were also times of deflation. The second effect picks up the tendency for reversals in monetary growth under the earlier monetary regime. By contrast, for the later subperiod 1954–82, the coefficients of the first lags of inflation and monetary growth are each strongly positive (0.81; $SE = 0.18$ and 0.67; $SE = 0.15$, respectively). Surprisingly, the coefficient of the nominal interest rate is still negative (-0.37; $SE = 0.14$). The results for the inflation equation remain basically similar in the specifications discussed later.

Expected inflation, π_t^e, is calculated from the coefficients in the inflation equation. In set 1 of table 6.1, the coefficient of π_t^e in the debt equation is constrained to equal one, while in set 2 this coefficient is left free. Note that the unconstrained estimate for this coefficient is 0.97; $SE = 0.12$, which is consistent with the theoretical value of unity. Therefore I focus on the constrained results, which appear in set 1.

The estimated coefficient of *GVAR* (0.27; $SE = 0.09$) is significantly positive, but well below the value of unity that is suggested by the tax-smoothing model. The results in Sahasakul (1983) indicate that a small part of this discrepancy reflects the crowding out of other components of federal spending during wartime. But the main element is the tendency for average tax rates to be above normal during wars. I discuss these results further when the observations for World War II are included.

The estimated coefficient of *YVAR* (3.88; $SE = 0.26$) is positive and highly significant, which shows the strong countercyclical behavior of deficits. Dividing by an Okun's law coefficient of 2.5 (see equation 15) suggests that the reaction of debt growth to shortfalls in output involves a coefficient of about 1.5. The excess of this coefficient above one reflects the tendency during recessions for average tax rates to be below normal and for real federal transfers to be above normal (see Sahasakul 1983 for a detailed breakdown between these two elements). To see the quantitative effect of unemployment on the deficit, recall that the pertinent variable is $YVAR_t = (U_t - .054) \cdot (g_t^*/b_t)$, which has an estimated coefficient of 3.9. In 1982 the variable g_t^*/b_t equals 0.83, which means that a one-percentage point increase in the unemployment rate

Table 6.1   **Basic Regression Results for Debt Growth and Inflation**

			Equation for DB_t				
Set	Sample	$\mathscr{L}$	Constant	π^e	GVAR	YVAR	$\hat{\sigma}$/DW
(1)	1920–40,	289.0	.009	1	.27	3.88	.023
	1948–82		(.006)		(.09)	(.26)	2.2
(2)	1920–40,	289.0	.010	.97	.27	3.90	.023
	1948–82		(.007)	(.12)	(.09)	(.26)	2.2
	For DB_t	290.6	.013	1	.26	3.48	.022
(3) I:	1920–40		(.017)		(.20)	(.45)	2.2
II:	1948–82		.013	1	.38	4.54	
			(.006)		(.12)	(.45)	
	For DB_t	293.1	.026	1.65	.30	3.21	.021
(4) I:	1920–40		(.021)	(.58)	(.21)	(.50)	2.1
II:	1948–82		.024	.71	.38	4.85	
			(.007)	(.15)	(.12)	(.42)	
	For DB_t	290.9	.009	1	.24	3.54	.022
(5) I:	1920–40,		(.010)		(.12)	(.32)	2.2
	1948–53		.014	1	.40	4.63	
II:	1954–82		(.007)		(.14)	(.45)	
	For DB_t	293.1	.011	1.32	.22	3.56	.022
(6) I:	1920–40,		(.011)	(.42)	(.12)	(.33)	2.1
	1948–53		.029	.64	.42	5.03	
II:	1954–82		(.009)	(.15)	(.14)	(.42)	
(7)	1920–82	288.7	.023	1	.76	4.90	.045
			(.006)		(.05)	(.41)	1.7
(8)	1920–82	288.7	.024	.97	.76	4.91	.045
			(.007)	(.15)	(.05)	(.41)	1.7

Note: For the debt equation, the dependent variable, DB_t, is the growth rate from end December to end December of the privately held, interest-bearing public debt. The figures are par value except for sets 13–14 in table 6.2, which use market values. For the inflation equation, the dependent variable, π_t, is the growth rate (January to January) of the consumer price index (measured without the shelter component since 1947).

The inflation equation (in sets 1–8 and sets 19–24 in table 6.3) allows for separate coefficients for the subperiod up to 1953 and for the later subperiod 1954–82. The earlier observations are weighted by .40 (the maximum likelihood estimate from set 1) to correct for heteroskedacity. In sets 7–8, which include World War II, the observations for 1943–47 are deleted from the inflation equation.

For the debt equation, there are separate coefficients over two subperiods in the cases indicated (sets 3–6 and 21–24). Otherwise a single set of coefficients applies for the full sample. In any event, the variance of the error term is assumed to be constant for the full sample.

$\mathscr{L}$ is the log of the value of the likelihood function. The independent variable π^e is calculated as a forecast of π_t from the coefficients of the inflation equation. The value

Table 6.1   (continued)

Equation for π_t (I. Sample up to 1953   II. Sample 1954–82)

Constant	π_{t-1}	π_{t-2}	μ_{t-1}	μ_{t-2}	RC_{t-1}	$\hat{\sigma}$/DW
0.33	.06	.14	.04	− .29	− 1.16	.015
(.010)	(.12)	(.11)	(.10)	(.09)	(.23)	1.6
.002	.81	− .02	. 67	.05	− .37	
(.006)	(.18)	(.12)	(.15)	(.20)	(.14)	
.033	.06	.14	.04	− .29	− 1.18	.015
(.010)	(.12)	(.11)	(.10)	(.09)	(.25)	1.6
.002	.82	− .03	.68	.05	− .37	
(.006)	(.18)	(.12)	(.16)	(.20)	(.14)	
.037	.01	.17	.05	− .31	− 1.26	.015
(.010)	(.12)	(.11)	(.11)	(.09)	(.24)	1.5
.004	.81	− .06	.71	.05	− .40	
(.006)	(.18)	(.13)	(.16)	(.20)	(.14)	
.025	− .01	.16	.01	− .24	− .94	.015
(.012)	(.10)	(.09)	(.08)	(.09)	(.30)	1.6
.000	.89	− .15	.81	.03	− .40	
(.006)	(.19)	(.14)	(.17)	(.21)	(.15)	
.037	.01	.17	.05	− .32	− 1.25	.015
(.011)	(.12)	(.11)	(.10)	(.09)	(.23)	1.5
.004	.81	− .07	.71	.05	− .41	
(.006)	(.18)	(.13)	(.16)	(.20)	(.14)	
.030	− .01	.16	.04	− .27	− 1.04	.014
(.013)	(.10)	(.10)	(.08)	(.10)	(.31)	1.7
− .002	.91	− .20	.84	.02	− .37	
(.007)	(.20)	(.14)	(.18)	(.22)	(.15)	
.005	.13	− .41	.19	− .04	− .55	.015
(.014)	(.16)	(.14)	(.15)	(.13)	(.32)	2.0
− .004	.91	− .34	.85	− .06	− .21	
(.007)	(.21)	(.14)	(.18)	(.24)	(.16)	
.005	.13	− .41	.19	− .04	− .55	.015
(.014)	(.16)	(.15)	(.15)	(.13)	(.33)	2.0
− .004	.91	− .35	.85	− .06	− .20	
(.007)	(.21)	(.14)	(.18)	(.24)	(.16)	

1 indicates that the coefficient of this variable is constrained to unity. The variable *GVAR*, based on temporary military spending, is discussed in the text.

The cyclical variable *YVAR*, described in the text, is based on the overall unemployment rate, $U_t - .054$, for sets 1–10 and 13–18. Sets 11 and 12 use the prime-age male unemployment rate, $U^m - .041$. Sets 19–24 use real GNP relative to trend.

In sets 13–14 of table 6.2 (which use the market value of debt), the variable $RVAR_t = \bar{h}_t(R_t - R_{t-1}) / (1 + \bar{h}_t R_t)$, where R is the average yield on government debt and h is the average maturity. Overbars indicate estimates of averages over the year. For sets 15–16 the variable is $RVAR_t = (\bar{R}_t - \bar{c}_t) / (1 + \bar{h}_t \bar{c}_t)$, where c is the average coupon rate on government debt. Sets 17–18 use the lagged value of this last measure of *RVAR*.

$\hat{\sigma}$ is the standard error of estimate; DW (shown below $\hat{\sigma}$) is the Durbin-Watson statistic.

In the inflation equation, π_{t-1} and π_{t-2} are lagged values of the dependent variable, μ_{t-1} and μ_{t-2} are lagged values of monetary growth (based on annual averages of M1), and RC_{t-1} is the value from the previous December of the four-to six-month rate on commercial paper.

raises the estimated growth of the debt by $3.9 \cdot (0.83) = 3.2$ percentage points per year. For a debt level of \$850 billion (December 1982), the corresponding increase in the deficit is by $3.2\% \cdot 850 = \$27$ billion.

The standard error of estimate for the debt equation is $\hat{\sigma} = 0.023$ (that is, ± 2.3 percentage points per year). This result corresponds to an R^2 of .91, although the maximization of R^2 is not the criterion for the estimation. The Durbin-Watson statistic of 2.2 suggests that serial correlation of residuals is not a problem.

The results in sets 3–6 of table 6.1 check whether the debt equation is stable over various subperiods. Sets 3 and 4 allow the coefficients for 1920–40 to differ from those for 1948–82. Sets 5 and 6 specify the first subperiod as 1920–40, 48–53 and the second as 1954–82. Also, sets 3 and 5 constrain the coefficient of the π^e variable to unity, while sets 4 and 6 relax this constraint. In all cases the hypothesis of stable coefficients over the two subperiods is accepted at conventional significance levels by likelihood-ratio tests. For example, for set 3 (where the samples are 1920–40 and 1948–82, and where the coefficient of π^e is fixed at one), the value of $-2 \cdot \log$ (likelihood ratio) is 3.2, which is below the 5% critical value for the χ^2 distribution with three degrees of freedom of 7.8. For set 4 (where the π^e coefficients are unrestricted), the test statistic is 8.2, with a 5% critical value with four degrees of freedom of 9.5. The results are basically similar in sets 5 and 6, where the break in the sample is at 1953–54.

These findings are important, since they indicate that the process for generating deficits in the interwar period, 1920–40 (or the period 1920–40, 1948–53) is broadly similar to that in the post–World War II period, 1948–82 (or 1954–82). In particular, the statistical evidence does not support the idea that there has been a shift toward a fiscal policy that generates more real public debt on average or that generates larger deficits in response to recessions. (In set 3 of table 6.1, the estimated coefficients of the *YVAR* variable are 3.48; $SE = 0.45$ for 1920–40; and 4.54, $SE = 0.45$ for 1948–82. However, even this pattern of higher point estimates in the later period reverses later when I consider an alternative measure of the *YVAR* variable.)

Sets 7 and 8 of table 6.1 deal with the full sample, 1920–82, which adds the years associated with World War II, 1941–47, to the previous sample.[16] Aside from the deterioration in fit—as measured by the standard error of estimate, $\hat{\sigma}$—the most striking change is the increase in the coefficient of the *GVAR* variable. Naturally this variable is the principal source of deficits during World War II. The estimated coef-

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16. Because of the problems with price controls (note 10 above), I exclude the years 1943–47 from the inflation equation. The values of π^e_t for these years are those implied by the estimated coefficients for the earlier subperiod, 1920–40, 1948–53.

ficient is now 0.76; $SE = 0.05$, which is highly significant and closer to the hypothesized value of unity. But it is also clear that the present formulation does not satisfactorily include the observations from World War II into the specification that works satisfactorily for the other years. One of the problems is that the estimated inflation equation (using the coefficients from the earlier subperiod, 1920–40, 1948–53—see note 16 above) generates implausibly low values of anticipated inflation during World War II. Specifically, these values are close to zero throughout the period 1941–45. The specification has to be changed to allow the earlier monetary regime to generate high values of monetary growth and inflation during wartime. (Similar problems arise when I attempt to add the observations from World War I, 1917–19.) It is also clear that the measure of temporary wartime spending, $GVAR$, is subject to substantial measurement error during the major wars, which accounts for some of the increase in the standard error of estimate. This problem can probably be handled by estimating the $GVAR$ variable (as I did in Barro 1981b) jointly with the debt and inflation equations.

Table 6.2 shows some additional results for the recent sample, 1954–82. Sets 9 and 10 (with the π^e coefficient restricted to one and unrestricted, respectively) are similar to those for the longer sample (with World War II excluded), as shown in sets 1 and 2 of table 6.1. Sets 11 and 12 of table 6.2 change the $YVAR$ variable to use the prime-age male unemployment rate, $U_t^m - .041$, where 0.041 is the mean value of U^m over the period 1954–82. Although the fit of the equation for debt growth in sets 11 and 12 is slightly worse than that in sets 9 and 10, the general nature of the results is similar.

Sets 13 and 14 of table 6.2 use the estimated market value of the public debt, rather than the par value, in the construction of the dependent variable. The equation for debt growth now includes an interest rate variable, $RVAR_t$, which picks up the effect on the market value of debt from changes in interest rates. For set 13 (where the coefficient of π^e is fixed at one), the estimated coefficient of $RVAR_t$ is -0.83; $SE = 0.13$, which differs insignificantly from the hypothesized value of -1. The other results are broadly similar to those found in sets 9 and 10, which are based on the par value of public debt.

In sets 15–18 of table 6.2 I attempt to find an effect from changes in interest rates on the growth in debt when measured at par value. (The variable $RVAR_t$ is now based on the difference between the yield and the coupon rate—see the notes to table 6.2.) Although the hypothesized coefficient of $RVAR_t$ is -1, the estimated values in sets 15 and 16 are positive, but with very high standard errors. Since the $RVAR_t$ variable may be proxying for within-period revisions of expected inflation, I used instead the lagged value, $RVAR_{t-1}$, in sets 17 and 18. The estimated coefficients do decrease—for example, to -0.13; $SE =$

Table 6.2   **Regression Results for 1954–82 Sample**

			Equation for DB_t					
Set	Sample	$\mathcal{L}$	Constant	π^e	GVAR	YVAR	RVAR	$\hat{\sigma}$/DW
(9)		156.0	.011	1	.31	4.21		.019
			(.007)		(.12)	(.42)		2.2
(10)		156.8	.024	.71	.35	4.67		.019
			(.009)	(.16)	(.12)	(.41)		2.0
(11)	YVAR uses U^m	152.5	.004	1	.19	3.73		.022
			(.008)		(.13)	(.44)		1.8
(12)	YVAR uses U^m	152.8	−.003	1.18	.20	3.57		.022
			(.012)	(.23)	(.12)	(.46)		2.0
(13)	DB from market value	151.6	.022	1	.39	4.72	−.83	.023
			(.008)		(.15)	(.49)	(.13)	2.3
(14)	DB from market value	153.2	.038	.66	.46	5.31	−.81	.023
			(.009)	(.16)	(.14)	(.47)	(.13)	2.1
(15)	Add $RVAR_t$ to (9)	156.3	.007	1	.30	4.18	.45	.019
			(.009)		(.11)	(.42)	(.59)	2.2
(16)	Add $RVAR_t$ to (10)	157.2	.020	.68	.32	4.63	.57	.019
			(.010)	(.17)	(.12)	(.14)	(.62)	2.1
(17)	Add $RVAR_{t-1}$ to (9)	156.0	.012	1	.32	4.23	−.13	.019
			(.009)		(.12)	(.44)	(.60)	2.2
(18)	Add $RVAR_{t-1}$ to (10)	156.9	.024	.70	.35	4.68	.11	.019
			(.010)	(.16)	(.12)	(.42)	(.65)	2.1

Note: See notes to table 6.1.

0.60, in set 17. These results are consistent with the theoretical value of −1, although the estimates are very imprecise.

Table 6.3, which refers to the sample 1920–40, 1948–82, uses output relative to trend rather than the unemployment rate in the construction of the cyclical variable, *YVAR*. The fits for the debt equation are substantially worse than those achieved with the unemployment rate—compare, for example, sets 19 and 20 in table 6.3 with sets 1 and 2 in table 6.1. It turns out that the main differences arise in the post–World War II sample, especially during the 1974–76 recession. In any event the results based on output relative to trend are still consistent with an unchanged structure of the debt equation over either the subperiods, 1920–40 and 1948–82 (sets 21 and 22 of table 6.3) or 1920–40/48–53 and 1954–82 (sets 23 and 24).

One advantage of the results in table 6.3 is that the estimated coefficient of the *YVAR* variable reveals directly the effect on debt growth from shortfalls in output. For example, in set 19, the estimated coefficient is 1.35; $SE = 0.13$. This estimate is significantly above the value of unity that comes from the tax-smoothing model, though some of this

Table 6.2   (continued)

			Equation for π_t			
Constant	π_{t-1}	π_{t-2}	μ_{t-1}	μ_{t-2}	RC_{t-1}	$\hat{\sigma}$/DW
.005	.77	.05	.63	.08	−.44	.015
(.005)	(.14)	(.11)	(.13)	(.15)	(.11)	1.5
.000	.88	−.08	.79	.06	−.45	.014
(.006)	(.17)	(.12)	(.16)	(.18)	(.13)	1.7
.000	.84	.08	.72	.12	−.52	.016
(.005)	(.14)	(.11)	(.13)	(.16)	(.11)	1.6
.003	.78	.13	.64	.12	−.50	.016
(.006)	(.15)	(.10)	(.14)	(.15)	(.12)	1.5
.001	.77	−.10	.70	.02	−.29	.014
(.006)	(.17)	(.12)	(.15)	(.19)	(.13)	1.7
−.003	.88	−.25	.84	−.02	−.27	.013
(.006)	(.19)	(.13)	(.17)	(.21)	(.14)	2.0
.006	.78	.06	.62	.09	−.47	.016
(.005)	(.14)	(.10)	(.12)	(.15)	(.11)	1.5
.001	.90	−.07	.78	.07	−.49	.014
(.006)	(.17)	(.12)	(.16)	(.18)	(.14)	1.7
.004	.77	.05	.64	.08	−.44	.015
(.005)	(.14)	(.11)	(.13)	(.15)	(.11)	1.6
.000	.88	−.09	.79	.06	−.45	.014
(.006)	(.17)	(.12)	(.16)	(.18)	(.13)	1.8

excess reflects the countercyclical behavior of federal transfers. (Sets
21–24 show that the point estimates of the *YVAR* coefficients from the
earlier subperiods exceed those from the later subperiods, which re-
verses the pattern found before with the unemployment rate. However,
these differences across subperiods are statistically insignificant.)

6.4   Some Episodes of United States Debt Issue

Table 6.4 shows actual and estimated values for the growth rate of
nominal debt, DB_t, and the inflation rate, π_t, over the sample 1920–
40, 1948–82. The estimated values come from the regressions shown
in set 1 of table 6.1 (where the coefficient of π^e is constrained to unity).
Table 6.5 shows the values of the explanatory variables *GVAR* and
YVAR (based on the overall unemployment rate), as well as the ratio
g^*/b, which enters into the construction of the *YVAR* variable.

Note first the negative values of *DB* and $\hat{DB}$ (i.e., "surpluses")
throughout the 1920s. These derive, first, from negative values of an-
ticipated inflation, especially for 1921–22; second, from the economic
boom (negative values of the cyclical variable, *YVAR*) for most of 1923–

Table 6.3   **Regression Results Using Output Relative to Trend**

Set	Sample	$\mathcal{L}$	Constant	π^e	GVAR	YVAR	$\hat{\sigma}$/DW
			Equation for DB_t				
(19)	1920–40,	277.1	.004	1	.08	1.35	.029
	1948–82		(.008)		(.10)	(.13)	1.7
(20)	1920–40,	281.4	−.011	1.56	.13	1.41	.025
	1948–82		(.011)	(.22)	(.09)	(.13)	2.1
(21)	For DB_t	278.0	−.005	1	.12	1.51	.029
	1920–40		(.024)		(.25)	(.28)	1.8
	1948–82		.003	1	−.02	1.17	
			(.008)		(.13)	(.23)	
(22) I:	For DB_t	282.1	−.007	1.85	.14	1.41	.025
	1920–40		(.026)	(.74)	(.23)	(.28)	2.1
II:	1948–82		−.013	1.58	.12	1.22	
			(.012)	(.26)	(.13)	(.23)	
(23) I:	For DB_t	278.5	−.002	1	.20	1.44	.028
	1920–40,		(.014)		(.13)	(.17)	1.8
	1948–53		.002	1	−.06	1.21	
II:	1954–82		(.009)		(.15)	(.23)	
(24) I:	For DB_t	282.4	.003	1.80	.18	1.44	.025
	1920–40,		(.020)	(.86)	(.13)	(.16)	2.1
	1948–53		−.023	1.69	.04	1.21	
II:	1954–82		(.016)	(.32)	(.14)	(.24)	

Note: See notes to table 6.1.

29; and third, from relatively low values of the GVAR variable. From 1931 to 1940 the values of debt growth are all positive (i.e., "deficits"). This behavior reflects the countercyclical response of deficits to the Great Depression (that is, to the positive values of the cyclical variable, YVAR, particularly for 1931–35). There are large increases in real federal spending during the New Deal period after 1932, but not in the wartime spending that is the basis for my measure of temporary spending, GVAR. Therefore, higher federal spending is not a major element in my estimates of debt growth during the 1930s. (The variable GVAR equals $(g - g^*)/b$, which is negative but declining in magnitude during the 1930s because of the substantial rise in the real debt, b.) However, the higher real spending on nondefense items—which I implicitly treat as permanent—would account for the large increases in tax rates that occurred under Hoover and Roosevelt from 1932 to 1936. (See Barro

Table 6.3   (continued)

	Equation for π_t	(I. Sample up to 1953	II. Sample up to 1954–82)			
Constant	π_{t-1}	π_{t-2}	μ_{t-1}	μ_{t-2}	RC_{t-1}	$\hat{\sigma}$/DW
.040	−.10	.26	−.02	−.37	−1.42	.017
(.009)	(.11)	(.10)	(.09)	(.08)	(.20)	1.3
−.005	.81	.23	.78	.23	−.62	
(.005)	(.15)	(.11)	(.14)	(.17)	(.12)	
.036	−.10	.21	−.01	−.29	−1.02	.017
(.007)	(.08)	(.07)	(.06)	(.06)	(.19)	1.3
.002	.65	.28	.64	.24	−.58	
(.005)	(.14)	(.09)	(.13)	(.15)	(.11)	
.039	−.08	.24	−.02	−.36	−1.30	.017
(.010)	(.11)	(.10)	(.10)	(.08)	(.23)	1.3
−.006	.80	.25	.72	.22	−.56	
(.005)	(.15)	(.11)	(.15)	(.17)	(.13)	
.032	−.08	.19	−.02	−.25	−.92	.017
(.011)	(.08)	(.08)	(.06)	(.08)	(.29)	1.4
.002	.65	.31	.57	.21	−.55	
(.006)	(.14)	(.09)	(.14)	(.15)	(.12)	
.041	−.08	.23	−.02	−.36	−1.29	.017
(.011)	(.11)	(.10)	(.09)	(.08)	(.21)	1.3
−.006	.79	.23	.73	.23	−.56	
(.005)	(.15)	(.11)	(.15)	(.17)	(.13)	
.025	−.09	.18	−.01	−.25	−.87	.017
(.016)	(.08)	(.09)	(.05)	(.11)	(.35)	1.4
.004	.61	.29	.55	.21	−.51	
(.006)	(.14)	(.09)	(.14)	(.14)	(.12)	

and Sahasakul 1983, for further discussion.) In any event, the actual debt growth, DB, is reasonably in line with the estimated values, $\hat{DB}$, throughout the 1930s.

I have already mentioned that the dramatic increases in public debt during World War II derive primarily from the high values of temporary federal spending, as reflected in the $GVAR$ variable. In fact, the average growth rate of the nominal debt from the end of 1940 until the end of 1945 is 34% per year. (From the end of 1916 until the end of 1919 it is over 100% per year.) However, since my detailed results for the periods of the world wars are at present unsatisfactory, I cannot say much more about these episodes.

For the post–World War II period, note first that neither the actual nor the estimated values of debt growth are very high during the Korean War, say, 1950–53. The values of $GVAR$ are high, but those for the cyclical variable, $YVAR$, are low. Also, the calculated values of expected inflation, π^e, are relatively low at this time. The response of deficits to recessions shows up, for example, in 1949, 1954, 1958, and

Table 6.4   **Values of Debt Growth and Inflation**

Year	DB	$\hat{DB}$	$DB - \hat{DB}$	π	$\hat{\pi}$	$\pi - \hat{\pi}$
1920	− .038	− .026	− .012	− .014	− .021	.007
1921	− .039	− .030	− .009	− .117	− .091	− .026
1922	− .036	− .054	.018	− .008	− .062	.054
1923	− .038	− .045	.007	.027	− .010	.038
1924	− .049	− .036	− .014	.002	− .028	.030
1925	.000	− .049	.049	.036	− .018	.054
1926	− .112	− .073	− .039	− .023	− .022	.000
1927	− .064	− .072	.008	− .015	− .038	.023
1928	− .049	− .048	− .001	− .010	− .023	.013
1929	− .059	− .072	.013	.000	− .031	.031
1930	− .007	.009	− .016	− .073	− .030	− .043
1931	.084	.132	− .048	− .106	− .008	− .098
1932	.123	.116	.007	− .103	− .021	− .082
1933	.162	.147	.015	.026	.010	.016
1934	.167	.172	− .005	.030	.040	− .011
1935	.177	.135	.042	.015	.036	− .022
1936	.104	.082	.022	.019	.016	.003
1937	.029	.032	− .002	.009	− .014	.023
1938	.043	.064	− .021	− .019	− .011	− .008
1939	.070	.081	− .011	− .002	.015	− .018
1940	.072	.090	− .018	.012	.030	− .018
1948	− .038	− .018	− .019	.008	− .008	.016
1949	.035	.006	.029	− .030	.002	− .032
1950	− .014	.019	− .033	.082	.015	.067
1951	− .018	.013	− .031	.041	.017	.023
1952	.019	.003	.016	.002	.014	− .012
1953	.019	− .022	.041	.007	.001	.006
1954	.013	.027	− .014	− .012	.018	− .031
1955	.000	− .019	.018	.000	− .001	.001
1956	− .029	− .010	− .019	.033	.013	.020
1957	− .011	.001	− .012	.034	.025	.010
1958	.033	.038	− .005	.013	.019	− .006
1959	.035	.001	.034	.011	.008	.004
1960	− .014	.011	− .025	.016	.018	− .002
1961	.022	.022	.000	.007	.005	.002
1962	.018	.002	.016	.014	.009	.005
1963	.006	.014	− .009	.015	.018	− .003
1964	.008	.004	.004	.010	.020	− .011
1965	− .009	− .005	− .004	.020	.023	− .003
1966	− .005	− .011	.005	.030	.031	− .001
1967	.018	.007	.012	.035	.035	.000
1968	.030	.000	.030	.040	.037	.004
1969	− .025	.012	− .037	.053	.058	− .005
1970	.036	.036	.000	.044	.052	− .019
1971	.076	.048	.028	.033	.043	− .010
1972	.057	.049	.008	.036	.055	− .020
1973	− .003	.016	− .020	.095	.059	.036

Table 6.4   (continued)

Year	DB	$\hat{DB}$	$DB - \hat{DB}$	π	$\hat{\pi}$	$\pi - \hat{\pi}$
1974	.039	.080	− .041	.112	.094	.018
1975	.255	.206	.050	.065	.093	− .028
1976	.159	.133	.027	.052	.062	− .011
1977	.114	.110	.003	.060	.064	− .004
1978	.092	.087	.005	.082	.076	.006
1979	.072	.089	− .016	.113	.084	.029
1980	.131	.154	− .022	.103	.097	.006
1981	.119	.137	− .018	.077	.065	.012
1982	.201	.189	.012	.041	.058	− .018

Note: $DB_t \equiv \log(B_t/B_{t-1})$, where B_t is the value from the end of December of the privately held part of the interest-bearing public debt—that is, the gross public debt less holdings by federal agencies and trust funds and the Federal Reserve. (See Barro 1979 for details.) $\hat{DB}_t$ is the estimated value from set 1 of table 6.1.

$\pi_t \equiv \log(P_{t+1}/P_t)$, where P_t is the January value of the seasonally adjusted CPI (less shelter since 1947). $\hat{\pi}_t$ is the estimated value from set 1 of table 6.1.

1961. The Kennedy-Johnson tax cuts for 1964–65 do not correspond to notable residuals in the equation for debt growth.

For the Vietnam War—say 1966–68—the positive residuals for debt growth support the common view that taxes were raised insufficiently at this time. But perhaps because of the surcharge on the income tax, a substantial negative residual does show up for 1969.

Since 1969 expected inflation has become an important influence on the deficit, as measured by the growth in the nominal debt. In particular, the values of π^e (which have a one-to-one effect on the estimates of debt growth, $\hat{DB}$) are between 4% and 6% for 1969–73, increase to 9% for 1974–75, fall to between 6% and 8% for 1976–79, reach 10% in 1980, and then decline to 6% for 1981–82.

The debt equation underpredicts the deficits during the recession years 1975–76. (However, the error is much greater if the *YVAR* variable is based on real GNP relative to trend rather than the unemployment rate.) But the debt equation is basically on track for the 1980–82 recession. For 1982 the actual growth rate of the nominal debt is 20% (corresponding to an increase by \$155 billion in the nominal, privately held, interest-bearing debt), while the estimated value is 19%. This estimate breaks down into six percentage points owing to anticipated inflation ($\pi_t^e = 6\%$, although $\pi_t = 4\%$) and thirteen percentage points owing to the recession ($YVAR_t = .034$, based on the unemployment rate of 9.5%). Because nothing special is going on with the constructed measure of temporary federal spending, *GVAR*, it turns out that the constant and the contribution from the *GVAR* variable essentially cancel out.

Table 6.5   **Values of Explanatory Variables**

Year	GVAR	YVAR	$g*/\bar{b}$
1917	1.203	− .004	1.12
1918	1.067	− .036	.89
1919	.284	− .014	.37
1920	− .072	.001	.31
1921	.015	.012	.16
1922	− .067	.004	.20
1923	− .071	− .006	.24
1924	− .070	.000	.22
1925	− .083	− .005	.25
1926	− .088	− .009	.28
1927	− .089	− .005	.29
1928	− .096	− .002	.32
1929	− .101	− .006	.34
1930	− .092	.014	.31
1931	− .069	.039	.31
1932	− .048	.036	.17
1933	− .045	.036	.17
1934	− .045	.035	.25
1935	− .037	.026	.22
1936	− .034	.017	.30
1937	− .035	.012	.24
1938	− .029	.019	.22
1939	− .029	.017	.23
1940	.008	.013	.24
1941	.147	.003	.35
1942	.476	− .008	.41
1943	.571	− .010	.27
1944	.494	− .008	.19
1945	.345	− .005	.14
1946	.039	− .002	.15
1947	− .016	− .003	.18
1948	− .022	− .004	.22
1949	− .034	.001	.25
1950	− .012	− .001	.23
1951	.044	− .007	.30
1952	.053	− .009	.36
1953	.029	− .010	.40
1954	.002	.000	.36
1955	− .033	− .005	.39
1956	− .036	− .006	.41
1957	− .038	− .006	.46
1958	− .041	.005	.47
1959	− .052	.000	.48
1960	− .054	.000	.49
1961	− .053	.006	.52
1962	− .053	− .001	.57
1963	− .058	.001	.57
1964	− .062	− .002	.59

Table 6.5   (continued)

Year	GVAR	YVAR	$g^*/\bar{b}$
1965	−.051	−.006	.62
1966	−.007	−.013	.70
1967	.041	−.013	.74
1968	.055	−.016	.78
1969	.038	−.017	.85
1970	−.018	−.005	.91
1971	−.055	.003	.94
1972	−.061	.000	.98
1973	−.087	−.007	1.06
1974	−.087	.000	1.16
1975	−.076	.032	1.10
1976	−.073	.021	.99
1977	−.067	.014	.95
1978	−.063	.005	.96
1979	−.060	.003	.97
1980	−.050	.016	.98
1981	−.049	.020	.94
1982	−.040	.034	.83

Note: $GVAR_t \equiv (g_t - g_t^*)/\bar{b}_t$, where $(g_t - g_t^*)$ is temporary real defense spending (based on Barro 1981b), and $\bar{b}_t \equiv \sqrt{B_t \cdot B_{t-1}}/P_t$, where B_t is the privately held public debt at the end of year t (table 6.4) and P_t is the GNP deflator for year t.
$YVAR_t \equiv (U_t - .054 \cdot g_t^*/\bar{b}_t$, where U_t is the unemployment rate in the total labor force (adjusted as suggested by Darby 1976 for 1933–43) and g_t^* is normal real federal spending, based on Sahasakul 1983.

I also use the estimated equation to forecast deficits for 1983 and 1984. The inflation equation implies the value $\pi_t^e = 4.8\%$ for 1983. (The actual value of the inflation rate for 1983 is about 3.5%.) The main element in the decline of inflationary expectations from 1982 to 1983 is the low actual rate of inflation, $\pi_t = 4.1\%$, for 1982. Using the actual unemployment rate of 9.5% for 1983, the resulting estimate for debt growth, $\hat{DB}_t$, for 1983 is 16.6%. Note that 4.8 percentage points of this total come from expected inflation, while 11.8 percentage points derive from the continuing effect of the recession. (The combined effect of the constant and the *GVAR* variable is near zero.) The projected value for debt growth implies that the level of debt would increase from $848 billion at the end of December 1982 to $1,001 billion at the end of December 1983. Thus the predicted nominal deficit—in the sense of the change in the privately held, interest-bearing public debt—for calendar 1983 is $153 billion. (To get closer to conventional measures of the deficit, one should add the increase in high-powered money, which is roughly $15 billion for calendar 1983.) The data I have at this writing (kindly supplied to me by Eric Hanushek) indicate that the actual value of privately held public debt at the end of December 1983 is about

$1,018 billion. This figure implies an actual growth rate of the debt, DB_t, of 18.3% for 1983, compared with my projected value of 16.6%. The gap of 0.017 between actual and estimated values is not out of line with the fitted equation, for which the standard error of estimate was $\hat{\sigma} = 0.023$. The actual deficit—in the sense of the change in the nominal, privately held debt for calendar 1983 is about $170 billion, compared with my forecast of $153 billion.

For 1984 the value of π_t^e turns out to be 6.6%. The main reason for the rise from 1983 (where $\pi_t^e = 4.8\%$) is the increase in the annual average rate of monetary growth from 6.3% in 1982 to 10.3% in 1983. Assuming an unemployment rate of 7.8% for 1984 (see, for example, Litterman 1984), the projected value of debt growth, $\hat{DB}_t$, for 1984 turns out to be 13.3%. This forecast breaks up into 6.6 percentage points from expected inflation and 6.7 percentage points from the cyclical variable, $YVAR_t$. The forecast implies that the level of debt would rise from about $1,018 billion at the end of 1983 to $1,163 billion at the end of 1984, or by $145 billion during calendar 1984. (Again, one should add about $15 billion for the creation of high-powered money to get closer to the standard concept of the nominal deficit.) This forecast seems to be roughly in line with other near-term projections of deficits. It also turns out that my forecasts for 1983–84 are basically similar if I use either the equation where the $YVAR$ variable is based on output relative to trend (table 6.3, set 19) or the one based on the prime-age male unemployment rate (table 6.2, set 11).

The main point is that the actual behavior of public debt through 1983—as well as popular forecasts for 1984—is reasonably well in line with the experience of debt issue since at least the end of World War I. The main things that are out of line with the previous structure are projections of longer-term deficits on the order of $300 billion, conditioned on relatively low values of the unemployment rate and expected inflation. Since there is nothing yet in the data to suggest this type of structural break, I view these forecasts of deficits as amounting to predictions that either taxes will be increased or spending will be decreased. Standard projections of deficits should not be regarded as forecasts, once the endogeneity of taxes and spending is taken into account.

For recent years, where the effects of the constant term and the $GVAR$ variable turn out to cancel, the forecasts of debt growth—and hence deficits—emerge from a remarkably simple equation. Namely,

$$\hat{DB}_t = \pi_t^e + 3.9 \cdot YVAR_t = \pi_t^e + 3.9 \cdot (U_t - .054) \cdot g_t^*/\bar{b}_t.$$

The values for $g_t^*/\bar{b}_t$ until 1982 appear in table 6.5, while the values for

1983 and 1984 are 0.75 and (roughly) 0.71, respectively. Using the value 0.71 in the expression above, the forecasting equation becomes

$$(16) \qquad \hat{DB}_t = -.15 + \pi_f^e + 2.8 \cdot U_t.$$

Equation (16) provides a close approximation to the previously mentioned forecasts of debt growth for 1983–84. The equation would also apply satisfactorily to projections further out, subject to the absence of major changes in the ratio of normal federal spending to the debt, g_t^*/b_t. (Recall that this ratio rose by a factor of five from 1933 to 1982.)[17] Notably, equation (16) implies that the planned growth rate of the real debt, $\hat{DB}_t - \pi_f^e$, would approach zero if the unemployment rate were to decline to about 5.5%. It implies further that the projected growth rate of the nominal debt, DB_t—which determines the conventional nominal deficit (aside from changes in high-powered money)—would approach zero if, in addition, the expected rate of inflation were to approach zero. The point is that there is nothing in the experience of actual deficits through 1983 that conflicts in any major way with these propositions.

Comment   Martin J. Bailey

I will concentrate my remarks mainly on the descriptive aspects of the paper, after a few words on the theory. Barro's first maintained hypothesis posits a long-range rational plan that produces tax smoothing. Contrary to initial appearances, his second is that nonwar government expenditures represent a random walk, exogenous to the government decision process. I am surprised that Barro takes these hypotheses seriously, either on their a priori merits or after seeing the results his data provide. On the merits, I see no basis for believing that it is even a fair approximation to say that Congress operates on a long-range rational plan, no basis for thinking that the congressional appropriations process is a mindless random walk, and especially no basis for claiming both simultaneously. Besides John Shoven's point on the history of

17. If one plugs in the 1933 unemployment rate of 27% into equation (16), then (with $\pi_f^e = 6\%$) the projected growth rate of debt is a remarkable 67%. The actual growth rate of debt for 1933 was only 16%, which I attribute primarily to the smaller size of the federal government, as measured by the ratio g_t^*/b_t. My assessment is that if the United States encounters a much more serious recession than that in 1982, then (with no change in structure) we will observe numbers for deficits that dwarf those experienced recently. The main element that generates high real deficits is the interaction between recession (high unemployment) and big government.

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marginal tax rates, we have direct evidence on tax smoothing through long-range planning in the history of the social security program. On this, as Barro delicately put it, "I have not yet isolated empirically this type of effect . . . for social security." Indeed not. Tax smoothing for social security purely and simply means full actuarial funding of the expected program of benefits. Further, the data for World War II fit neither the regressions based on other years nor the maintained hypothesis. So much for the theoretical framework.

The empirical results viewed as pure description, however, merit attention. The equations for expected inflation are reasonable versions of the Feige/Pierce concept of economically rational expectations: they use a small, reasonably efficient set of lagged variables. Their change in coefficients after the period break at the end of 1953 roughly confirm Gordon's (1980) findings on Phillips curves and the Sargent (1973) argument on the dependence of the appropriate lag structure on the policy regime. However, the best time for a period break was about 1970. Before that, inflation decayed rapidly or reversed itself; afterward, it persisted.

The deficit regressions provide a provocative characterization of the way our political system has on the average worked out. The main findings are the following, as I interpret them.

1. The portion of nominal federal interest costs that compensate for expected inflation is either partly, wholly, or more than wholly financed by new debt, depending on which regression you prefer. The regressions I prefer include an interest rate variable; they show the compensation for inflation to be about two-thirds financed by nominal bond issues and one-third financed by tax and seigniorage (money printing) revenues.

2. The budgeted costs of small wars were about two-thirds financed by taxes and seigniorage, and the remaining third by net new bond issues. The difference between this allocation and the preceding one for expected inflation does not appear to be statistically significant.

3. Debt issues increase in recessions as revenues net of transfers fall more than proportionately to income and decrease in recovery and boom periods. That's reassuring; any regression with such an implication can't be all bad.

4. The question whether recent deficits are out of line with past experience is not answered conclusively. In the regressions that contain an interest-rate variable, the question was not tested (as it could have been by including a dummy for the pertinent period, say that after 1971). However, there are indications of a shift, contrary to Barro's claim. Equation (6), which breaks the periods at the end of 1953, has a higher constant term for the post-1953 period than that for the pre-1954 period; the difference exceeds its standard error but is short of

significance. The poorer fitting but parallel equation (24), which uses output instead of employment as the output variable, has a coefficient for expected inflation significantly greater than one. Inasmuch as both inflation and real deficits had uptrends, this otherwise surprising coefficient probably is a proxy for an uptrend of deficits since 1953. The question is still open.

5. In the regressions that included World War II, the coefficient for wartime expenditures, no doubt driven by the extreme points given by that war, shows the war to have been financed three-fourths by debt held by the private sector. Even apart from the poor fit of these regressions, the World War II experience cannot possibly help the tax-smoothing hypothesis, because the government allowed the allocation of financing between debt financing and money printing to be decided by the private sector. Acceding to the Treasury preference of the day, the Federal Reserve System stood ready to buy all treasury bonds offered at prices low enough to yield 2.5% nominal interest; it pegged the treasury bill yield even lower. (It is amazing to me that households and firms were willing to hold such huge amounts of government debt on such unattractive terms.)

In summary, if we dismiss Barro's maintained hypotheses, we can nevertheless read his results with some instruction and profit. I think we could learn even more from a study that tried alternative, more plausible specifications and that tested the popular hypothesis of increasing budget indiscipline more directly. I would want the test to be imbedded in a regression that allows the data to determine how nonwar spending changes are financed. Besides that one, other systematic tendencies of fiscal behavior are worth investigating and describing. For most issues, I would want to see a different breakdown of periods. For all that, Barro's work is a useful, and in some ways original and surprising, contribution.

Comment   John B. Shoven

This is an interesting and thought-provoking paper, along the same lines as Barro's 1979 *Journal of Political Economy* article. Frankly, though, it is not clear at all that it is successful. It presents Barro's earlier tax-smoothing model of deficits. The argument is that under certain restrictive assumptions regarding separability of utility between goods and leisure and the like, it can be shown that a constant marginal tax rate on commodities is Pareto optimal. Under these conditions, the

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tax rate should be constant both across commodities and through time. The time constancy prevents people from inefficiently allocating market activity toward those periods with temporarily low tax rates. The conclusion of this model is that tax rates should not follow the uneven pattern of government expenditures, and that deficits are the vehicle that allows the government to separate the timing of expenditures and taxes.

Taken literally, the theory provides strong predictions about the size of the government deficit as a function of the deviations of aggregate output and government expenditure from their "normal" path. The theory, of course, is not very plausible. How is it that policymakers in Washington figured out the Ramsey optimal tax rule fifty years before public finance economists? Does anyone really believe that the projected 1984–88 deficits are what they are owing to tax smoothing?

The theory, though, is clear in its predictions. However, the empirical results of the paper do not lend support to the theory. The paper finds that the deficit generating process has been more or less stable, but that it has not followed a pattern consistent with tax-smoothing principles. First, Barro ran twenty-four sets of aggregate time series regressions in tables 6.1 through 6.3, and in none of them did the temporary government spending variable have a coefficient approximating unity, which the theory predicts. In fact, the results of table 6.3, which use output relative to trend for the economic activity variable, show the coefficient of temporary government spending as being not significantly different from zero. Second, and more disturbing, in almost all of his regressions Barro has had to throw out the World War II years. This is particularly destructive to the theory, since these years provide, in some sense, "the real test" of the theory, especially when one notices that battle casualties are the primary proxy for temporary government expenditures. When Barro does include the World War II years, the fit of his regressions seriously deteriorates and produces very large residuals for the World War II years.

Another approach to investigating the tax-smoothing theory would be to look at the tax rates themselves. The broadest measure of average tax rates is the ratio of total federal tax collections to GNP. This ratio has been relatively stable, at least in the post–World War II period. However, constant average tax rates do not imply fixed average marginal tax rates. Barro and Sahasakul (1983) have calculated average marginal tax rates for the federal personal income tax. The rates they find certainly are not constant. I have not done any statistical analysis of the series, and it is hard to recognize a random walker when you see one, but this series certainly looks as though it is headed toward higher average marginal tax rates. Even if the average marginal tax rate were constant, we know the composition of tax rates has changed. For

instance, the highest rate has fallen from roughly 90% to 50%. Further, we know that the marginal income tax rate changes in predictable ways for individuals facing a typical age/earnings or experience/earnings profile. Certainly medical students do not believe their marginal tax rates are going to follow a random walk; they know that their tax rate is going to rise, and they can and will retime economic activity on this account. The point is that the optimal tax literature Barro invokes calls not for constant average marginal tax rates, but rather for a flat marginal tax rate.

What have we learned after Barro's analysis? Well, not much that we did not know before. First, average tax rates tend to rise in wars; on the other hand, wars are partially financed with debt. Some would argue that this spreads the burden of the war onto future generations, but that is not an argument I want to get into here. Second, deficits are countercyclical—even more so than a constant average tax rate suggests. This either means that we have a progressive tax system (which we clearly do, since the elasticity of tax receipts to nominal income is about 1.5) or that an active countercyclical tax policy was pursued—probably a little of both. The final conclusion of the paper that I will mention, and perhaps the one I find most interesting, is that the current deficits, even those projected for 1984, are not far off the usual pattern. The assertion is that if ''normal'' unemployment is taken as 5.4% (which is lower than the consensus today for NAIRU [non-accelerating rate of unemployment]) and if 1984 unemployment comes in at 7.8% (which is higher than the consensus), and if inflation is 6.6% (again, higher than the consensus), then Barro's operation predicts a $145 billion deficit for 1984, lower than other projections, but in the ballpark. It is clear that the historical deficit generating process can almost account for the current deficit, but it requires several assumptions, each shaded relative to consensus in a direction that will generate higher deficit forecasts.

Let me conclude by saying that I think Barro is conducting an interesting and important line of research despite the fact that the data did not come through in this paper in support of the posited theory. More work is required for us to gain a better picture of the deficit generating process.

Discussion Summary

Alan Auerbach pointed out that the Ramsey tax-smoothing model predicts that there should be no capital taxes but simply levies on labor

or consumption. The existence of capital taxes in the United States system, and the progressivity of income taxes, was, he felt, inconsistent with the thrust of the paper. Robert Hall noted that upward drift of tax rates was not at all inconsistent with the Ramsey model in a world with real growth—the optimal tax rate would rise. A problem that both he and Lawrence Summers saw with the paper was the "positive versus normative" issue; he suggested that World War II exemplified bad policy in that it was financed by increases in marginal tax rates, and this fact made him doubt the relevance of the analysis. Christopher Sims received some comfort from the accuracy of the predictions but felt that the use of future values of anticipated inflation could rationalize any deficit projection. Stanley Fischer also believed that the "unrealistic" inflation projections used for 1983 and 1984 adversely affected the interpretation of the results.

Both Fischer and Herschel Grossman felt that the temporary nature of wars was overdone, since many of the costs of wars are paid long after they have ended on the battlefield, and Grossman gave as an example the permanent change in the defense posture of the United States following Pearl Harbor. Summers also noted that wartime expenditures were mismeasured in conventional accounts, since they ignore the "draft tax" imposed on the economy.

Grossman suggested that the analysis should have been conducted for the consolidated federal and state and local government sectors, and he suspected that there was substantial crowding out of state and local spending by federal expenditures, especially in wartime. Summers suggested that modeling government expenditures as a random walk was misleading, since random walks not only rise but also fall—unlike government spending; he felt a model with irreversibility was necessary. He also noted that economists' advice was endogenous, hence when deficits rise, economists provide pressure for these deficits to be reduced.

Alan Blinder noted that a major reason the model was incapable of explaining the events of the World War II was that it generated excessively high inflation expectations. To test the substantive part of the model, he believed that an alternative expectational assumption such as perfect foresight should have been attempted. Second, he suggested that aggregating money and taxes was inadequate; he felt that money, taxes, and bonds deserved separate treatment. Robert Gordon suggested that an incorrect place had been selected for the regime breaks. He felt that a more natural break occurred in the 1960s when the decision was made to finance the Vietnam War with money, not bonds. Rudiger Dornbusch questioned making expenditures independent of tax rates, since he felt the two were interdependent. He also believed that including unanticipated tax collections in the empirical analysis

was inadvisable, since the model purported to account for the planning behavior of the government. Finally, he observed that the real interest rate used in the paper should be posttax, and that this might influence the results.

In response to the concerns about the appropriateness of the inflation predictions used, Robert Barro pointed out that the predictions were implicit in the estimated model, not picked from an outside source. He also noted that the ratio of government purchases to GNP did both rise and fall, so modeling it as a random walk was not obviously at variance with the facts. He also defended the aggregation of money and taxes by drawing attention to the similarity of the inflation taxes and other taxes.

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