E C O N O M I C S B U L L E T I N

Ricardian Equivalence Revisited: Evidence from OECD countries

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Abstract

Using a theoretical model based on dynamic optimizing agents, we test empirically the Ricardian Equivalence Proposition (REP) for 26 OECD countries. The empirical specification allows us to obtain estimates of the structural parameters of the theoretical model and to test directly the hypothesis implied by the REP. We find that the REP cannot be rejected for 10 out of 26 countries, where 9 of these 10 countries are European.

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1 Introduction

The effects of government budget variables on private consumption is one of the crucial issues that need to be quantified when assessing and planning fiscal policy. During the last decades a huge controversy has emerged as to the size and sign of the fiscal multiplier, which has been claimed to be positive (Keynesian view), zero (Ricardian view) or even negative (expectational view). Contributions dealing with the possibility of the fiscal multiplier being zero or negative are either centered around the Ricardian Equivalence Proposition (henceforth, REP) or the so-called expansionary fiscal contractions according to which, ceteris paribus, a reduction in the deficit is expansionary.

The REP concludes that a tax cut has no effect on consumption since rational individuals – being aware of the intertemporal government budget constraint – base their consumption decisions on permanent income and will hence anticipate a future increase in taxes by saving the amount of the tax cut. The theory is based on relatively strong assumptions such as rational and forward-looking individuals, lump-sum taxes, perfect capital markets and infinite lives of consumers all of which may render the REPs practical relevance – at least in its perfect form – questionable.

Since the seminal contribution of Barro (1974), many studies have tested the empirical relevance of the REP with mixed results. Feldstein (1982), Seater and Mariano (1985) and Bernheim (1997) investigated the REP empirically for the US. While the first two contributions reject the parametric constraints implied by the REP, the latter finds a stimulative effect of fiscal policy on private consumption. Evans (1993), Masson *et al.* (1995), Bernheim (1997), Brunila (1997) and Giavazzi *et al.* (2000) are examples of cross-country comparative studies aiming at evaluating the relevance of the REP for industrialized countries. The diversity of results in these studies can be at least partly attributed to the estimation of atheoretical reduced-form models. In our contribution, we will embed the econometric specification in the framework of a theoretical model with dynamic optimizing agents.

This piece of research contributes to the economic policy discussion and to the empirical literature on the REP by testing for the REP for 26 OECD countries using the theoretical model by Leiderman and Razin (1988) as extended by Khalid (1996). The model is based on dynamic optimizing agents and has the advantage of arriving at an empirically tractable specification where the structural parameters can be identified. The paper is organized as

follows. Section two introduces the theoretical model and briefly derives the closed-form specification for private consumption, which will be the baseline for our empirical analysis. Section three presents the econometric methodology and the results of the empirical analysis. Section four concludes.

2 The theoretical model

The basic theoretical setting to the empirical study is given by the model proposed by Khalid (1996), which builds upon the work of Leiderman and Razin (1988).

Consider an economy consisting of both liquidity-constrained and liquidity-unconstrained consumers. The liquidity-constrained group of individuals receives a fixed proportion θ of total labour income and spends total current income on consumption, while liquidity-unconstrained consumers (which receive a proportion $1-\theta$ of total labour income) have free access to capital markets and may lend and borrow at the prevailing interest rate.

The expected lifetime utility of the liquidity-unconstrained representative consumer at time t is given by $E_t \sum_{\tau=0}^{\infty} (\gamma\delta)^{\tau} U(c_{t+\tau}^{u^*})$, where E_t is the conditional expectations operator in period t, $c_t^{u^*}$ denotes effective consumption of individuals facing no liquidity constraints in period t, γ the probability of survival from one period to the next[1] and δ is a subjective discount factor. We will further assume a quadratic utility function, $U(x) = \alpha x - 1/2x^2$, and $c_t^{u^*}$ will be taken to be a combination of public consumption g_t and private consumption c_t ($c_t^{u^*} = c_t + \sigma g_t$), where σ indicates the degree of substitutability between private and public consumption. Liquidity-unconstrained individuals maximize their expected lifetime utility subject to the lifetime budget constraint,

$$c_t^{u^*} = b_t^u + y_t^u - \left(\frac{R}{\gamma}\right) b_{t-1}^u + \sigma g_t,$$

and the transversality condition,

$$E_t \lim_{t\to\infty} \left(\frac{\gamma}{R}\right) b_t^u = 0,$$

where b_t is a real one-period bond issued to unconstrained individuals in period t, y_t is real

[1] For simplicity, this probability is assumed to be independent of age. Thus the probability that the individual survives at τ periods is $(\gamma)^{\tau}$, see Blanchard (1985).

income net of taxes in period t of unconstrained individuals, $R = 1 + r$ where r is the (risk-free) real interest rate (for analytical tractability assumed constant).[2]

The intertemporal budget constraint of the liquidity-unconstrained individual is given by:

$$E_t \sum_{\tau=0}^{\infty} \left(\frac{\gamma}{R}\right)^{\tau} c_t^{u^*} = E_t \sum_{\tau=0}^{\infty} \left(\frac{\gamma}{R}\right)^{\tau} \left[y_{t+\tau}^{u} + \sigma g_{t+\tau}^{u}\right] - \left(\frac{R}{\gamma}\right) b_{t-1}^{u} \tag{1}$$

Equation (1) implies that the present discounted value of real consumption equals the present discounted value of real income plus the contribution of public consumption to effective consumption less the real interest paid on debt commitment. The liquidity-constrained group, on the other hand, consumes its entire current income. It can then be easily shown that aggregate consumption, C_t – defined as the sum of consumption of the liquidity-constrained and the liquidity-unconstrained group – can be written as[3]

$$\begin{aligned} C_t \;=\; & (1-R)\,\beta_0 + (1-\beta_1)\,RC_{t-1} + (1-\gamma)(1-\theta)\beta_1 E_{t-1} \sum_{\tau=0}^{\infty} \left(\frac{\gamma}{R}\right)^{\tau} (1-\theta) Y_{t+\tau} + (2) \\ & + (1-\gamma)\beta_1 E_{t-1} \sum_{\tau=0}^{\infty} \left(\frac{\gamma}{R}\right)^{\tau} \sigma G_{t+\tau} + \theta Y_t - \sigma G_t + (1-\beta_1)\,(R\theta Y_{t-1} - \sigma G_{t-1}) \\ & (\beta_1 \gamma\,[e_t^y + \sigma e_t^g]) \end{aligned}$$

where $\beta_0 = [\alpha\gamma(1-\delta R)]/[\delta R(R-\gamma)]$, $\beta_1 = 1-[\gamma/(\delta R^2)]$ and e_t^y and e_t^g are the expectational errors for income and government consumption made by individuals. It will be assumed that government expenditure and income follow an ARIMA (1, 1, 0) process, so that

$$\triangle Y_t = \rho_1 \triangle Y_{t-1} + \eta_t^Y$$

and

$$\triangle G_t = \rho_2 \triangle G_{t-1} + \eta_t^G,$$

where η_t^Y and η_t^G are *iid* errors, independent from each other. This assumption yields a closed-form solution for aggregate consumption such as

$$C_t = \lambda_0 + \lambda_1 C_{t-1} + \lambda_2 Y_{t-1} + \lambda_3 Y_{t-2} + \lambda_4 G_{t-1} + \lambda_5 G_{t-2} + \upsilon_t \tag{3}$$

[2] (R/γ) is then the effective interest rate due to life-time uncertainty.

[3] Notice that the size of the population in the model is constant and equal to $1/(1-\gamma)$ if each cohort is normalized to be of unit size.

where υ_t is the error term, assumed to be *iid* normal. Equation (3) states that private consumption is determined by an ARDL (1, 2, 2) process without contemporaneous effects of government spending and income. λ_0 to λ_5 are the closed-form parameters, given by

$$\lambda_0 = \frac{\alpha\gamma\left(1-R\right)\left(1-\delta R\right)}{\delta R\left(R-\gamma\right)} \tag{4}$$

$$\lambda_1 = \frac{\gamma}{\delta R} \tag{5}$$

$$\lambda_2 = \left[\theta\left(1+\rho_1-\frac{\gamma}{\delta R}\right)+\left(1-\theta\right)\left(1-\gamma\right)\left(1-\frac{\gamma}{\delta R^2}\right)\left(\frac{R^2\left(1+\rho_1\right)-R\gamma\rho_1}{\left(R-\gamma\right)\left(R-\gamma\rho_1\right)}\right)\right] \tag{6}$$

$$\lambda_3 = \left[\left(1-\theta\right)\left(\gamma-1\right)\left(1-\frac{\gamma}{\delta R^2}\right)\left(\frac{R^2\rho_1}{\left(R-\gamma\right)\left(R-\gamma\rho_1\right)}\right)-\theta\rho_1\right] \tag{7}$$

$$\lambda_4 = \left[\left(\frac{\gamma}{\delta R}-1-\rho_2\right)+\left(1-\gamma\right)\left(1-\frac{\gamma}{\delta R^2}\right)\left(\frac{R^2\left(1+\rho_2\right)-R\gamma\rho_2}{\left(R-\gamma\right)\left(R-\gamma\rho_2\right)}\right)\right]\sigma \tag{8}$$

$$\lambda_5 = \left[\rho_2+\left(\gamma-1\right)\left(1-\frac{\gamma}{\delta R^2}\right)\left(\frac{R^2\left(1+\rho_2\right)-R\gamma\rho_2}{\left(R-\gamma\right)\left(R-\gamma\rho_2\right)}\right)\right]\sigma \tag{9}$$

The parameter constraints implied by the REP are those of infinite horizon ($\gamma = 1$) and no liquidity constraints ($\theta = 0$). If we impose these restrictions on (3), the terms with lags of disposable income vanish. Therefore, under this scenario, current consumption depends only on its own lag and the degree of substitutability between the private and public consumption spending σ. If $\sigma = 0$, then the model reduces to Hall's model (Hall, 1978) where consumption follows a random walk and thus consumption changes are not predictable. However, as soon as $0 < \gamma < 1$ and/or $\theta > 0$, income affects private consumption since, as can be inferred from equation (3), a tax cut in period t raises expected wealth with a corresponding effect on private consumption.

3 The empirics of Ricardian Equivalence in the OECD

The aim of the empirical analysis is to estimate the structural parameters in (4)-(9) for 26 OECD countries and explicitly test for the parameter constraints implied by the REP ($\gamma = 1$ and $\theta = 0$). The countries included in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and the US. We use yearly data on private consumption (C_t), gov-

ernment consumption (G_t) and disposable income (Y_t) for the period 1960-2002.[4] Given the complex set of parameter restrictions implied by (4)-(9) we will exogenously set the value of three parameters of the model. The parameter corresponding to the risk-free real interest rate, R, was calculated as the average long-term real interest rate for the period 1960-2002. The parameters corresponding to the ARIMA representation of Y_t and G_t (ρ_1 and ρ_2) for each country were obtained by estimating these univariate time series models on Y_t and G_t.

Insert Table 1 around here

After imposing these parameters, the original model (4)-(9) is left with five structural parameters to be estimated ($\alpha, \gamma, \delta, \theta$ and σ). The estimation of these parameters was performed using full information maximum likelihood.[5] A likelihood ratio test for $\gamma = 1$ and $\theta = 0$ was then performed in order to evaluate the validity of the REP. For those countries in which the null hypothesis implied by the REP was rejected we also performed individual tests for $\gamma = 1$ and $\theta = 0$, so as to obtain an insight into which one of the two assumptions is responsible for the rejection of the REP. The results of the maximum likelihood estimation and the likelihood ratio tests are presented in Table 1 for all countries in the sample.[6] The results show γ (the survival probability) to be highly significant and very close to one for practically all countries except for Australia and Norway, where the estimated value of γ is of around 0.8. The estimates of θ (the proportion of labour income corresponding to liquidity-constrained agents) are individually insignificant for all countries in our sample except for France, Germany, Netherlands and Sweden. The σ parameter estimate is positive and significant in Norway, Spain and Iceland, implying a certain degree of substitutability of private and public consumption. In Turkey, Belgium, Luxemburg and the US, on the other hand, it seems as if public consumption has a crowding-out effect on private consumption. The likelihood ratio test indicates significant deviations from the REP for Australia, Canada, Finland, France, Iceland, Italy, Japan, Mexico, Netherlands, New Zealand, Portugal, Sweden Turkey, United Kingdom and the US. For the remaining ten countries (Austria,

[4] All data used in the paper were obtained from the European Commission's Ameco database.

[5] Notice that, given the nonstationary nature of the variables included in the analysis, the ARDL(1,2,2) specification admits an error correction representation and a cointegration relationship between C_t, Y_t and G_t is assumed to exist. Results concerning the stationarity of the deviations from the long-run equilibrium are, however, not conclusive for all countries, and are available from the authors upon request.

[6] Due to lack of comparability, the estimates of the utility function parameter α are not reported, but are available from the authors upon request.

Denmark, Germany, Greece, Ireland, Luxembourg, Spain, Switzerland, Norway and Korea) the null of Ricardianity ($\gamma = 1$ and $\theta = 0$) cannot be rejected at standard levels of significance. Compared to other studies with a similar model setting, our results correspond to those of Khalid (1996) and of Haque and Montiel (1989) for Portugal and Turkey; and to those of Brunila (1997) for Austria, France, Italy, Sweden and the UK. Our results for Belgium, Finland, Greece, Korea and Germany, however, do not correspond to those of these three studies.

The last two columns in Table 1 present the results of the individual likelihood ratio tests corresponding to each one of the parameter constraints implied by the REP. This test statistic is reported for those countries where the REP was rejected. The individual assumption of infinite planning horizon seems to be a source of deviation from Ricardian neutrality for Australia, France, New Zealand and the US. For France, the Netherlands, Sweden, Turkey, United Kingdom and the US, the null of no liquidity-constrained individuals is rejected. In the case of Belgium, Canada, Finland, Iceland, Italy, Japan, Mexico and Portugal, the source of rejection of the REP cannot be properly identified.

An interesting conclusion from our results is that the REP seems to be a predominantly European phenomenon: Out of the ten countries for which the parameter restrictions imposed by the REP cannot be rejected, Korea is the only non-European country. A tentative conclusion which could be drawn from this result is that, as fiscal frameworks in Europe have tended to show a high degree of prudence and transparency, this may have led to reduced myopia among European households as compared to other OECD countries.[7]

4 Conclusions

We presented evidence concerning the validity of the REP for 26 OECD countries in the last four decades. In the theoretical framework proposed by Khalid (1996) (which can be seen as a generalization of Leiderman and Razin, 1988), the lack of responsiveness of private consumption to fiscal impulses implied by the REP emerges if economic agents have infinite planning horizons and no liquidity constraints. These two conditions were tested in the form

[7] It may also be argued that the introduction of fiscal rules such as the one implied by the Maastricht Treaty could lead to a more Ricardian behaviour of consumers. This hypothesis is explicitly tested in Crespo Cuaresma and Reitschuler (2004).

of parameter restrictions using an empirical specification which can be derived from a model with dynamic optimizing agents.

Our results for the time period 1960-2002 imply that the parameter restrictions implied by the REP cannot be rejected for 10 out of the 26 OECD countries in the sample. The vast majority of the countries for which the REP cannot be rejected (9 out of 10) are European economies, which opens a new path of further research aimed at shedding a light on the institutional differences that may be responsible for the different degree of responsiveness of private consumption to fiscal impulses.

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Table 1: Maximum likelihood estimates and likelihood ratio test

Country	γ	δ	θ	σ	LRT (γ=1, θ=0)	LRT (γ=1)	LRT (θ
Australia	0.83 *** (0.05)	0.99 *** (0.06)	-1.48 (1.26)	0.73 (0.51)	19.58 ***	8.21 ***	1.38
Austria	1.03 *** (0.40)	0.96 *** (0.28)	0.08 (0.24)	-0.49 (0.48)	1.47	–	–
Belgium	1.03 ** (0.55)	0.96 *** (0.35)	0.19 (0.22)	-0.43 * (0.26)	5.77 **	0.00	0.71
Canada	0.93 *** (0.07)	0.98 *** (0.07)	-0.22 (0.75)	0.25 (0.48)	20.00 ***	0.79	0.09
Denmark	1.03 *** (0.21)	0.96 *** (0.04)	0.09 (0.31)	0.23 (0.59)	0.38	–	–
Finland	0.99 *** (0.03)	0.99 *** (0.06)	0.30 (0.29)	0.65 (0.54)	23.78 ***	0.06	1.07
France	1.02 *** (0.01)	0.97 *** (0.00)	0.31 *** (0.08)	0.17 (0.33)	14.28 ***	4.29 *	12.39 **
Germany	1.01 *** (0.01)	1.53 *** (2.62)	0.94 *** (0.16)	0.34 (2.10)	0.74	–	–
Greece	0.99 *** (0.04)	1.02 *** (0.02)	0.11 (0.16)	-1.07 (1.63)	1.49	–	–
Iceland	0.99 *** (0.00)	1.26 *** (0.34)	-0.00 (0.00)	1.75 * (1.06)	15.74 ***	0.22	0.05
Ireland	1.02 *** (0.12)	0.97 *** (0.18)	0.39 (0.38)	1.30 (1.09)	1.91	–	–
Italy	1.02 *** (0.62)	0.98 *** (0.37)	0.30 (0.27)	-0.81 (0.59)	5.08 **	0.00	1.21
Japan	1.02 *** (0.38)	0.97 *** (0.18)	0.27 (0.39)	-0.07 (0.58)	8.84 **	0.00	0.48
Korea	0.99 *** (0.00)	1.11 (0.72)	-0.00 (0.00)	-0.03 (6.81)	2.83	–	–
Luxemburg	0.98 *** (0.00)	1.02 *** (0.11)	-0.22 (0.18)	-1.24 *** (0.49)	4.30	–	–
Mexico	0.99 *** (0.00)	1.35 *** (0.32)	-0.00 (0.00)	2.40 (2.33)	12.64 ***	1.22	0.00
Netherlands	1.00 *** (0.02)	0.97 *** (0.11)	0.35 ** (0.16)	-0.34 (0.49)	6.23 **	0.00	4.56 **
Norway	0.84 *** (0.09)	0.94 *** (0.05)	-0.66 (0.05)	2.03 *** (0.56)	2.83	–	–
New Zealand	0.99 *** (0.00)	1.04 *** (0.12)	0.00 (0.00)	2.32 (1.82)	15.27 **	4.59 **	1.75
Portugal	0.97 *** (0.02)	1.16 *** (0.10)	0.04 (0.48)	-0.54 (0.44)	6.99 **	0.67	0.00
Spain	0.91 *** (0.06)	0.96 *** (0.07)	0.13 (0.31)	1.54 * (0.94)	2.47	–	–
Sweden	1.00 *** (0.02)	0.97 *** (0.12)	0.37 *** (0.12)	-0.18 (0.40)	10.69 ***	0.03	8.94 ***
Switzerland	0.99 *** (0.00)	1.00 *** (0.11)	0.00 (0.00)	0.14 (1.13)	0.80	–	–
Turkey	0.99 *** (0.00)	0.89 *** (0.03)	0.00 (0.00)	-15.04 ** (7.90)	11.22 ***	0.19	11.22 **
UK	1.03 *** (0.01)	0.96 *** (0.02)	0.20 * (0.12)	0.54 (0.71)	6.73 **	2.46	2.83 *
USA	0.98 *** (0.00)	0.51 *** (0.08)	0.49 (0.05)	-0.34 ** (0.17)	336.99 ***	6.92 ***	72.84 **

The estimation was carried out using full information maximum likelihood. Standard errors in parenthesis.

Time period: 1960-2002. ***(**)[*] stands for 1% (5%) [10%] significant.