

## Ricardian equivalence for sub-national states

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### *Abstract*

The authors test Ricardian equivalence within an endogenous growth model for U.S. states, which have high rates of migration relative to most countries. Results are consistent with both Ricardian equivalence and endogenous growth, despite the relative ease of migration. Increases in productive government expenditures increase long-run real growth by the same amount, for example, whether financed by taxes or bonds. State rules limiting the use of bond financing may play a role in supporting Ricardian equivalence. The study provides the first explicit test of Ricardian equivalence for sub-national states in the context of an endogenous growth model.

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## 1. Introduction.

Ricardian equivalence implies that government bonds are not viewed by taxpayers as net wealth (Barro 1974), and correspondingly that the effects of government spending in a closed economy will be invariant to tax versus bond financing. Most tests of Ricardian equivalence have focused on the relative effects of taxation and debt financing on private consumption and/or real interest rates, with varying and inconsistent results.<sup>1</sup>

Recently, Bleaney *et al.* (2001) test Ricardian equivalence in a Barro (1990) style endogenous growth model for OECD countries over the period 1970-95, extending tests in an earlier Barro (1989) cross-country study. Based on a full specification of the government budget constraint, including distinctions between productive and nonproductive government expenditures (as well as distortionary and nondistortionary taxes), their results are consistent with the endogenous growth model, in that productive expenditures raise the *long-run* growth rate and distortionary taxes reduce it. Furthermore, consistent with Ricardian equivalence, a budget deficit arising solely from an equal decrease in taxes has no net effect on the long-run growth rate, all else the same. Equivalently, an increase in productive expenditures has the same impact on long-run growth regardless of whether the increase is funded by taxes or bonds.

OECD countries are open economies in terms of trade and capital flows, but migration rates are relatively low for most OECD countries. Does Ricardian equivalence hold for sub-national states, which typically have much higher rates of migration, and where current residents could escape future tax liabilities arising from current state debt by moving to another state? In this paper, we test Ricardian Equivalence in the context of an endogenous growth model for states within the United States, which have high rates of migration relative to most countries. As compared to previous tests, e.g., Bleaney *et al.*, the data we employ extend over both a longer period (1962-1997) and across more cross-sectional states (49 of the 50 U.S. states, Alaska excluded).

Overall, our results are strikingly consistent with both Ricardian equivalence and the endogenous growth model, despite the relative ease of cross-state migration. Increases in productive government expenditures increase long-run real growth by the same amount, whether financed by taxes or bonds. While others have explored sub-national growth in the U.S. at the state or metropolitan levels (c.f., Helms 1985, Mofidi and Stone 1990, and more recently Mark *et al.* 2000, Holcombe and Lacombe 2004, Razzolini and Shughart 1997, and others reviewed by Fisher 2004), no previous sub-national study has, to our knowledge, tested explicitly for Ricardian equivalence.

To provide a brief overview, in section 2 we summarize the theoretical context for Ricardian equivalence in endogenous growth models. In section 3 we describe our data and empirical methodology and in section 4 present our empirical results. In a final section we discuss the implications and possible extensions of our findings.

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<sup>1</sup>A few examples, among many, include Cardia 1997, Engen and Hubbard 2004, Evans 1988, Feldstein and Elmendorf 1990, Himarios 1995, Kormendi 1983, Kormendi and Meguire 1990, Monadjemi 1996.

## 2. Theoretical Background

Unlike the neoclassical growth model, where fiscal effects on savings or investment alter the *level* of the long-run output path, the endogenous growth model permits fiscal effects to alter the *slope* of the long-run output path, as illustrated for example in Barro (1990). Here we adapt the presentation of Bleaney *et al.* (2001) of the Barro and Sala-i-Martin (1992, 1995) model of endogenous growth. There are  $n$  producers, each producing output ( $y$ ) according to the production function:

$$y = Ak^{(1-a)}g^a \quad (1)$$

where  $k$  is private capital,  $g$  is a publicly provided input, and  $a$  is a parameter between 0 and 1.<sup>2</sup> The government funds its budget in each period with a proportional tax on output at the rate  $r$  or an equivalent amount of borrowing ( $-b$ ), where  $b$  is the budget surplus. For current purposes, we approximate all state and local taxes as a proportional tax.<sup>3</sup> The government budget constraint is therefore:

$$ng + C + b = rny \quad (2)$$

where  $C$  is government-provided consumption (or “non-productive”) goods.

Barro and Sala-i-Martin show that with an isoelastic utility function the long-run growth rate in this model ( $V$ ) can be expressed as:

$$V = w(1-r)(1-a)A^{1/(1-a)}(g/y)^{a/(1-a)} - u \quad (3)$$

where  $w$  and  $u$  are constants reflecting parameters in the utility function.

Equations (2) and (3) together are typically used to motivate a static or dynamic linear regression equation, in which long-run growth rate is hypothesized to increase by the same amount in response to an increase in  $g$ , productive government expenditures, regardless of whether financed by an increase in taxes or an increase in debt – provided that Ricardian equivalence holds. Such equations often include additional variables to control for other conditioning effects.

In practice, one avoids perfect multicollinearity in such a regression by omitting at least one element of equation (2), the linear government budget constraint, from the estimating equation (c.f., Helms 1985 and Mofidi and Stone 1990). In this case, coefficients on the remaining elements are interpreted as the net effect of simultaneous

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<sup>2</sup> Evans and Karras (1994), among others, provide mixed evidence of the significance of  $g$  in private production based upon data for U.S. states.

<sup>3</sup> Bleaney *et al.* distinguish between distortionary and nondistortionary taxes, whereas here, for simplicity, we treat all state and local taxes as distortionary. Kneller *et al.* (1999) find that results tend not to be sensitive to distinctions in the definitions of distortionary versus nondistortionary taxes.

unit changes in the relevant variable and in the omitted variable (or a combination of omitted variables, if more than one is omitted), as implied by equation (2).

To illustrate, assume that only productive government expenditures ( $g$ ) are omitted, consistent with the theoretical specification in Barro (1990), as in the static, linear equation below:

$$V = \omega_0 + \omega_1 r + \omega_2 (b/ny) + \omega_3 (C/ny) + \omega_4 z + e \quad (4)$$

The  $\omega$ 's represent fixed coefficients,  $z$  represents an auxiliary control variable (or set of variables), and  $e$  represents a stochastic term. The state fiscal variables are all scaled to output to permit direct comparisons of the coefficients.

All else the same, the coefficient on taxes ( $r$ ) should be positive, since an increase in taxes is implicitly spent on productive government expenditures.<sup>4</sup> The coefficient on the budget surplus relative to output ( $b/ny$ ) should be negative, since an increase in the budget surplus is implicitly taken from productive government expenditures.<sup>5</sup> Under Ricardian equivalence, the two coefficients should also be equal in magnitude and opposite in sign. The coefficient on nonproductive expenditures relative to output ( $C/ny$ ) should be negative, all else the same, as it reflects the effect of a unit shift of expenditures from productive to nonproductive government expenditures.

### 3. Data and Empirical Methodology

Our measure of  $V$ , the dependent variable, is GROWTH, the (log) growth in state personal income per capita. The key fiscal variables are TAXES, the ratio of all state and local taxes and related revenues to state personal income, SURPLUS, the ratio of the state budget surplus to state personal income, H&W, the ratio of health, welfare, and other transfer payment expenditures in the state to state personal income, and PROD, the corresponding ratio of productive government expenditures to state personal income. PROD includes expenditures on highways, education, and other related expenditures.

In addition, we employ a number of state-level time-varying controls in various specifications, including the ratio of unemployment expenditures to state personal income, the unemployment rate, the proportion of the population age 18 to 64, and the proportion of union members in the labor force. We find, as in Bleaney *et al*, that two-way fixed effects for both country (in our case, state) and period are important, so all specifications include two-way fixed effects.

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<sup>4</sup> A linear specification is commonly used, even though the theoretical effects are nonlinear. In theory, taxes spent on productive goods could rise to the point of decreasing growth. Even so, Ricardian equivalence should still hold at the margin for tax versus bond financing.

<sup>5</sup> Bleaney *et al* typically exclude nonproductive not productive expenditures, so the expected coefficient on taxes in their specifications is negative, rather than positive. The two specifications are fully equivalent and can be mapped one to the other.

Our data for state fiscal variables, including unemployment insurance expenditures, are from the Census of Governments at five year intervals from 1962 through 1997. Related economic, demographic and other data for corresponding years are obtained from the Current Population Reports for age composition of state population, from the Bureau of Labor Statistics for the state unemployment rate, from Hirsch *et al.* (2001) for the proportion of nonagricultural wage and salary employees in the state who are union members, and the Department of Commerce for real state personal income per capita.<sup>6</sup> We exclude Alaska, since the variance in its state fiscal variables is extreme relative to the other 49 states, due in part to the Alaska pipeline.

Thus, we have data on the relevant variables for 49 states at five-year intervals from 1962 to 1997, a total of 343 cross-section, time-series observations. Annual data are available consistently at the state level only beginning in the 1970s, so we focus on the longer sample period, based on five-year intervals, to better identify long-run effects.

Table I presents summary statistics for our key dependent and explanatory variables: GROWTH, TAXES, SURPLUS, H&W, and PROD. The latter two are our measures of nonproductive and productive government expenditures, respectively. Note that PROD necessarily equals the difference between TAXES, on the one hand, and SURPLUS and H&W, on the other. The average value for GROWTH for the *five-year* data interval is approximately 13%, roughly 2.5% per annum. The average ratio for TAXES is about 17.4%, which consists of 0.3% for SURPLUS, 3.3% for H&W, and 13.8% for PROD.

We take the following approach in specifying the dynamics for the growth equation. First, we assume *a priori* that the current five-year growth rate is unaffected by contemporaneous fiscal variables, but is a function of the fiscal variables from the previous five-year period. Thus, for example, real personal income growth per capita between 1962 and 1967 may be influenced by the values of TAXES, SURPLUS, and H&W in 1962, but is unaffected by the values of these variables in 1967. Mofidi and Stone (1990) successfully employ this recursive approach for five-year data for states. Bleaney *et al.* (2001) find evidence of slightly longer adjustment for OECD countries, about eight years, so we test for the significance of effects of additional lags of the fiscal variables.

In addition, we explore the sensitivity of our results to the explicit inclusion of a lagged dependent variable and instrumental variable methods. Dynamic fixed-effects models can generate biased and/or inefficient parameter estimates arising from the (explicit or implicit) presence of the lagged dependent variable. In our case, the number of periods is well below the number of states included, so the Arellano-Bond style generalized method of moment (GMM) estimates are appropriate. The GMM estimator uses all possible (first-differenced or orthogonalized) lagged values of the dependent variable and levels of the exogenous regressors as instruments.

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<sup>6</sup> Use of personal income, rather than gross state product, enables us to extend our sample period as far back as 1962, when state fiscal variables are also available.

#### 4. Regression & GMM Results

Table II presents various regression and GMM instrumental variable estimates for our equation for GROWTH, which again is the log-change in real state personal income per capita (times 100). For all estimates, the fiscal variable in the government budget constraint omitted from the estimated equation is PROD, the ratio of state and local expenditures on highways, education, and other related items to real personal income per capita (times 100). Hence, our model predicts a positive coefficient on TAXES, a negative coefficient on SURPLUS, and a negative coefficient on H&W – since these reflect the net effect of simultaneous unit changes in the relevant regressor and the omitted variable PROD, productive government expenditures. Ricardian equivalence requires that the effects of a given increase in taxes or the same decrease in budget surplus be equal, i.e., that the coefficients on TAXES and SURPLUS be equal and opposite in sign. As an aside, Bleaney *et al* typically omit nonproductive government expenditures, and hence expect a negative coefficient on taxes – and with Ricardian equivalence an equivalently positive coefficient on the budget surplus – but these are exactly equivalent specifications and can be mapped directly one to the other.

Column (1) of Table II presents a baseline specification with lagged TAXES, SURPLUS, and H & W as regressors and two-way fixed effects for period and state. It includes no auxiliary controls for other conditioning variables. Robust (panel corrected) standard errors are in parentheses, correcting for heteroskedasticity, autocorrelation, and contemporaneous correlations. As predicted by the endogenous growth model, the coefficient on TAXES(-1) (0.881) is significantly positive at the five percent level, and the coefficient on SURPLUS(-1) (-1.380) is significantly negative. While the coefficient on H&W(-1) is negative, it is not significantly so. Despite the absolute difference between the coefficients on TAXES(-1) and SURPLUS(-1), a test of the null hypothesis that Ricardian equivalence holds (i.e., that the coefficients are equal and opposite in sign) is not rejected at the five percent level ( $p=0.266$ ). Overall, the fit of the equation (R-squared of 0.440) is relatively good for a growth equation with no lagged dependent variable.

In column (2) of Table II, we add lagged auxiliary controls at the state level for potentially confounding variables, especially short-term cyclical influences. The additional variables added are lagged values for the ratio of unemployment expenditures to real state personal income per capita, the unemployment rate, the percentage of the working age (18-64) population, and the percentage of union membership in the labor force. (Coefficients for these controls are omitted in the table for brevity.) These coefficients enter significantly at the five percent level, but have little effect on the coefficients of the state fiscal variables – though the absolute difference between the coefficients on TAXES(-1) (0.867) and SURPLUS(-1) (-1.138) narrows by about half. The null hypothesis that Ricardian equivalence holds is, again, not rejected ( $p=0.555$ ).

In column (3) of Table II, we add contemporaneous as well as lagged values of the auxiliary control variables, which may err on the side of over-controlling for contemporaneous factors. The contemporaneous variables do enter significantly at the

five percent level, and also further narrow the absolute difference between TAXES(-1) (0.958) and SURPLUS(-1) (-1.081). As before, the null hypothesis that Ricardian equivalence holds is not rejected ( $p=0.635$ ). Notably, the coefficient on H&W(-1) (-1.377) in column (3) of Table II is much larger in absolute value and now significant at the five percent level, which suggests that the long-term effects implied by the endogenous growth model may be obscured by shorter term effects related to cyclical unemployment.

In column (4) of Table II, we add the lagged value of the dependent variable (i.e., GROWTH(-1)) and present estimates based upon the Arellano-Bond GMM instrumental variables estimator.<sup>7</sup> This estimator uses all possible (orthogonal) lagged values of the dependent variable and levels of the other regressors as instruments, so it is appropriate only when the number of periods is small relative to the number of cross-sectional units. While the coefficient on the lagged dependent variable is significantly negative, as expected, it is relatively small (-0.184), and Ricardian equivalence is again not rejected ( $p=0.261$ ). Near the bottom of the table, the J-statistic (35.885) for the validity of the overidentifying restrictions fails to reject their validity at the five percent level ( $p=.248$ ).

In other results (not presented), we explore two robustness tests of our results. First, we add second-period lags of the fiscal variables to specifications in columns (1) through (3), which do not enter significantly at the five percent level. Hence, the dynamics do not appear to extend significantly out to 10 years. Next, we explore the sensitivity of the results in all four columns to the definitional relationship between the lagged personal income variable implicit in GROWTH and in the denominator of the lagged fiscal variables. To do this, we omit the first period lag and add instead the second-period period lags of the fiscal variables. These now enter significantly, in the absence of the first-period lags, and their coefficients are only marginally smaller in absolute value than those for the first period lags. Hence, spurious definitional correlations between the measures of GROWTH and the lagged fiscal variables appear modest.

## 5. Concluding Discussion

Despite the greater degree of migration across U.S. states, we fail to reject Ricardian equivalence in any of our specifications. Given that taxpayers could capture current benefits of state spending via bond financing and then potentially escape future tax liabilities by moving to another state, this result might be unexpected. However, states have varying degrees of restrictions on the extent to which bond financing can be used to finance current expenditures (c.f., Poterba and Rueben 2001). While there are mechanisms in some states to get around these rules in some cases (e.g., some states borrow against future income streams, as in the case of recent tobacco liability settlements), state taxpayers are generally constrained in capturing current benefits of state spending via bond financing, so these variations are relatively small.

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<sup>7</sup> GMM estimates are obtained using E-Views 5.1, with fixed period effects, an orthogonal transformation for cross-section effects, and robust Period SUR standard errors.

For the kinds of expenditures for which bond financing is typically allowed, e.g., public infrastructure investments like highways, roads, airports, and even to some extent education, the stream of benefits from the investments is spread over future periods, along with the financial obligations of the corresponding bond repayments. In this case, incentives to move to avoid future tax obligations of current bond financing are diminished, since both benefits and obligations are spread over future periods.

As a result, we may fail to reject Ricardian equivalence because state fiscal rules tend to permit bond financing primarily for public infrastructure investments, whose benefits are spread over the future along with the tax obligations of the corresponding bonds. One extension of this research would be to explore the extent to which Ricardian equivalence holds in each state is related to the strictness of the state's fiscal rules, since these vary both by state and across time.



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Table I Summary statistics (U.S. states, 1962-1997)

Variable	Definition	Mean	Std. dev.	Minimum	Maximum
GROWTH	log change in real state personal income per capita (times 100)	13.036	6.126	-8.554	29.081
TAXES	ratio of state & local taxes to state personal income per capita (times 100)	17.422	2.987	10.792	36.110
SURPLUS	ratio of state & local Budget surplus to state personal income per capita (times 100)	0.311	1.020	-2.419	8.617
H&W	ratio of state & local expenditures on health, welfare, and other transfers (times 100)	3.278	1.028	1.365	6.850
PROD	ratio of state & local expenditures on high-ways, education, and other related areas (times 100)	13.834	2.351	9.104	26.346

Notes: Data are for 49 of the 50 states in the U.S. (Alaska is excluded) from 1962 to 1997 in five-year intervals. See text for sources and further details.

Table II Regression and GMM Estimates (robust standard errors)

Variable	(1)	(2)	(3)	(4-GMM)
Constant	-0.830 (3.868)	26.919 (22.435)	-2.957 (16.179)	
TAXES(-1)	0.881** (0.297)	0.867** (0.339)	0.958** (0.238)	0.560** (0.261)
SURPLUS(-1)	-1.380** (0.455)	-1.138** (0.473)	-1.081** (0.333)	-0.846** (0.846)
H&W(-1)	-0.396 (0.741)	-0.553 (0.767)	-1.377** (0.553)	-0.612 (0.589)
GROWTH(-1)				-0.184** (0.052)
Fixed period effects	yes	yes	yes	yes
Fixed state effects	yes	yes	yes	yes
Lagged controls	no	yes	yes	yes
Current controls	no	no	yes	yes
p-value for null hypothesis of Ricardian equivalence	0.266	0.555	0.635	0.261
R-squared	0.440	0.465	0.755	0.716
J-statistic				35.885
nobs	294	294	294	245

Notes: Data are for 49 of the 50 states in the U.S. (Alaska is excluded) from 1962 to 1997 in five-year intervals. See text for sources and further details. Robust (panel-corrected, period SUR) standard errors are in parentheses, which correct for heteroskedasticity, autocorrelation, and contemporaneous correlation. The J-statistic is a test of the validity of the over-identifying restrictions in the GMM instrumental variables estimates in column (4).