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THE RICARDIAN EQUIVALENCE HYPOTHESIS
Some Canadian Evidence

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This paper analyzes the effects of government debt and provides a test of the Ricardian equivalence hypothesis for the Canadian economy. The empirical evidence for the period 1964.II–1984.IV indicates that the Ricardian equivalence hypothesis cannot be rejected.

1. Introduction

The effects of government debt on output and interest rates have been the subject of controversy in macroeconomics on both theoretical and empirical grounds. The controversy stems from whether government debt (hereafter debt) is perceived as net wealth or not. In order to determine whether debt is net wealth, the statistical significance of debt in an output equation or a consumption (saving) function is often tested. While Kochin (1974), Tanner (1979), Seater (1982), Kormendi (1983), Aschauer (1985), and Seater and Mariano (1985) find evidence supporting the view that government debt is not net wealth, Yawitz and Meyer (1976), Feldstein (1982), Koskela and Virén (1983), and Johnson (1987) find contrary evidence.

As indicated by Hirschhorn (1984), the discovery of a positive correlation between debt and output does not necessarily imply that government bonds are net wealth. Within a rational expectation macro model, even when debt is not net wealth, there are output and interest rate effects of unanticipated changes in debt because these shocks are misperceived by agents as relative demand shocks. This implies that in empirical work a distinction should be made between unanticipated changes in debt and the level of debt.

The empirical evidence on the Ricardian equivalence proposition, with the exceptions of Koskela and Virén (1983) and Johnson (1987), is from the U.S. Given the important implications of this hypothesis, it is crucial to provide further evidence from other industrialized economies. The relevant debt measure for testing the Ricardian equivalence hypothesis is the market value of privately held debt, and the only economy, other than the U.S., for which such a series is available is the Canadian economy. In this paper, we employ the model by Hirschhorn (1984) and present empirical evidence from the Canadian economy on the effects of government debt and the Ricardian equivalence hypothesis.

2. The model

Following Hirschhorn (1984), output supply and demand functions are expressed by

$$y_{st} = k_{st} + \alpha_s r_t - \beta_s (m_t - m_t^e) - \omega_s (b_t - b_t^e) - \gamma_s B_{t-1} + u_{st}, \tag{1}$$

$$y_{dt} = k_{dt} - \alpha_d r_t + \beta_d (m_t - m_t^e) + \omega_d (b_t - b_t^e) + \gamma_d B_{t-1} + u_{dt}, \tag{2}$$

where 's' and 'd' denote supply and demand, y_t is the log of current real output, k_t is a systematic output term, r_t is the current expected real rate of return, $m_t - m_t^e$ is unanticipated money growth, $b_t - b_t^e$ is unanticipated debt growth, B_{t-1} is the lagged, log level of the market value of privately held debt, and u_t reflects random factors influencing output. If debt is not wealth, then $\gamma_s = \gamma_d = 0$.

Setting (1) equal to (2) yields the solution for r_t. Substituting this in (1) yields the following expression for output:

$$y_t = \tilde{y}_t + \alpha (m_t - m_t^e) + \omega (b_t - b_t^e) + \gamma B_{t-1} + u_t, \tag{3}$$

where

$$\tilde{y}_t = (\alpha_d k_{st} + \alpha_s k_{dt})/(\alpha_s + \alpha_d), \quad \alpha = (\alpha_s \beta_d - \alpha_d \beta_s)/(\alpha_s + \alpha_d), \quad \omega = (\alpha_s \omega_d - \alpha_d \omega_s)/(\alpha_s + \alpha_d),$$

$$\gamma = (\alpha_s \gamma_d - \alpha_d \gamma_s)/(\alpha_s + \alpha_d), \quad \text{and} \quad u_t = (\alpha_d u_{st} + \alpha_s u_{dt})/(\alpha_s + \alpha_d).$$

Therefore, the Ricardian equivalence proposition holds and privately held debt is not net wealth if γ is not significantly different from zero.

3. Empirical evidence

3.1. Data

The data consist of quarterly observations for the period 1961.I–1984.IV. Data on GNP, GNP deflator, money supply (*M1*), AAA corporate bond yield, government purchases, and the par value of public debt held by foreigners are from the Bank of Canada, the U.S. money supply (*M1*) is from Citibank Database; the market value of privately held direct government of Canada debt and the price index for marketable direct debt from Cox and Haslag (1986); the exchange rate (Canadian dollars per US dollar, period average) is from the November 1986, *International Financial Statistics* tape. All the series except the AAA corporate bond yield and the exchange rate are seasonally adjusted. (The market value of privately held direct debt, the price index for marketable direct debt, and public debt held by foreigners were not seasonally adjusted. These series were seasonally adjusted using the X-11 procedure of SAS.) The market value of privately held domestic direct debt is obtained by multiplying the price index for marketable direct debt by the par value of government debt held by foreigners and then subtracting the product from the market value of privately held direct debt. The reason for using the market value of private, domestic holdings of direct debt rather than the market value of privately held direct debt is due to the consideration that foreigners are not subject to future taxes implied by government debt.

3.2. The empirical model

The empirical model is based on the following system of equations:

$$m_t^e = X_{t-1}\psi,$$

$$b_t^e = Z_{t-1}\phi, \tag{4}$$

$$dy_t = \sum_{i=0}^{N} (m_{t-i} - m_{t-i}^e)\alpha_i + \sum_{i=0}^{N} (b_{t-i} - b_{t-i}^e)\omega_i + \sum_{i=1}^{N} B_{t-i}\gamma_i + \sum_{i=0}^{N} G_{t-i}\delta_i,$$

where m, b, and dy are the first differenced series of the log of the money supply, the market value of private, domestically held direct debt, and real GNP; B is the log level of the market value of private, domestically held direct debt; X_{t-1} is a vector of variables used to forecast m_t which are available at time $t-1$; Z_{t-1} is a vector of variables used to forecast b_t which are available at time $t-1$; G is real government purchases (in logs); u_t is an error term which is assumed to be uncorrelated with any information, available at $t-1$; and ψ, ϕ, α, ω, γ, and δ are vectors of coefficients. Real government purchases are included since one might improperly attribute to debt effects due solely to changes in government purchases if only debt were included in the system. Ideally one might want to include a tax rate measure for the same reason. This was not done due to the lack of availability of a good tax rate measure. The first differenced series of the log of real GNP (dy) is employed since a test of the type described by Nelson and Plosser (1982) indicated that the hypothesis of a first-order unit root could not be rejected.

3.3. Specification of the variables included in the money and debt growth equations

The variables included in the X_{t-1} and V_{t-1} vectors were decided by following an atheoretical statistical procedure. Specifically, money (debt) growth was regressed on a constant, four lagged values of money (debt) growth as well as four lagged values of another macro variable from a set of variables including real government purchases (in logs), real GNP (in logs), AAA corporate bond yield, inflation rate, rate of growth of real government purchases, rate of growth of real GNP, exchange rate (in logs), and U.S. money growth. If the null hypothesis that the coefficients of the variable are zero is rejected at the 5% level, the variable is included among the set of regressors and then the procedure is repeated for other variables.

The variables included in the final money growth equation were lagged money growth, AAA corporate bond yield, and real government purchases (in logs) while the variables included in the final debt growth equation were the AAA corporate bond yield, and real GNP (in logs). The modified Portmanteau Q statistic by Harvey (1981) for the first twelve autocorrelations indicated that the residuals of the money and debt growth equations were white noise. The Q statistic was 9.79 for the money growth equation and 8.69 for the debt growth equation while the marginal significance level was 0.63 for the money growth equation and 0.73 for the debt growth equation. The stability of the coefficients of the two equations were tested by splitting the sample period into two equal halves. For the money growth equation, $F(13,57) = 1.86$, and for the debt growth equation, $F(13,57) = 1.70$, while the critical F at the 5% level = 1.90. Therefore, the hypothesis that the coefficients are stable cannot be rejected.

3.4. Estimation and results

After determining the variables that enter the money and debt growth equations, system (4) was estimated for the period 1964.II–1984.IV by non-linear three-stage least squares (NL3SLS). In order to increase the efficiency of the NL3SLS estimator the set of exogenous variables in the system and their cross products were used as instruments.

NL3SLS was used rather than maximum likelihood estimation for two reasons. First, in order to use maximum likelihood estimation the disturbances must be assumed to be normally distributed. The NL3SLS estimators do not require the assumption of normal errors and are still consistent and asymptotically normal. Secondly, the NL3SLS are computationally much more efficient than maximum likelihood estimators.

System (4) is the unrestricted model. Imposing the restriction $\gamma_i = 0$ yields the restricted model. The Ricardian equivalence hypothesis was tested by constraining the contemporaneous covariance matrix of the errors across equations to be identical *across the models* and using a test statistic based on differences in the generalized sums of squared errors as described in Gallant and Jorgenson (1979). The computer package used in the estimation was the SYNLIN procedure of SAS, Version 5.16.

In testing the Ricardian equivalence hypothesis, we followed a strategy of experimenting with different lags to verify the robustness of our results. With a lag length of $N = 4$ for the output equation, the value of the χ^2 test statistics was 1.28 and the critical $\chi^2(4)$ at the 5% level was 9.49.

Table 1
NL3SLS estimates of the output equation. [a]

Dependent variable	$d y_t$			
constant	0.04159	(1.63)	0.03983	(1.80)
$(b_t - b_t^e)$	−0.06644	(−1.33)	−0.07170	(−1.50)
$(b_{t-1} - b_{t-1}^e)$	0.09990	(1.38)	0.08140	(1.61)
$(b_{t-2} - b_{t-2}^e)$	0.10126	(1.29)	0.16297	(2.90) [c]
$(b_{t-3} - b_{t-3}^e)$	0.15400	(2.08) [b]	0.13557	(2.54) [c]
$(b_{t-4} - b_{t-4}^e)$	0.04715	(0.79)	0.01790	(0.32)
$(m_t - m_t^e)$	−0.12078	(−0.91)	−0.14154	(−1.13)
$(m_{t-1} - m_{t-1}^e)$	0.14038	(1.12)	0.12289	(1.00)
$(m_{t-2} - m_{t-2}^e)$	0.11238	(0.91)	0.13612	(1.13)
$(m_{t-3} - m_{t-3}^e)$	0.11079	(0.83)	0.13279	(1.02)
$(m_{t-4} - m_{t-4}^e)$	0.02273	(0.19)	0.02682	(0.23)
B_{t-1}	−0.02133	(−0.39)		
B_{t-2}	0.07887	(0.95)		
B_{t-3}	−0.08850	(−1.12)		
B_{t-4}	0.03186	(0.59)		
G_t	0.06108	(0.71)	0.04994	(0.60)
G_{t-1}	0.01331	(0.10)	0.02257	(0.18)
G_{t-2}	−0.14764	(−1.19)	−0.14752	(−1.20)
G_{t-3}	0.08061	(0.59)	0.10617	(0.81)
G_{t-4}	−0.01894	(−0.17)	−0.04125	(−0.40)
R^2	0.4078		0.3865	
DW	1.892		1.901	

[a] The t-ratios are in parentheses.
[b] Significant at the 5% level.
[c] Significant at the 1% level.

With a lag length of $N = 8$, the value of the χ^2 test statistic was 7.41 and the critical $\chi^2(8)$ at the 5% level was 15.51. Therefore, the Ricardian equivalence hypothesis was not rejected in both cases. Including lagged U.S. money growth as a proxy for foreign influences on the Canadian economy or using the rate of growth of real government purchases instead of real government purchases (in logs) did not change the results. System (4) implicitly assumes that anticipated money and debt growth do not affect output. In order to take into account the possible effects of systematic policy actions, we also estimated (4) by including anticipated money and debt growth as explanatory variables in the output equation and tested the null hypothesis that the coefficients of anticipated debt growth and the level of debt were equal to zero. The null hypothesis was not rejected at the 5% level.

Since including irrelevant variables in a regression equation reduces the precision of the estimated coefficients, the output equation with 4 lags was re-estimated without the lagged level of debt. The output equation with and without the level of debt is reported in columns (1) and (2) of table 1. The results indicate that the impact of debt on the Canadian economy is primarily due to unanticipated shocks to privately held domestic debt.

4. Conclusions

This paper presents empirical evidence from the Canadian economy on the effects of government debt and the Ricardian equivalence hypothesis. Following Hirschhorn (1984) a distinction is made between unanticipated changes in debt growth and the level of debt. The Canadian evidence for the period 1964.II–1984.IV indicates that the Ricardian equivalence hypothesis cannot be rejected and the effects of government debt on output are primarily due to unanticipated changes in debt growth.

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