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Surplus–debt regressions

Eric M. Leeper [a,b], Bing Li [c,*]

[a] Department of Economics, Indiana University, Bloomington, IN 47405, USA
[b] National Bureau of Economic Research, Cambridge, MA 02138, USA
[c] Department of Economics, School of Economics and Management, Tsinghua University, Room 525, Weilun Building, Beijing, 100084, China

HIGHLIGHTS

- Surplus–debt regressions are potentially subject to simultaneity bias.
- Bias stems from ignoring general equilibrium relationship between debt and surplus.
- The nature of the bias depends on the underlying monetary–fiscal policy regime.
- Bias can be serious enough to produce misleading inferences about fiscal behavior.
- Good estimate of fiscal behavior calls for estimation in general equilibrium setup.

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ABSTRACT

Single-equation estimates of fiscal reaction functions, which relate primary surpluses to past debt–GDP ratios and control variables, are subject to potentially serious simultaneity bias that can produce misleading inferences about fiscal behavior. Biases arise from failure to model the general equilibrium relationships between government debt and surpluses, relationships that bring in the forward-looking nature of nominal debt valuation and the role of monetary policy in that valuation.

1. Introduction

Elevated government debt levels worldwide and recent sovereign debt troubles in the Euro Area have increased interest in estimates of fiscal rules to shed light on the sustainability of fiscal policies. Many studies follow Bohn (1998) to regress the primary surplus–GDP ratio, s_t, against the lagged debt–GDP ratio, b_{t-1}, and a set of controls, X_t

$$s_t = \gamma b_{t-1} + \mu_t \tag{1}$$

where $\mu_t \equiv \Gamma X_t + \varepsilon_t^S$ and ε_t^S is the fiscal policy shock. Bohn (1998, p. 949) interprets significantly positive estimates of γ as evidence that "the government is taking actions – reducing noninterest outlays or raising revenue – that counteract the changes in debt". Those fiscal actions, Bohn argues, imply that fiscal policy is sustainable.

Regressions like (1) play a key role in policy analyses. They underlie the IMF's calculations of "fiscal space" (Mendoza and Ostry, 2008; Ghosh et al., 2012; Mauro et al., 2015) and a large literature that aims to test for fiscal sustainability [see D'Erasmo et al. (2016) for an overview]. Those studies refine Bohn's criterion by requiring that γ exceed the real-interest rate–economic growth rate differential to ensure that the debt–GDP ratio stabilizes in the long run. Because estimates of γ lie at the heart of important policy decisions, it is essential to explore the conditions under which the regressions that (1) describes are likely to recover accurate estimates of this critical parameter.

This note does not dispute the theoretical claim that if fiscal policy obeys (1) with γ larger than the interest rate–growth rate differential, then fiscal policy is sustainable. Instead, we question whether single-equation regressions of equilibrium surpluses on debt can reliably recover *fiscal policy behavior*.

* Corresponding author.
E-mail addresses: eleeper@indiana.edu (E.M. Leeper), libing@sem.tsinghua.edu.cn (B. Li).

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For (1) to be a regression, b_{t-1} must be predetermined. That is, $E[\varepsilon_t^S | b_{t-1}] = 0$. The economic content of this orthogonality condition is that shocks at $t-1$ that affect b_{t-1} must not predict ε_t^S and that the real value of debt at $t-1$ (or the debt–GDP ratio) cannot depend on the expectation of ε_t^S. This note scrutinizes these requirements.

Scrutiny begins by recognizing that policy rule (1) is just one of many equations that determine equilibrium sequences of surpluses and real government debt.[1] Three features of any equilibrium can be important for estimates of γ:

(i) Asset-pricing relations that determine government bond yields.
(ii) Monetary policy behavior, which affects the aggregate price level and the relationship between inflation and nominal bond returns.
(iii) The debt valuation equation, a forward-looking equilibrium condition that equates the value of government debt to the expected discounted value of primary surpluses.

The third feature, which embeds the first and optimizing private behavior, implies that

$$b_{t-1} = E_{t-1} \sum_{T=t}^{\infty} q_{t-1,T} s_T \tag{2}$$

where $q_{t-1,T}$ is the stochastic discount factor between periods $t-1$ and T and E_{t-1} denotes the expectation conditional on date $t-1$ information. This expression implies that *in any equilibrium* real debt tends to be positively correlated with future surpluses. Viewed in conjunction with the policy rule, (2) raises the possibility that b_{t-1} is not a predetermined regressor in regression (1), as it will be correlated with the policy disturbance ε_t^S when that disturbance is serially correlated.[2]

The second feature, monetary policy, comes into play once one acknowledges that the vast majority of debt that governments issue is nominal, denominated in the country's home currency. Nominal debt is a claim to currency in the future. Governments make a *policy choice* about whether to pay the claim in goods (primary surpluses) or currency ("paper money"). Because $b_{t-1} \equiv B_{t-1}/P_{t-1}$, where B is nominal debt, if the price level at $t-1$ depends in any way on expected future surpluses, then an additional channel exists to stabilize real debt that can undermine the maintained predeterminedness assumption that underlies treating (1) as a regression.

This note uses a simple model to illustrate the nature of potential simultaneity biases in surplus–debt regressions. Bias depends on the joint monetary–fiscal regime that determines the equilibrium price level. Bias problems are negligible when the monetary–fiscal mix implies the price level is unrelated to budget surpluses, an implication of the Ricardian nature of this equilibrium. In regimes where the price level is a function of expected surpluses, the bias is ubiquitous and may be positive or negative, depending on monetary policy behavior and the persistence of the fiscal shock. When monetary policy follows an interest-rate rule that reacts weakly to inflation – which Clarida et al. (2000) document was true in the United States before 1980 and as it has in most countries since 2009 – the bias is positive and can be quite large: estimates of γ can be large and positive even when surpluses have evolved independently of debt.

[1] For the purposes of this note, we need not distinguish between levels and ratios of variables. We also need not examine the determinants of the control variables. For actual estimation, both of these are important

[2] Serial correlation is not necessary to generate bias. We use a simple tax rule for tractability. Leeper and Li (2016) examine more general rules, as well as alternative information structures for fiscal disturbances, and find bias even with *i.i.d.* fiscal shocks.

In sum, the model suggests that studies that rely on estimates of γ from regressions like (1) are valid only conditional on the maintained assumption that a particular monetary–fiscal regime prevails in which γ is positive. That maintained assumption cannot be scrutinized by single-equation analyses. Scrutiny comes only from empirical work that combines (1) with the features in (i)–(iii).

2. An illustrative model and solution

Consider a cashless version of Leeper (1991). The real interest rate is $1/\beta$, the representative agent's discount factor. Government purchases are zero, but the government issues nominal, one-period discount bonds, B_t, and levies lump-sum taxes, which equal primary surpluses, s_t. An infinitely-lived agent derives utility from consumption and optimally chooses consumption and bond holdings each period.

Baseline surplus–debt regressions are linear, so it is without loss of generality to examine a version of the model that is log-linearized around a deterministic steady state with zero net inflation and a surplus–debt ratio of $s/b = 1-\beta$. The linearized model is summarized by the four equations

$$\text{Fisher relation}: \quad R_t = E_t \pi_{t+1} \tag{3}$$

$$\text{Monetary policy}: \quad R_t = \alpha \pi_t + \varepsilon_t^R \tag{4}$$

$$\text{Fiscal policy}: \quad s_t = \gamma b_{t-1} + \varepsilon_t^S \tag{5}$$

$$\text{Government budget}: \quad b_{t-1} = \beta b_t - \beta R_t + \pi_t + (1-\beta) s_t \tag{6}$$

where R_t is the one-period nominal interest rate controlled by the central bank, so its inverse is the price of government bonds, $\pi_t \equiv P_t/P_{t-1}$ is the inflation rate, and ε_t^R and ε_t^S are exogenous, $AR(1)$ policy disturbances with AR coefficients $0 \le \rho_R, \rho_S < 1$ and innovations ξ_t^R and ξ_t^S, which are serially and mutually uncorrelated with bounded support and variances σ_R^2 and σ_S^2. Equation (3) is the model's asset-pricing relationship, Eq. (4) is a simplified Taylor-type rule, Eq. (5) is the fiscal rule, the model analog to the rule that (1) aims to estimate, and (6) is the government's flow budget constraint.

We focus on two regions of the policy parameter space that deliver unique bounded equilibria [see Leeper (1991)]:

$|\alpha| > 1, |\gamma| > 1$: active monetary/passive fiscal policies "Regime M"

$|\alpha| < 1, |\gamma| < 1$: passive monetary/active fiscal policies "Regime F"

2.1. Regime M

Equilibria in regime M are conventional monetarist/new Keynesian/Ricardian solutions. Active monetary policy makes inflation depend only on monetary policy parameters and shocks and passive fiscal policy makes debt converge gradually back to steady state following either kind of policy disturbance. The equilibrium is

$$\pi_t = -\frac{1}{\alpha - \rho_R} \varepsilon_t^R \tag{7}$$

$$b_{t-1} = (1 - \Gamma L)^{-1} \left[\left(\frac{\beta^{-1} - \rho_R}{\alpha - \rho_R} \right) \varepsilon_{t-1}^R - (\beta^{-1} - 1) \varepsilon_{t-1}^S \right] \tag{8}$$

$$s_t = \gamma b_{t-1} + \varepsilon_t^S \tag{9}$$

where $\Gamma \equiv \beta^{-1} - \gamma(\beta^{-1} - 1) < 1$ and L is the lag operator.