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HOW LITTLE WE KNOW ABOUT BUDGET POLICY EFFECTS

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Do budget deficits matter for the economy in general, or real interest rates in particular? The answers provided by a multitude of empirical studies seem to divide somewhat evenly into the "yes" and "no" columns of the ledger. In this paper we provide an explanation for how investigators examining the same body of data can arrive at diametrically opposed conclusions. Our explanation is that these studies are flawed by an identification problem, arbitrary resolutions of which color the studies' results. We argue that satisfactory resolution of this problem requires a structural model approach.

With the large budget deficits recorded in the 1980s and the attention paid to them by politicians and the media, it is not surprising that many analysts have attempted to empirically determine their economic effects. But, what is somewhat surprising is the difference in the analysts' conclusions. On the side of the ledger that finds significant effects from budget deficits are studies such as those of Feldstein (1986), Miller (1983), Miller-Roberds (1988), Poterba-Summers (1987), and Thomas-Abderrezak (1988). On the other side of the ledger that finds no significant effects from budget deficits are studies such as those of Aschauer (1985), Dwyer (1982), Evans (1987a,1987b), Kormendi (1983), and Plosser (1982,1987).

While these studies represent just a small sample of the literature, they do represent the three main approaches investigators have taken to measure deficit effects. In the context of vector autoregressions, Miller and Miller-Roberds consider times when the budget policy rule apparently changed and examine economic relationships before and after the breaks. Aschauer assumes a representative agent economy and simultaneously tests the permanent income theory and Ricardian equivalence. All the other studies use nonstructural model approaches to attempt to directly measure the effects of budget policies.

What all these studies share is a failure to identify the effects of a change in policy rules. Miller and Miller-Roberds share this problem, because they have so few observations on potential breaks in policy rules. They then can't be confident that the changes in economic relationships they observe after the breaks are due to the changes in policy rather than to change in other factors.[1] For instance, the change in tax levels under Reagan's policies was accompanied by a change in tax structure, so which was responsible for the observed change in economic relationships?

The Aschauer study fails to identify the effects of policy changes, because it examines a period (1948-81) when the budget tended to be balanced over the business cycle. What the study examines, then, are the effects of policy actions under a given policy rule. In fact, policy stability is a maintained hypothesis of that study.

The other studies attempt to identify the effects of policy changes but are forced to use incredible assumptions to do so. Since their models otherwise would be under-identified, their test results hinge on these arbitrary assumptions. Some assumptions imply that deficits don't matter while others do.[2] So the test results are predetermined by what is being assumed.

This preliminary discussion of the econometrics of deficit policies touched on a number of issues and was notably imprecise. In the remainder of the text we attempt to clarify the issues and make the statistical arguments precise with the use of a simple pseudo-structural model. It is structural in the sense that it is intended to be behavioral; it is pseudo-structural in the sense that the relationships are not explicitly derived from individual optimizing behavior. Yet, we argue that theory suggests aggregate relationships with the arguments we posit. The model is useful in that it subsumes other models used in the literature and allows us to clearly state the identification problem.

Our pseudo-structural model is not estimable, however, because it includes expectations terms. We take a simple, annual version of the model, put it in estimable form, and then estimate it. Our estimated coefficients appear similar to what is found in other studies.

We show, however, that many values of the underlying parameters of the pseudo-structural model are consistent with the estimated coefficients. For one set of parameters, deficit policy matters, while for another, it doesn't. The identification problem suggests that structural methods, such as those of Hansen-Sargent (1980), are needed. Until they are used, we are forced to admit how little we know about the effects of budget policies.

A Pseudo-Structural Model of Budget Deficits

We posit our model based on both statistical and theoretical considerations. We discuss these considerations in turn.

A model of budget deficits needs to distinguish among at least three sources of deficit changes. Although budget deficits are often taken as short-hand for policy, they respond to shocks from a variety of sources. The change in an economic variable, such as a real interest rate, which accompanies a change in the observed deficit, moreover, can be expected to depend on the source of change in the deficit.

Budget deficits change when the state of the economy changes. The degree of sensitivity is suggested by the CBO's rules-of-thumb, which estimate how much the deficit would change when the level of output, prices, or interest rates change--all else held equal.[3] A recession for example, generally leads to a fall in real interest rates, which is due to a fall in demand, accompanied by a rise in budget deficits, which is due to a fall in income tax revenues.[4]

The CBO's rules-of-thumb suggest that the deficit is quite sensitive to changes in the real economy and interest rates but not to changes in inflation. For instance a one-percentage point decline in real growth beginning January 1988 and continuing indefinitely is estimated to increase the fiscal 1990 budget deficit by $41 billion. Similarly, a one-percentage point increase in interest rates beginning January 1988 is estimated to increase the fiscal 1990 budget deficit by $16 billion. However, a one-percentage point decline in inflation is expected to raise the 1990 budget deficit by only $1 billion. The deficit is more sensitive to interest rate changes now than it was in the past due to the stock of public debt roughly tripling since 1980. The deficit is much less sensitive to inflation changes now than it was in the past due to the indexing of income taxes and entitlements begun in 1982.

Budget deficits can also change due to policy actions under a given policy rule. For instance, over much of the postwar period, the budget tended to be balanced over the business cycle. Yet, within this policy regime the government tended to cut taxes and institute public works programs in recessions and raise taxes and phase out such programs in recoveries. One would expect the effect on the real interest rate of such short-term, predictable actions to be slight.

Finally, budget deficits can change when the budget policy rule changes. The rule of budget balance over the business cycle seemed to change to one of permanent deficits, for example, when the Reagan administration took office. According to some theories, policy rule changes of this type can be expected to result in higher real interest rates.

This distinction among deficit sources is important, because the theoretical issue about deficit effects concerns only changes in policy rules. The two dynamic theories used to analyze budget policy are the representative-agent, Ricardian model (a la Barro) and the overlapping-agent, nonRicardian model (a la Wallace). Since both theories are dynamic, policy in them must be considered as functions which determine the values of policy variables at any given time conditional on information then available. A rule such as this is a solution to the government's optimization problem, and it is what individuals need to know to solve their expected utility maximization problems.

The two theories can imply differences in effects of deficit policies on real variables, such as real interest rates. One basic difference concerns the neutrality of inflation. According to either theory, seignorage on money creation--the inflation tax--is a potential source of revenue to the government. Also, according to either theory, the budget must be balanced in a present value sense when seignorage is included. Given a path of spending, the government can choose alternative mixes of the inflation tax and explicit taxes. At issue is whether a change in this mix has real effects.

For Ricardian theories changing the mixture of inflation and explicit taxes, like changing the time distribution of a given distorting tax, is assumed to have essentially no real effects. As Barro (1988) states:

> "The Ricardian approach to budget deficits amounts to the statement that the government's fiscal impact is summarized by the present value of its expenditures. Given this present value, rearrangements of the timing of taxes--as implied by budget deficits--have no first-order effect on the economy" (p. 25).

For nonRicardian theories a change in the mix of inflation and explicit taxes is not neutral. As shown, for example, in Miller-Wallace (1985), such a change corresponds to a different path of government debt-to-output. In nonRicardian models a change in deficit financing policies that results in a higher debt-to-output ratio can be associated with a higher real interest rate.[5]

The issue about whether deficits matter then is which of these two theories is best supported by the data. More specifically, a question is whether, and, if so, by how much, real economic processes change when the deficit policy rule changes.

Based on the above considerations, we posit our pseudo-structural model. They suggest that the policy rule will take a form like:

$$(1) \qquad D_t = \alpha + \beta(L)D_{t-1} + \xi X_t + \delta(L)X_{t-1} + \theta_t,$$

$$E(\theta_t) = 0, \ \theta_t \perp I^*_{t-1},$$

where D_t is a measure of the budget deficit, X_t is a vector of variables which represent the state of the economy, β and δ are polynomials in the lag operator, with $\beta(L) = \beta_0 + \beta_1 L + \ldots$, and $\delta(L) = \delta_0 + \delta_1 L + \ldots$, and the information set $I^*_{t-1} \equiv X_t \cup I_{t-1}$, and $I_{t-1} \equiv \{D_{t-1}, X_{t-1}, D_{t-2}, X_{t-2}, \ldots\}$. Because, as we discussed earlier, the deficit is affected by the current state of the economy, we explicitly allow for this dependence with the argument X_t. This simple rule allows for the three sources of budget deficit changes: 1) a change in the state of the economy: X_t, X_{t-1}; 2) a policy action under a given rule: θ_t; and 3) a change in the policy rule: α, β, ξ, or δ.

Our discussion of theory suggests the economic process might take the form:

$$(2) \qquad X_t = \rho + \sigma(L)D_{t-1} + \tau(L^{-1})E_{t-1}D_t + \nu(L)X_{t-1} + \psi_t,$$

$$E_{t-1}(\psi_t) = E_{t-1}(\theta_t \psi_t) = 0$$

$$\psi_t \perp I_{t-1}$$

where

$$\tau(L^{-1})E_{t-1}D_t \equiv \tau_0 E_{t-1}D_t + \tau_1 E_{t-1}D_{t+1} + \cdots + \tau_n E_{t-1}D_{t+n} + \cdots$$

$$E_{t-1}D_{t+i} \equiv E(D_{t+i}|I_{t-1}).$$

In the economic process we include real variables, such as a real interest rate. We imagine the economic process aggregates individual decision rules, giving rise to the $E_{t-1}D_{t+i}$ terms from individuals' dynamic optimization problems. We also imagine the economic process incorporates market clearing conditions. Thus, based on Ricardian theories, the economic process for real variables would be invariant to any path of the deficit, which together with seignorage, satisfies present-value balance. That follows because such theories hold that markets will clear with the same real quantities and prices, but with changes in private saving offsetting any changes in deficits. Since the invariance must hold for any path of deficits and seignorage satisfying present-value balance, according to Ricardian theory, the τs associated with real variables X must be zero. NonRicardian theories, in contrast, do not imply invariance to changes in the path of the deficit and, thus, do not imply τ is zero. Based on some nonRicardian theories, for example, it follows that for the τ^is associated with the real interest rate X^i, $\sum_n \tau_n^i > 0$, since an addition of one unit to the deficit each period would raise the real interest rate.[6]

An Identification Problem

Our model is not directly estimable, because it includes the expectations terms $E_{t-1}D_{t+i}$. We can, however, estimate a plausible reduced form for (D_t, X_t), which is just the unrestricted VAR system[7]

$$(3) \qquad D_t = a + b(L)D_{t-1} + c(L)X_{t-1} + u_t$$

$$(4) \qquad X_t = d + e(L)D_{t-1} + f(L)X_{t-1} + v_t,$$

where u_t and v_t are white noise error terms.

In order to determine the effects of a change in deficit policy--a change in the coefficients of (1)--on the economic process in (2), we must be able to identify the coefficients in (1)-(2) from the estimated coefficients in (3)-(4). That would enable us to answer such questions as how does a permanent increase in the deficit ($\Delta\alpha > 0$) affect the real interest rate ($dX^i/d\alpha > 0$?).

It is clear, though, that the coefficients of (1)-(2) cannot in general be identified from the estimated coefficients of (3)-(4). For arbitrary values of τ, values can be found for the other coefficients of (2), so that the model (1)-(2) generates the model (3)-(4). This point can be shown simply in the special case where all lag polynomials and X are taken to be scalars.

Thus, suppose the underlying pseudo-structural model is given by:

$$(1.1) \qquad D_t = \alpha + \beta D_{t-1} + \xi X_t + \delta X_{t-1} + \theta_t$$

$$(2.1) \qquad X_t = \rho + \sigma D_{t-1} + \tau E_{t-1}D_t + \nu X_{t-1} + \psi_t,$$

with

$$E_t\theta_t = E_t\psi_t = E_t(\theta_t\psi_t) = 0.$$

Assuming $\xi\tau \neq 1$, the model (1.1)-(2.1) can be put in estimable form to yield:

$$(3.1) \qquad D_t = \left(\frac{\alpha+\xi\rho}{1-\xi\tau}\right) + \left(\frac{\beta+\xi\sigma}{1-\xi\tau}\right)D_{t-1} + \left(\frac{\delta+\xi\nu}{1-\xi\tau}\right)X_{t-1} + [\theta_t+\xi\psi_t]$$

$$(4.1) \qquad X_t = \left(\frac{\rho+\alpha\tau}{1-\xi\tau}\right) + \left(\frac{\sigma+\beta\tau}{1-\xi\tau}\right)D_{t-1} + \left(\frac{\nu+\delta\tau}{1-\xi\tau}\right)X_{t-1} + \psi_t.$$

Regressions provide the estimated coefficients and residuals to the equations

$$(\text{E}3.1) \qquad D_t = \hat{a} + \hat{b}D_{t-1} + \hat{c}X_{t-1} + \hat{u}_t$$

$$(\text{E}4.1) \qquad X_t = \hat{d} + \hat{e}D_{t-1} + \hat{f}X_{t-1} + \hat{v}_t.$$

Although the system (E3.1)-(E4.1) provides 7 restrictions, the underlying system (1.1)-(2.1) has 8 unknown coefficients, suggesting the system is not identified. Since (1.1) is already a regression equation, its coefficients can be identified from (E3.1)-(E4.1). Thus, the coefficients of the economic process (2.1) are the ones not identified.

The identification of the coefficients of (1.1) is given simply by:

$$\hat{\xi} = \textstyle\sum_t \hat{u}_t \hat{v}_t / [(\sum_t \hat{u}_t^2)(\sum_t \hat{v}_t^2)]^{\frac{1}{2}}$$

$$\hat{\alpha} = \hat{a} - \hat{\xi}\hat{d},$$

$$\hat{\beta} = \hat{b} - \hat{\xi}\hat{e}, \quad \text{and}$$

$$\hat{\delta} = \hat{c} - \hat{\xi}\hat{f}.$$

Given these values, (4.1) and (E4.1) provide three equations in the four unknown coefficients of the economic process, ρ, σ, τ, and ν:

$$\rho = \hat{d} - (\hat{\alpha}+\hat{\xi}\hat{d})\tau,$$

$$\sigma = \hat{e} - (\hat{\beta}+\hat{\xi}\hat{e})\tau,$$

$$\nu = \hat{f} - (\hat{\delta}+\hat{\xi}\hat{f})\tau.$$

For any arbitrary value of τ (as long as $\hat{\xi}\tau \neq 1$), these three equations can be solved for ρ, σ, and ν. (This same argument about underidentification goes through for any finite order lag lengths for the polynomials in (1)-(2).)

An Estimated Model

We estimate (E3.1) and (E4.1) using annual data over the period 1950-87. We take D to be the growth in outside federal debt less the growth in nominal GNP and we take X to be the annual average of quarterly ex-post real Treasury bill rates. Plots of the two series are shown in Figure 1 (p. 10).

Although our choice of deficit measure is motivated by our theoretical discussion, it is somewhat limited due to the constraints of a bivariate system. Our measure is not affected only by budget policy. It also changes due to forces which alter the economy's real interest rate or real growth rate; such as, changes in tastes, technological shocks, or, perhaps, changes in monetary policy. We can simply illustrate the relationship between budget policy and our measure using the derivation:

$$D_t = (\pi_t^e - \pi_t) + (X_t - g_t) + DEF_t/B_{t-1};$$

where D is our measure of budget policy, $D_t = B_t/B_{t-1} - Y_t/Y_{t-1}$, in which B is end-of-period outside government debt and Y is nominal GNP;

π^e is expected inflation;

π is actual inflation;

X is the one-period real interest rate;

g is the growth rate of real GNP, and

DEF is the government deficit net of interest.[8]

We chose D_t rather than DEF_t/B_{t-1} as our policy measure for two reasons:

1. Even though the latter is a purer measure of budget policy, nonRicardian theories such as Miller-Wallace (1985) suggest that the real interest rate is affected by changes in the mix of monetary and budget policies which lead to changes in the government debt-to-output ratio. Thus, changes in DEF_t/B_{t-1} would be expected to have no effect on the real interest rate if they were accommodated by monetary policy and resulted in no change to D_t.

2. The basic issue separating Ricardian and nonRicardian theories seems to be whether a change in the government debt-to-output ratio is perfectly offset by a change in the opposite direction in the private debt-to-output ratio. For Ricardian theories it is offset, so that the real interest rate should not be sensitive to our policy measure. For nonRicardian

theories it is not perfectly offset, so that the real interest rate could be sensitive to our measure.

The two equations (E3.1) and (E4.1) are estimated using ordinary least squares. Standard tests of lag lengths in VARs indicate that a one lag specification is appropriate for this system. Estimated coefficients and summary statistics are shown in Table 1.

Our estimated model seems to share some properties with other models that purport to show deficits do not matter. The coefficient on our deficit measure in the real interest rate equation is not significant at standard levels of confidence. The F-tests indicate that deficits do not help in predicting real interest rates. In fact, the real interest rate appears to be well approximated as a continuous time random walk process.

Despite appearances, this estimated model is consistent with deficits mattering as we have defined. The change in the real interest rate to a change in the intercept of the policy rule is given in (4.1) by $dX_t/d\alpha = \tau/(1-\hat{\xi}\tau)$. Our model's estimate of $\hat{\xi}$ is 1.05.

Since any value of τ is consistent with our estimated coefficients, we can ask for what values will $dX_t/d\alpha$ be significantly positive; say, $dX_t/d\alpha > 0.5$. We solve for τ from the inequality

$$\frac{dX_t}{d\alpha} = \frac{\tau}{1 - 1.05\tau} > 0.5 \iff 0.33 < \tau < 0.95.$$

For these values of τ, then, it follows that a persistent 1 percent increase in the growth of debt relative to GNP will raise the real interest rate by at least half a percentage point. For these values of τ one could find that past deficits do not help in predicting the real interest rate; yet, a change in the policy rule to higher permanent deficits would significantly raise the real interest rate. In fact, as τ gets close to 0.95, the effect of higher deficits on the real interest rate becomes arbitrarily large.

Approaches to Identification

Studies in the literature have taken three approaches to quantifying the effects of budget policy changes. In this section we describe these approaches in the context of our pseudo-structural model. This discussion suggests why previous studies have not been successful.

One approach is to directly estimate the effects of policy changes as in Miller and Miller-Roberds. They propose dates of policy rules changes, judge whether policy actually changed, and then examine the estimated economic process before and after the potential breaks to check for structural change. The logic is that if the policy rule changes and individuals incorporate the new rule in their expectations, estimated coefficients of a linear econometric process can change. More specifically, in a model such as (1)-(2), a change in α, β, ξ, or δ will lead to a change in the estimated coefficients of (4).

This approach is related to Marschak's method for identifying policy effects. If there were enough observations on policy changes, one could, as Marschak points out, simply estimate the relationship between the coefficients in (4) and the parameters of (1). In this perspective the shortcoming of the Miller and Miller-Roberds approach is too few observations to be sure that the effects of policy have been identified. This point is illustrated in the following example.[9]

Suppose there are observations on n policy changes at dates: $t_i = t_0 + i\Delta t$, $i = 0, \ldots, n - 1$, consisting of a change in α of $\Delta\alpha$: $\alpha_{t_i} = \alpha_0 + i\Delta\alpha$ $i = 0, \ldots, n - 1$. We could estimate (4) over each subperiod (t_i, t_{i+1}) and get n estimates of d, e, and f. The estimated change in the coefficients from one period to the next will in general be different, however, because the θ's and ψ's will be different in each subperiod. With enough observations the mean of the change in coefficients will go to the true change. With only one policy change, as in the Miller or Miller-Roberds studies, there is essentially only one observation to estimate the change in coefficients. There are too few observations then to determine whether the change in estimated coefficients is due to a change in α or to different draws of θ and ψ in each subperiod.

A second approach to identifying budget policy effects is to attempt to identify the coefficients of the pseudo-structural model using restrictions not derived from individual optimizing behavior. That is, if τ in (2) can be identified, the effects of a change in budget policy can be determined from (4), as in (4.1). Since τ cannot be identified from (3) and (4) without some restrictions, the values of τ found in the literature are as arbitrary as the restrictions which have been imposed. Arbitrary restrictions cannot solve this identification problem.

Most studies in the literature follow this second approach. They arbitrarily restrict coefficients in (2) to be zero. Dwyer, Evans (1987b), Kormendi, and Plosser (1982) estimate a version of (4) and test whether the coefficients $\hat{e}(L)$ are significant. As can be seen in (4.1), knowing $\hat{e} = 0$ by itself only implies that σ and τ are on a particular line. So these studies can be interpreted in one of two ways. Either they assume $\sigma = 0$ and take $\hat{e} = 0$ to imply $\tau = 0$ or they assume $\tau = 0$ and take $\hat{e} = 0$ to imply $\sigma = 0$. Either assumption is arbitrary.

Ideally, a test will allow discrimination between Ricardian and nonRicardian theories. For nonRicardian theories there is no reason to believe either σ or τ is zero. Restricting either one to be zero then biases the test result in this case to favor Ricardian theories. For our estimated model, for example, we found $\hat{e}$ to be insignificantly different from zero, but that finding was shown to be consistent with deficit policies mattering in a significant way.

Some studies using this second method have tried to estimate τ directly by using various measures of predicted deficits, the $E_{t-1}D_{t+i}$. If the measures are derived within the model, they are constructed with the aid of incredible identifying assumptions. If the measures are derived from without the model, they are inconsistent with the model's predictions.

Several studies attempt to construct a series for $E_{t-1}D_{t+i}$ using the predictions of their models. Evans assumes that deficits are an exogenous process and tests whether past or future deficits significantly affect interest rates. In terms of our model Evans constructs $E_{t-1}D_t$ by assuming $\xi = \delta = 0$. In the (1.1)-(2.1) version of the model this assumption leads to the estimation equations:

$$D_t = a + bD_{t-1} + u_t$$

$$X_t = d + eD_{t-1} + fX_{t-1} + g\,(\hat{a}+\hat{b}D_{t-1}) + v_t,$$

where $\hat{a}$ and $\hat{b}$ are ordinary least squares estimates of a and b.

Two criticisms can be made of Evans' approach. First, the assumption that deficits are exogenous (that $\xi=\delta=0$) is not reasonable. The CBO's rules of thumb suggest they are not exogenous. Our simple annual model implies values of $\hat{\xi} = 1.05$, and $\hat{\delta} = 0.37$. An F test of the null hypothesis H_0: $\xi = 0$, $\delta = 0$ was significant only at the 10.5 percent level. If we form a trivariate system by including also federal expenditures net-of-interest relative to GNP, exogeneity of deficits is easily rejected. Hence we regard the assumption of exogeneity to be unrealistic. Second, given the assumption that deficits are exogenous only sums of coefficients on D can be estimated, such as $e + \hat{b}g$. The coefficients e and g cannot be estimated separately, and knowing their weighted sum indicates nothing about their individual values.

Thomas-Abderrezak use their model to generate values for $E_{t-1}D_{t+i}$ under the assumption that $\sigma = 0$. The estimate of e together with estimates for f and ξ will then provide an estimate of τ (see 4.1):

$\hat{\tau} = \hat{e}/(\hat{\beta}+\hat{e}\hat{\xi})$. There is no reason to believe, however that $\sigma = 0$.

Plosser (1987) uses two estimated equations such as (E3.1)-(E4.1) to generate $E_{t-1}D_{t+i}$ and then tests whether the coefficient g is significant in the augmented equation (E4.1):

$$X_t = d + eD_{t-1} + fX_{t-1} + gE_{t-1}D_t + v_t.$$

But, as in Evans' case, the calculated series $E_{t-1}D_t$ is a linear function of D_{t-1} and X_{t-1}. So adding $E_{t-1}D_t$ to the equation cannot by construction improve the fit of the equation.

Yet others who use this second approach take $E_{t-1}D_{t+i}$ from outside the model [for example, Evans, (1987a) Feldstein, and Plosser (1987)]. Their measures for $E_{t-1}D_{t+i}$ implicitly incorporate a path for E_tX_{t+i} since predictions of deficits generally depend upon an assumed path for the economy. If the $E_{t-1}D_{t+i}$, $E_{t-1}X_{t+i}$ paths from outside the model match those generated by the model, than those paths are spanned by past D and X and individual coefficients on past and future Ds cannot be identified, as when these paths were generated from within the models. However, in general the paths generated from within the model will be different from those assumed without. This difference implies an inconsistency. Either the model is misspecified or the values assumed for $E_{t-1}D_{t+i}$ and $E_{t-1}X_{t+i}$ are not individuals' expectations.[10]

Finally, there are studies in the literature that attempt to identify policy effects using structural methods. The problem with these studies (e.g., Aschauer 1985) is that this approach assumes a single policy rule and uncovers information about the effects of policy actions, such as how the path of X responds to a shock of θ_t. This impulse response does not indicate how X responds to a change in α, β, ξ, or δ.

Conceivably, structural approaches can provide the answer to how the economic process changes when policy changes. Unfortunately, no one has yet succeeded with this approach. Within a dynamic utility-maximizing framework where individual decisions incorporate future policy, it is necessary to estimate the deep parameters of individual preference functions. Only then can it be determined how individual decisions change when budget policy changes.

Conclusion

Budget policies may matter, and then again they may not. Existing studies really don't tell us much about their effects.

The problem cannot be solved by further work using the existing approaches. We need to test models that are explicitly derived from utility-maximizing theories. These models must allow estimation of deep parameters in order to determine the response of individual decisions to a change in policy.

Footnotes

[1]Some economists, such as Chris Sims and Steve LeRoy, have the view that policy regimes never change; all that occurs are different drawings of policy from a given distribution which is known by the public. Their view, however, implies that the economy should be modeled as nonlinear. Given their view, the Miller and Miller-Roberds results can be interpreted as determining how far off linear models go when there is a different drawing of policy rather than as determining how much economic relationships change when there is a shift in policy regimes.

[2]Similar arguments were made more generally, or in other contexts, in Sargent (1976) and Sims (1980). We make the argument again since it seems to receive so little attention in the many articles published in the empirical deficit policy literature.

[3]See CBO (1988).

[4]The relationship of interest rates and deficits when the path of output changes could also depend on the source of change. A demand shock might suggest one relationship, while a supply shock may suggest another.

[5]In these nonRicardian models a higher government debt-to-output ratio is associated with a lower capital-to-output ratio. If the production technology is strictly convex, the latter implies a higher real interest rate (see, for example, Miller). There exist other nonRicardian models, however, in which policies are not neutral but the real interest rate in equilibrium is totally determined by technology or by individuals' constant rate of time preference. Because nonneutral policy changes need

not affect the real interest rate, a finding of no relationship between the real interest rate and budget deficit policies does not lead to rejection of nonRicardian theories. However, a finding of a relationship does lead to rejection of Ricardian theories. Our point in this paper, though, is not to argue whether that relationship is there or not; it is to argue that no one has determined what that relationship is.

[6] We can imagine models for which X is the real interest rate and $\tau_i = \tau / \prod_{j=1}^{i} (1+X_{t+j-1})$ with $X_0 = 0$. Even with a single expectations coefficient τ, the model is not identified as long as the degree of σ is arbitrary.

[7] Conditions under which the model (1)-(2) has a unique reduced form corresponding to (3)-(4) can be derived from Watson ( ). Since these conditions are algebraically complicated for the general case and not intuitively meaningful, we will assume that such conditions hold without explicitly stating them.

[8] We derive the relationship using simple algebra. We have by definition: $B_t = (1+r_t)B_{t-1} + DEF_t$, where B is debt, DEF is the net-of-interest deficit, and r is the nominal one-period interest rate. Relative to nominal income Y_t, we have:

$$\frac{B_t}{Y_t} = (1+r_t)\,\frac{B_{t-1}}{Y_{t-1}}\,\frac{Y_{t-1}}{Y_t} + \frac{DEF_t}{Y_t}, \quad \text{so that}$$

$$\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}} = (1+r_t)\,\frac{Y_{t-1}}{Y_t} - 1\,\frac{B_{t-1}}{Y_{t-1}} + \frac{DEF_t}{Y_t}.$$

Our measure D_t is given by:

$$D_t = \frac{B_t}{B_{t-1}} - \frac{Y_t}{Y_{t-1}}$$

$$= \frac{Y_t}{B_{t-1}}\left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}\right) = \left[(1+r_t)\left(\frac{Y_{t-1}}{Y_t}\right)-1\right]\left(\frac{Y_t}{Y_{t-1}}\right) + \frac{DEF_t}{B_{t-1}}.$$

Let

$$\frac{Y_t}{Y_{t-1}} = 1 + g_t + \pi_t,$$

where g is the real growth rate and π is the inflation rate, and let

$$r_t = X_t + \pi_t^e,$$

where X is the real interest rate and π^e is the expected inflation rate.

We then have:

$$D_t = (1+X_t+\pi_t^e) - (1+g_t+\pi_t) + \frac{DEF_t}{B_{t-1}}, \quad \text{or}$$

$$D_t = (\pi_t^e-\pi_t) + (X_t-g_t) + \frac{DEF_t}{B_{t-1}}.$$

[9]This example essentially describes the method used in Poterba-Summers. That study suffers, also, from too few observations.

[10]It could be, for instance, that $E_{t-1}D_{t+i}$ incorporates announced changes about policy, such as a change in α, β, ξ, or δ. However, E3.1 and E4.1 (augmented or not) assume no change in policy.

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Table 1

Estimated Coefficients

Equation	Dependent Variable	Adjusted R^2	Coefficient on	T-Statistic	Significance Level of $F(=T^2)$ - Statistic
(E3.1)	D	.48			
			1: $\hat{a} = -2.09$	-1.39	
			D_{-1}: $\hat{b} = 0.57$	3.99	0.0003
			X_{-1}: $\hat{c} = 1.15$	1.67	0.1053
(E4.1)	X	.61			
			1: $\hat{d} = 0.29$	1.10	
			D_{-1}: $\hat{e} = 0.02$	0.86	0.3932
			X_{-1}: $\hat{f} = 0.74$	6.00	0.0000*

*More precisely 8E - 7.