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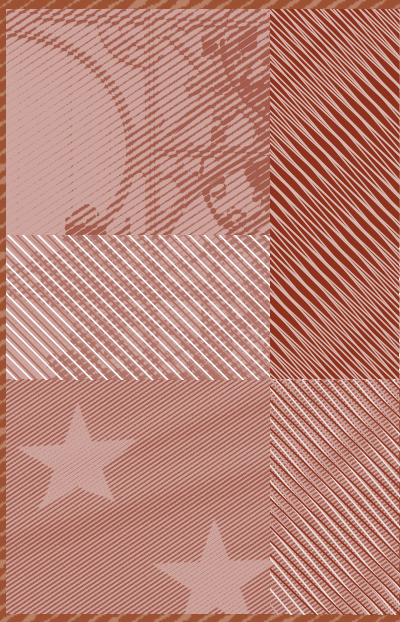

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Francisco de Castro and José Luis Fernández (*)

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Abstract

This paper aims to test the validity of the Ricardian proposition for the Spanish economy from three different approaches: a) by testing its theoretical implications on the stability of national saving and the relationship between fiscal and current account balances, b) by carrying a number of tests on different structural consumption equations and, c) by testing this hypothesis in consumption functions stemming from the Euler equations derived from a consumer's maximization problem. Our results lean toward rejection of the Ricardian proposition, although some degree of substitution between public and private saving is detected. In terms of policy implications, these results would suggest that there is some room for fiscal policy to exert its countercyclical role in the case of Spain. However, the effectiveness of such a policy might be limited in a context of rising debt ratios that trigger sustainability concerns and make consumers increasingly Ricardian.

Keywords: Ricardian equivalence, debt neutrality, saving, fiscal policy.

JEL codes: E62, E21, H30.

1 Introduction

The Ricardian equivalence proposition states that, under certain circumstances, the decision to finance public expenditure via higher taxes or by public debt issuance (and thus future higher taxes) is immaterial for private consumption decisions. Accordingly, households do not consider public debt holdings as net wealth. For this result to hold consumers have to be fully rational and be aware that current and future public spending will eventually have to be paid. Thus, the present value of such public expenditure flows enters their intertemporal budget constraint, thereby reducing their permanent income. Consequently, changes in the intertemporal allocation of taxes only affect private saving, leaving consumption unaffected. Moreover, within a Ricardian framework, fiscal policy measures implying shifts in public spending will induce responses of private consumption and saving with opposite signs. It is worth noting that this theoretical proposition is derived under very tight conditions, difficult to observe in practice.

The extent to which consumers behave in relation to the provisions of Ricardian equivalence may have important policy implications in real economies. In particular, Ricardian equivalence may condition the effectiveness of discretionary fiscal policy measures. Specifically, Ricardian consumers would anticipate the future cost of public spending increases and would react accordingly by increasing saving. In this context, one should not expect much from fiscal measures due to consumers' reaction. By contrast, fiscal stimuli are expected to be effective with non-Ricardian or credit-constrained consumers.

Many empirical papers have tested whether actual data are consistent with the Ricardian equivalence, the bulk of which focus on the US economy. In particular, Kochin (1974), Barro (1979), Seater (1982), Kormendi (1983), Aschauer (1985), Seater and Mariano (1985), Kormendi and Meguire (1986) or Leiderman and Razin (1988) have reported evidence consistent with the Ricardian hypothesis (although sometimes in its weak version[1]), whereas Buiter and Tobin (1979), Blinder and Deaton (1985), Modigliani and Sterling (1986), Feldstein and Elmendorf (1990), Evans (1993) or Himarios (1995) among others have obtained the opposite result. Likewise, some interesting empirical studies can be found for Spain, most of them rejecting Ricardian equivalence. In particular, while Raymond and González-Páramo (1987), Argimón (1996) or Marchante (1993) reject this proposition, Fuster (1993) and García and Ramajo (2002) collect evidence consistent with partial debt neutrality, thereby rejecting the strict version of Ricardian equivalence. Finally, Afonso (2008), with panel data for 15 European countries[2], gets evidence against the hypothesis of debt neutrality, especially for countries with lower debt-to-GDP ratios, among which Spain enters given the sample used.

This paper analyses whether the Ricardian equivalence proposition holds for the Spanish economy by running a number of tests that address this question from different angles. In this regard, our study is similar to García and Ramajo (2002) since they test the Ricardian hypothesis with different specifications stemming from alternative approaches.

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1. The weak version of the Ricardian equivalence proposition (also referred to as partial debt neutrality) holds when private consumption is negatively affected by public expenditure, although with a lower coefficient than income. Intuitively, it means that private and public savings are substitutes, though imperfect. It is worth noting that, in this situation, the Ricardian equivalence proposition in its strict theoretical formulation does not hold. This terminology is borrowed from Fuster (1993) and García and Ramajo (2002).
2. The former EU-15.

In this regard, one of the novelties of our paper is the use of quarterly data along with covering the most recent period. As for the rest of the paper, section 2 explains very simply the Ricardian proposition and the assumptions thereof to illustrate the rationale of the tests used. Next, section 3 reviews the different approaches proposed in the literature, and followed in this paper, to test the validity of the Ricardian proposition. Section 4 presents our econometric results and confronts them briefly with previous studies. Finally, section 5 offers some conclusions.

2 The Ricardian equivalence hypothesis

The Ricardian equivalence is a theoretical proposition whose first formal formulation is due to Barro (1974), although the intuitive idea had already been introduced well before by the British economist David Ricardo in the nineteenth century.[3] Basically, this proposition states that, under certain circumstances, it would be irrelevant whether deficits are financed by issuing public debt or by raising taxes. The reason is that fully rational households discount the financial implications of public expenditure decisions or, in other words, they internalise the government's intertemporal borrowing constraint. Households are aware that the current stream of public outlays, jointly with the current stock of public debt, will eventually have to be paid. If their consumption decisions are determined by their permanent or life-time income, they are indifferent between paying more taxes at present and lower in the future, or vice versa, to finance a given amount of public spending provided that their time horizon coincides with the government's one. In any case, households' permanent income is reduced by the expected discounted present value of current and future public expenditure. In a simplified way, period-t government's budget constraint can be written as

$$\Delta b_t = g_t + r b_{t-1} - t_t$$

where b_t is the end-of-period t government debt, g_t primary government spending, t_t represents government revenue, typically lump-sum taxes, and r is the nominal interest rate on government debt, assumed to be constant for simplicity. Solving forward, the government's intertemporal budget constraint is obtained

$$b_{t-1} = \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j+1}} (t_{t+j} - g_{t+j})$$

where the transversality condition $\lim_{j\to\infty} \left(\frac{1}{1+r} \right)^{j+1} b_{t+j} = 0$ is assumed to hold. The intertemporal borrowing constraint implies that the current market-value stock of debt has to be equal to the present discounted value of the future stream of primary surpluses. The government's intertemporal budget constraint can be re-arranged as

$$b_{t-1} + \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j+1}} g_{t+j} = \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j+1}} t_{t+j} \qquad (1)$$

Analogously, the representative consumer's budget constraint can be represented as

$$\Delta a_t = w_t + r a_{t-1} - c_t - t_t$$

where a_t are net assets held by consumers, including public debt holdings, w_t households' labour income, c_t private consumption and t_t (lump-sum) taxes paid. Following the same logic as for the government, the representative infinitely-lived consumer's intertemporal budget constraint can be expressed as

3. See Ricardo (1817).

$$a_{t-1} = \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j+1}} (c_{t+j} - w_{t+j}) + \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j+1}} t_{t+j} \quad (2)$$

Let us assume for simplicity that the only assets in the economy are public bonds, i.e. $a_t = b_t$.[4] Substituting (1) into (2) and re-arranging leaves the consumer's budget constraint as

$$\sum_{j=0}^{\infty} \frac{c_{t+j}}{(1+r)^{j+1}} = \sum_{j=0}^{\infty} \frac{w_{t+j}}{(1+r)^{j+1}} - \sum_{j=0}^{\infty} \frac{g_{t+j}}{(1+r)^{j+1}} \quad (3)$$

Accordingly, (3) shows the way public spending is financed does not affect households' consumption decisions. All that matters is the present-value of the government spending path, which is understood as reducing permanent income. Consequently, given that tax or debt financing of a given public expenditure path is immaterial for consumption decisions, public debt does not constitute net wealth for households. For this reason, the Ricardian equivalence proposition is also known as the debt neutrality hypothesis. Moreover, consumption decisions are not affected by the intertemporal allocation of taxes. Changes in their intertemporal profile are reflected in both private and public saving with opposite signs. Consequently, public and private saving are perfect substitutes. Hence, if consumers are Ricardian, national saving as a percentage of total income should be stable and the general government balance by itself should not affect the current account balance. Specifically, fiscal policy shocks should translate into responses of private saving of the same size but with opposite sign, leaving the current account unaffected.[5]

Notwithstanding the fact that Ricardo largely dismissed this idea on practical grounds because of being aware of its numerous limitations, this proposition was called the "Ricardian equivalence hypothesis" [Buchanan (1976)]. In this respect, the above equations show that the Ricardian equivalence proposition is derived under very restrictive assumptions. In particular, the Ricardian proposition is based on the assumption of infinitely-lived individuals. However, if consumers' life horizons are shorter than those of which taxes are levied upon to repay the debt, tax duties will not fully offset present-value interest payments. Barro (1974) attempts to solve this shortcoming by introducing intergenerational links. Therefore, future generations are allowed to receive bequests from the current ones, whereas the utility function of consumers is also affected by the utility of their descendants, thereby restoring Ricardian equivalence. Nevertheless, the presence of childless households or finite horizons due to a given probability of dying [Blanchard (1985)] makes the Ricardian hypothesis fail. In fact, the effect of finite horizons is claimed by the literature as the most obvious reason for Ricardian equivalence to fail.[6] However, there are other important reasons for this proposition to fail, notably liquidity constraints, distortionary taxes rather than lump-sum ones[7], or uncertainty about future taxes and income. Therefore, since there are good arguments for Ricardian equivalence to fail, it is clear that the issue is essentially empirical, namely how important departures from Ricardian equivalence are [Blanchard and Fischer (1989), Seater (1993)].

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4. This assumption does not modify the theoretical implications in that if a_t includes assets other than public debt, for instance foreign assets, (3) would still hold, augmented only with the stock of foreign assets in period t-1.

5. By contrast, if agents are not Ricardian, for a given path of government spending, a shift from tax to debt financing raises private consumption and contributes to deteriorate the current account. Therefore, non-Ricardian behaviour, as suggested by the Keynesian model, is consistent with the twin-deficit hypothesis.

6. See, for instance, Blanchard and Fischer (1989) or Cardia (1997).

7. Distortionary taxes may entail non-linear effects on consumption decisions. In this regard, different intertemporal tax profiles affect permanent income and thus consumption decisions. On the other hand, the Ricardian proposition is derived under the assumption of non-productive public expenditure; if a given share of productive public expenditure is assumed, the utility and production functions call for different formulations, thereby making the Ricardian proposition fail.

3 Empirical attempts to test Ricardian equivalence in the literature

3.1 The implications for the national saving ratio and the correlation between fiscal and current account balances

As explained above, the Ricardian equivalence proposition would imply stability of total national saving in a way that changes in general government's saving should be offset by private saving. Accordingly, a strict version of the Ricardian proposition would suggest that the national saving ratio (g^{tot}) should be stationary.[8] In other words, although not being constant, it should resume to its "normal" value after some time following a shock, even when neither the public (sg) nor the private (sps) saving ratio were stationary. Thus, for such a result to hold it is necessary that the trends of both types of saving offset each other, thereby leading to perfect substitution between them. This theoretical implication has led some authors to test the stationarity of national saving as an indirect way of addressing the neutrality issue.

In a similar fashion, Ricardian equivalence has important implications for the relationship between fiscal and current account balances. Specifically, under the equivalence theorem, for a given path of government expenditures, the timing of taxes should not affect the consumption decision made by tax payers. Therefore, the financing of government spending via debt or taxes should not affect the current account either. Moreover, under Ricardian regimes, higher government spending would lead to lower private consumption by the same amount, thereby improving the current account balance. Conversely, under Keynesian regimes a positive relationship between fiscal and current account balances is expected, i.e. the twin-deficits hypothesis. Within this framework, a shift from tax to debt financing increases private consumption and worsens the current account balance. Basically, this test would consist of estimating

$$ca_t = \beta_0 + \beta_1 gb_t + \beta_2 reer_t + u_t \qquad (4)$$

where ca_t is the current account balance, gb_t the general government balance and $reer_t$ is the real effective exchange rate vis à vis the OECD countries, calculated with CPI indexes[9]. Hence, under the Ricardian hypothesis $\beta_1 \leq 0$ should hold, whereas $\beta_1 > 0$ would be consistent with the Keynesian (twin-hypothesis) framework.

However, it should be borne in mind that stationarity of national saving or non-significant or even negative correlation between current account and fiscal balances are only necessary but not sufficient conditions for Ricardian equivalence to hold. For instance, national saving could be stationary for reasons other than Ricardian behaviour of consumers. Accordingly, the most prominent attempts to tackle this question rely on direct tests over different consumption equations. Roughly speaking, two families of consumption equations have been employed for this purpose, notably structural consumption equations nesting alternative behavioural hypothesis and consumption equations derived from Euler maximization conditions.

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8. Since this hypothesis is not formulated in terms of ratios with respect to GDP, an implicit additional constraint is imposed.

9. Afonso and Rault (2008) estimate a similar equation for different panels of EU and OECD countries.

3.2 Ricardian equivalence testing in structural consumption equations

The starting point to test the empirical validity of the Ricardian equivalence hypothesis could be the estimation of a consumption function with disposable income and public debt as regressors. Within this framework, a positive and significant coefficient of public debt would be interpreted as evidence against Ricardian behaviour in that public debt would represent net wealth for households and would therefore affect consumption decisions. A similar approach would consist of using the general government balance instead of public debt as explanatory variable. This is the approach adopted in Kochin (1974), which aims at estimating the effects of public deficits on private consumption in the United States. For this purpose, Kochin estimates the following consumption function

$$c_t = \alpha_0 + \alpha_1 y_t^d + \alpha_2 c_{t-1} + \alpha_3 gb_t + u_t \tag{5}$$

where c_t is private consumption of non-durables and services, y_t^d households' disposable income, gb_t the government balance and u_t a residual. His results are obtained on the basis of annual data covering the period 1952-1971 and estimation of (5) in first differences. With this specification, if consumers were Ricardian (in its strong version), α_3 should be significant and equal to the coefficient of disposable income α_1. If, on the other hand, α_3 were significant but lower than α_1, the strong version of the Ricardian proposition would not hold, although it would imply that future tax duties are partially discounted, still in line with the permanent income hypothesis. This is what it has been called the "weak version" of the neutrality hypothesis by some authors. Finally, if α_3 were non-significant, it would mean that consumers behave in a Keynesian way. In Kochin's estimations the coefficient of the government balance turns out to be significant, although lower than the coefficient of disposable income, thereby rejecting the strong version of the Ricardian hypothesis.

However, equation (5) is subject to numerous shortcomings. In particular, it has been argued that it cannot be taken as a conclusive test for the neutrality hypothesis; rather, as an attempt to measure the wealth effect of public deficits/debt on consumption within a Keynesian framework. Moreover, it raises a number of econometric concerns. Specifically, Buiter and Tobin (1979) argue that Kochin's estimates are affected by simultaneity and identification problems in that consumption, disposable income and government balance are closely linked to the economic cycle. In their analysis, they consolidate the entrepreneurial sector with households. Under the Barro's neutrality assumption, the relevant income for consumption decisions is y-g, where y is total income and g government spending. Accordingly, they propose the following specification:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 ntr_t + \alpha_3 gb_t + u_t \tag{6}$$

where y_t is households' income before taxes and transfers and ntr_t transfers net of taxes. With this specification the neutrality hypothesis would hold in its strong version if the coefficients of income, transfers net of taxes and the government balance were equal in absolute value ($\alpha_1=\alpha_3=\alpha_2$), whereas the weak version of this hypothesis would be accepted if only $\alpha_3=\alpha_2$ held. Conversely, consumers would be Keynesian if the coefficient of the government balance was non-significant and the coefficients of income and taxes net of transfers were equal in absolute value.

Another possibility is to disaggregate net transfers into transfers strictly speaking and government receipts, mainly tax-revenue. Therefore, such specification would include

households' income before taxes and transfers, total government revenues, transfers and the general government balance as the main regressors[10]:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 t_t + \alpha_3 tr_t + \alpha_4 gb_t + u_t \quad (7)$$

Similarly to (6), specification (7) nests the Ricardian and the Keynesian hypotheses. Thus, a "weak" version of the neutrality hypothesis would hold if the effects of the government balance and transfers on consumption were just the opposite to that of taxes. Accordingly, the restriction would be $\alpha_3 = \alpha_4 = -\alpha_2$, implying

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_4 g_t + u_t$$

where g_t is government expenditure on goods and services. Likewise, the "strong" version of the neutrality hypothesis would verify if, additionally to the latter, the restriction that the coefficients of income, transfers and government balance were the same held. In this case,

$$c_t = \alpha_0 + \alpha_1 (y_t - g_t) + u_t$$

Conversely, if consumers behaved according to the Keynesian view, the joint hypothesis of $\alpha_1 = \alpha_3 = -\alpha_2$ and $\alpha_4 = 0$ should hold, leading to the following consumption equation

$$c_t = \alpha_0 + \alpha_1 (y_t - t_t + tr_t) + u_t$$

with the term in parentheses being households' disposable income.

In turn, Kormendi (1983) proposes a more general specification aiming at distinguishing between the "standard" (Keynesian) approach as opposed to the "consolidated" (Ricardian) one. He estimates the following consumption function:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 y_{t-t} + \alpha_3 g_t + \alpha_4 w_t + \alpha_5 tr_t + \alpha_6 t_t + \alpha_7 re_t + \alpha_8 g\,int_t + \alpha_9 pd_{t-1} + u_t \quad (8)$$

where here y_t is national income, w_t net wealth, re_t corporate retained earnings, $gint_t$ interests paid on government debt and pd_{t-1} end-of-period t-1 public debt. Therefore, under the "standard" approach the private sector is assumed to ignore government spending, implying $\alpha_3 = 0$, whereas negative coefficients for retained profits and taxes, jointly with positive coefficients for interest payments and public debt are expected. By contrast, under the consolidated approach government consumption is expected to affect private consumption negatively, whereas the decision of financing spending via taxes or debt issuance is immaterial for consumption decisions. Moreover, if neutrality holds, neither retained profits, interest payments nor public debt are considered to affect consumption decisions and accordingly $\alpha_7 = \alpha_8 = \alpha_9 = 0$ should verify.

10. This is the specification adopted by Raymond and González-Páramo (1987) or Fuster (1993) in the case of Spain.

3.3 Ricardian equivalence testing in consumption equations derived from Euler conditions

This family of consumption equations is derived directly from the Euler first order conditions of the consumer's intertemporal optimization problem. The main advantage of this approach is that the use of first order conditions avoids misspecification of consumption functions based on the Permanent Income hypothesis [see Seater (1993)]. Accordingly, it allows testing directly to what extent the necessary conditions for Ricardian equivalence hold, namely the absence of liquidity constraints or infinite horizons for consumers' decisions, similar to those of the government, among others.

The main empirical studies testing the neutrality hypothesis are largely based on the uncertainty model proposed in Blanchard (1985), where a constant fraction μ of the population dies every period. Blanchard's model implies the following consumption function:

$$c_t = \alpha\left[(1+r)a_{t-1} + \sum_{j=0}^{\infty}\left(\frac{1-\mu}{1+r}\right)^j E_t y_{t+j}\right] \tag{9}$$

where a_{t-1} is the stock of assets at the end of period t-1, including public debt holdings, r is the real rate of return of assets, y_t labour income net of taxes, E_t the expectation operator conditional to the information set at period t and α the propensity to consume out of wealth. The aggregate budget constraint can be written as

$$a_t = (1+r)a_{t-1} + y_t - c_t \tag{10}$$

Within this framework, Ricardian equivalence does not hold if $\mu > 0$ —which implies that consumers have finite horizons— in that a wedge between consumers' discount rates of future interest payments and future tax payments shows up. Thus, the effect of a finite constant probability of death increases consumers' time preference, raising its effective subjective discount rate. In this case, the Ricardian proposition fails because consumers implicitly perceive that they will pay only part of future taxes and, accordingly, current public debt holdings are seen as net wealth. From (9) and (10) and defining a stochastic process for labour income an aggregate consumption function can be written without explicitly incorporating human wealth as follows:

$$\Delta c_t = \beta - \mu\frac{r+\mu}{1-\mu}a_{t-1} + \varepsilon_t + \rho\varepsilon_{t-1}$$

where ρ is such that $-1 < \rho < 1$, β is another parameter and ε_t is a serially uncorrelated error term with a zero mean and a finite variance [Evans (1993)]. On the other hand, the aggregate consumption function can also be expressed in terms of non-human wealth only, as shown by Leiderman and Razin (1988). In this case, the consumption function would look as:

$$c_t = (1+r)\left(1-\alpha+\frac{1}{1+\mu}\right)c_{t-1} - (1-\alpha)\frac{(1+r)^2}{1-\mu}c_{t-2} - \alpha\mu\frac{1+r}{1-\mu}y_{t-1} + \alpha\varepsilon_t - \alpha\frac{1+r}{1+\mu}\varepsilon_{t-1}$$

Interestingly, Blanchard's specification can easily be modified in order to allow for the presence of liquidity constrained households. Accordingly, (9) can be rewritten as

$$c_t = \lambda y_t + \alpha\left[(1+r)a_{t-1} + (1-\lambda)\sum_{j=0}^{\infty}\left(\frac{1-\mu}{1+r}\right)^j E_t y_{t+j}\right] \tag{11}$$

where λ is the proportion of liquidity-constrained consumers. Hence, in this framework, consumers would be Ricardian if $\mu = 0$ and $\lambda = 0$. On the contrary, the opposite is true.

Amongst the alternative specifications that can be derived from Blanchard's model we shall consider those in Haque (1988), Hayashi (1982) and Evans (1988), modified after the contribution in Himarios (1995). These are

$$\begin{aligned} c_t = {} & (1+r)\left((1-\alpha)+\frac{1}{1-\mu}\right)c_{t-1} - (1-\alpha)\left(\frac{(1+r)^2}{1-\mu}\right)c_{t-2} + \lambda y_t - \\ & -\left(\frac{1+r}{1-\mu}\right)(\alpha\mu + \lambda(2-\alpha-\mu))y_{t-1} + \lambda(1-\alpha)\left(\frac{(1+r)^2}{1-\mu}\right)y_{t-2} + \varepsilon_t \end{aligned} \tag{12}$$

$$\begin{aligned} c_t = {} & \left(\frac{1+r}{1-\mu}\right)(1-\alpha(1-\mu))c_{t-1} - \alpha\mu\left(\frac{(1+r)^2}{1-\mu}\right)a_{t-2} + \lambda y_t - \\ & \left(\frac{1+r}{1-\mu}\right)(\lambda - \alpha(\lambda-\mu))y_{t-1} + \varepsilon_t \end{aligned} \tag{13}$$

$$\begin{aligned} c_t = {} & \left(\frac{1+r}{1-\mu}\right)(1-\alpha)c_{t-1} - \alpha\mu\left(\frac{(1+r)}{1-\mu}\right)a_{t-1} + \lambda y_t - \\ & \lambda\left(\frac{1+r}{1-\mu}\right)(1-\alpha)y_{t-1} + \varepsilon_t \end{aligned} \tag{14}$$

Another alternative specification is due to Aschauer (1985). He models the intertemporal optimization problem of a representative agent's effective consumption. Thus, effective consumption can be defined as

$$ce_t = c_t + \theta g_t^{tot} ,$$

where θ represents the degree of substitution between private and public consumption[11], ce_t effective consumption and g^{tot}_t total public expenditure. The consumer faces a usual intertemporal optimization problem, but taking into account the government's budget constraint. Therefore, the following two-equation system, comprised of one consumption equation strictly speaking and one equation used to forecast public consumption, is obtained:

11. The literature is not conclusive in this regard. For instance, Fiorito and Kollintzas (2004) find that, for 12 European countries including Spain, public goods, such as defence, public order, and justice, tend to behave as substitutes for private consumption. By contrast, merit goods including health, education, and other services that could have been provided privately, complement private consumption. However, they find that the relationship between merit goods and private goods turns out to be stronger than that between public goods and private goods. Thus, in the aggregate government and private consumption tend to behave as complements.

$$
\begin{aligned}
c_t &= \delta + \beta c_{t-1} + \eta(L) g_{t-1} + \phi(L) dp_{t-1} + \varepsilon_t \\
g_t &= \gamma + \xi(L) g_{t-1} + \omega(L) dp_{t-1} + \nu_t
\end{aligned}
\tag{15}
$$

where dp_t is public deficit. The theoretical structure of the system imposes the following set of restrictions characterising the Ricardian behaviour:

$$
\begin{aligned}
&\delta = \alpha - \theta\gamma \\
&\eta_i = \begin{pmatrix} \theta(\beta - \xi_i) & i = 1 \\ -\theta\xi_i & i = 2,3,\ldots n \end{pmatrix} \\
&\phi_j = -\theta\omega_j \quad j = 2,3,\ldots n
\end{aligned}
\tag{16}
$$

Nevertheless, the main shortcoming of this approach is that the alternative to the neutrality hypothesis is not well defined. More generally, despite it has been argued that the main advantage of the Euler-condition based approach is that it avoids misspecification problems, it requires some parameter restrictions and testing of the model basic assumptions. Therefore, as pointed out by Himarios (1995), misspecification is still possible.

4 Econometric results

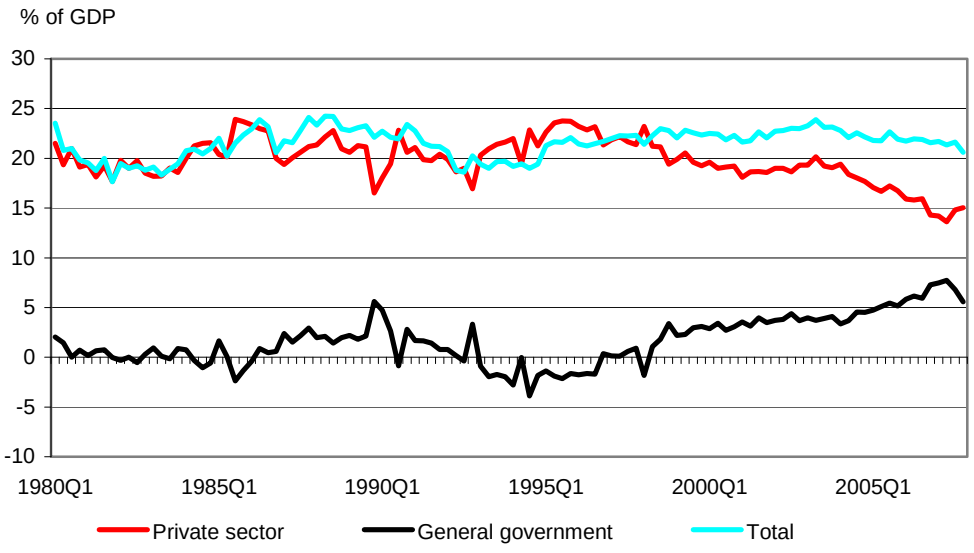
4.1 The data

We use quarterly data covering the period 1980:1-2007:4. Private consumption, gross total income and gross disposable income, as well as the private consumption deflator were taken from the quarterly national accounts. In turn, the quarterly fiscal variables were taken from Estrada et al. (2004), which were estimated applying monthly and quarterly official fiscal indicators on a cash basis to the official ESA-95 annual accounts data (see Appendix A for details). Households' net wealth has been obtained as the sum of total financial wealth, including shares, other securities and government bonds, and the overall stock of immovable property. An estimation of private wealth was needed for some specifications. In this case, private wealth has been obtained by subtracting the stock of public debt from total wealth. All variables have been expressed in real terms by using the private consumption deflator. Finally, the real effective exchange rate vis à vis the OECD countries, calculated with CPI indexes, has been taken from the OECD Main Economic Indicators database.

4.2 Is national saving stable?

As mentioned above, Ricardian equivalence entails that total national saving as a percentage of GDP should be constant in that, under this hypothesis, public and private saving would become perfect substitutes. Figure 1 shows that total gross saving as a percentage of GDP has remained broadly stable over the period 1980-2007. By contrast, after a period of relative stability, private and public saving have displayed opposite trends following EMU accession. ADF unit root tests in Table 1 support the hypothesis of stationarity at the 10% significance level of total gross saving around a constant, whereas public and overall private saving seem to be I(1).[12] In principle, this result would be consistent with the hypothesis of substitution between private and public saving and, therefore, with the Ricardian proposition.

Figure 1: Private and public saving



12. The null hypothesis of two unit roots is rejected in all cases.

Table 1: ADF tests on gross saving

		I(1) vs. I(0)	
	t_α	t_{α^*}	$t_{\alpha^{**}}$
sg_t *(general government.)*	-1.80	-2.45	-3.46*
sps_t *(private sector)*	-0.51	-2.54	-3.30
$shous_t$ *(households)*	-0.77	-3.85**	-5.10**
$stot_t$ *(total)*	0.01	-3.19*	-3.10
		I(2) vs I(1)	
sg_t *(general government.)*	-14.14**		
sps_t *(private sector)*	-13.49**		
$shous_t$ *(households)*	-15.43**		
$stot_t$ *(total)*	-13.14**		

Note: The symbols *, ** and *** denote rejection of the null hypothesis of existence of one unit root at the 10%, 5% and 1% significance levels, respectively.

Stationarity of national saving suggests that private and public saving should be cointegrated, with cointegration vector (1, -1). Table 2 presents the Johansen cointegration test between both series. However, in this case neither the trace nor the LR maximum eigenvalue statistics are able to reject the null of no cointegration.[13] In principle, these results would be in contradiction with the Ricardian hypothesis. However, although no stationary linear combination between both series is obtained, in view of the stationarity at the 10% significance level of total saving[14], some degree of substitution between both appears to exist, as Figure 1 unveils.

Table 2: Johansen cointegration test between private and public saving

Nº coint. Eq.	LR_{max}	5% crit. value	Trace	5% crit. value
r=0	8.379	14.1	9.638	15.41
r=1	1.26	3.76	1.26	3.76
Cointegration Vector		**sps_t**	**sg_t**	**Constant**
		1	-0.80	20.956

ECM	Const.	Coint. eq_{t-1}	Δsps_{t-1}	Δsps_{t-2}	Δsg_{t-1}	Δsg_{t-2}	Δsg_{t-3}	Δsg_{t-4}
Δsps_t	5.05**	-0.23**	-	0.23	0.42**	0.45**	0.31**	0.09
	(0.17)	(0.08)		(0.15)	(0.10)	(0.16)	(0.10)	(0.06)
Δsg_t	-2.63*	0.13	-0.21**	-0.21	-0.68**	-0.57*	-0.27**	-
	(0.17)	(0.08)	(0.10)	(0.15)	(0.13)	(0.16)	(0.10)	
H_0: Cointegration vector = (1,-1)					χ_1^2= 0.78	P Value= 0.38		

Notes: Standard deviations in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

13. In view of the important structural undergone by the Spanish economy over the period under analysis, we took into account the possibility of structural breaks in the series (see Zivot and Andrews, 1992) and tested the hypothesis of cointegration equation with endogenously determined structural breaks between private and public saving [see Gregory and Hansen (1996)]. Nevertheless, the relevant statistics for structural breaks turned out to be non-significant.

14. By definition, stationarity of national saving would also imply a contegration vector (1,-1) between total gross fixed capital formation and the net lending/net borrowing of the economy provided that both are not stationary. In fact, the ADF unit root tests in Appendix B show that these series are I(1), whereas the Johansen cointegration test confirms the existence of a cointegration vector (1,-1) between both variables (see Table B.3).

Table 3 presents the estimation results of (4) and shows evidence in favour of cointegration at the 5% significance level between current account and fiscal balances according to the LR maximum eigenvalue statistic. As the long-term cointegration vector from (4) is expressed as (1, $-\beta_0$, $-\beta_1$, $-\beta_2$), the coefficient of the fiscal balance is negative, which would be consistent with the Ricardian hypothesis. This result is in line with that obtained by Afonso and Rault (2008) for Spain. Summing up, this subsection offers some contradictory results; while the stability of the national saving ratio and the long-term negative correlation between current account and fiscal balances would support the neutrality hypothesis, the lack of cointegration between private and public saving would point to the opposite conclusion. Nevertheless, as mentioned above, the implications tested in this subsection are only necessary but not sufficient conditions for Ricardian equivalence.

Table 3: Johansen cointegration test between current account and fiscal balances

Nº coint. Eq.	LR_{max}	5% crit. value	Trace	5% crit. Value
r=0	22.19	21.13	27.76	29.80
r=1	4.00	14.26	5.57	15.49
r=2	1.57	3.84	1.57	3.84

Cointegration Vector	ca_t	gb_t	$reer_t$	**Constant**
	1	2.37	441.32	-29687.40

Note: according to the Akaike information criterion, the VECM has been estimated with 1 lag.

4.3 Results from structural consumption equations

In view of the various empirical methodologies, we followed an eclectic approach and tested the Ricardian hypothesis in the different specifications explained in section 3. However, given that the data are I(1), ECMs were estimated when possible to test for the existence of cointegration among the relevant variables. Such ECMs models were estimated in one step by maximum likelihood using a Marquardt algorithm[15]. In our specifications total (cpr) and non-durable (cpr^{nodur}) private consumption were included as dependent variables in turn. In both cases, estimations were obtained with and without including lagged private wealth (wh_{-1}) as a regressor. The inclusion of households' wealth is justified by the importance of this variable in determining consumption behaviour in theoretical models. Therefore, wealth is often found to be significant in consumption equations[16].

Table 4 shows the results corresponding to the estimation of equation (5). The significance of the coefficient affecting the cointegration equation constitutes evidence in favour of the rejection of the null of no cointegration. All the coefficients display the expected signs when significant and, in most cases, the coefficient of the general government balance is significant. However, equality between the coefficients of disposable income and the government balance is rejected. In principle, this would constitute evidence in favour of the weak version of the neutrality hypothesis, indicating that future tax duties are discounted only partially. Accordingly, these results would reject the strict version of the Ricardian hypothesis, although they would still be consistent with some degree of substitution between public and private saving. Nevertheless, as explained above, this test should be taken more

15. The ECMs were also estimated in two steps by OLS. Since these estimations led to similar results to those presented here, we decided not to present them for the sake of brevity.
16. See Sastre and Fernández (2005) for consumption functions in Spain.

as an attempt to measure the wealth effect of public deficits/debt on consumption within a Keynesian framework than a real test of the neutrality proposition.

Table 4: Kochin test

	cpr	cpr	cpr^{nodur}	cpr^{nodur}
Cointegration equation				
y^d	0.92***	1.04***	0.76***	0.76***
	(0.03)	(0.15)	(0.01)	(0.03)
gb	0.30**	0.21	0.22***	0.17**
	(0.14)	(0.28)	(0.05)	(0.07)
wh_{-1}		-0.003		-0.000
		(0.003)		(0.001)
Short-term dynamics				
ECM_{-1}	-0.13**	-0.08	-0.28***	-0.26***
	(0.05)	(0.06)	(0.06)	(0.07)
Δcpr_{-1} / Δcpr^{nodur}_{-1}	0.36***	0.25***	0.16*	0.12
	(0.08)	(0.08)	(0.08)	(0.09)
Δy^d	0.21***	0.16***	0.24***	0.22***
	(0.06)	(0.05)	(0.05)	(0.05)
Δgb	0.13***	0.07*	0.14***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)
Δwh_{-1}		0.004***		0.002**
		(0.001)		(0.001)
Constant	-114.87	-418.96	1038.94***	985.89*
	(295.64)	(390.29)	(357.74)	(528.31)
R^2	0.44	0.52	0.45	0.48
Nº obs.	110	110	110	110
Wald tests				
y^d = gb	16.91***	6.92***	94.23***	87.62***

Notes: Standard deviations in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

As for the test proposed by Buiter and Tobin, we estimated (6), both for total and non-durable private consumption as dependent variables. As before, households' private wealth was included as an additional regressor and we took into account the possibility that the series were cointegrated. In fact, the Johansen cointegration tests rejects in all cases the null of no cointegration, with the Trace and Maximum eigenvalue statistics indicating the existence of (at least) one cointegration equation (see Table 5). However, in no case both statistics were simultaneously significant at the 5% significance level, which led us to consider only one cointegration equation in the VECM models.

Table 5: Buiter-Tobin test: Johansen cointegration test

	cpr	cpr	cpr^{nodur}	cpr^{nodur}
Cointegration equation				
y	0.68***	0.86***	0.70***	0.66
	(0.03)	(0.06)	(0.03)	(0.15)
gb	-0.21	-0.80*	0.79***	-1.76
	(0.15)	(0.31)	(0.17)	(0.90)
ntr	-0.18	-0.46	0.21*	-0.18
	(0.10)	(0.27)	(0.10)	(0.84)
wh_{-1}		-0.003**		-0.005
		(0.001)		(0.004)
Constant	6586.96	3590.00	8020.65	3924.04
Trace statistics				
r=0	58.89***	91.67***	47.86***	96.20***
r≤1	29.40*	52.12**	29.80	52.95**
r≤2	4.30	28.12*	15.49	25.63
r≤3	0.13	7.46	3.84	11.01
r≤4		2.80		2.63
$LR_{max.}$ Statistics				
r=0	29.50**	39.55***	27.58***	43.25***
r≤1	25.10**	24.00	21.13	27.31*
r≤2	4.17	20.67*	14.26	14.62
r≤3	0.13	4.66	3.84	8.38
r≤4		2.80*		2.63
Nº obs.	110	106	107	109
LR tests				
y = ntr; gb=0 (Keynesian)	18.75***	6.93**	18.04***	2.62
y = gb=ntr (Ricardian)	22.56***	12.20***	34.31***	12.61***

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

In VECM estimates (Table 5), income coefficients are always positive and significant, ranging from 0.66 to 0.86. The coefficients of the general government balance and net transfers are also positive, as expected, and significant in the non-durable consumption equation without wealth. Conversely, in the total private consumption equation the coefficients of the general government balance and wealth are, unexpectedly, negative and significant, although in the former case at the 10% significance level only. In the remaining cases, the coefficients of the fiscal variables are not significant. In order to check the consistency of these estimates single ECMs were estimated in one step. Table 6 shows these results. As in the VECMs, the income coefficients are always positive and significant, and similar to those in the VECM estimates. By contrast, the long-term coefficients of the fiscal variables are not significant in any specification. The short-term coefficients display the expected sign.

Table 6: Buiter-Tobin test: One-step ECM estimation

	cpr	cpr	cpr^{nodur}	cpr^{nodur}
Cointegration equation				
y	0.87***	0.94***	0.64***	0.64***
	(0.10)	(0.16)	(0.03)	(0.03)
gb	0.58	0.70	0.10	-0.0004
	(0.44)	(0.64)	(0.14)	(0.15)
ntr	0.30	0.63	-0.02	-0.11
	(0.29)	(0.69)	(0.09)	(0.14)
wh_{-1}		-0.0002		-0.001
		(0.002)		(0.001)
Short-term dynamics				
ECM_{-1}	-0.12**	-0.10	-0.28***	-0.29***
	(0.06)	(0.06)	(0.07)	(0.07)
Δcpr_{-1} / Δcpr^{nodur}_{-1}	0.33***	0.23***	0.20**	0.14*
	(0.09)	(0.09)	(0.08)	(0.08)
Δy	0.24***	0.20***	0.26***	0.23***
	(0.05)	(0.05)	(0.05)	(0.05)
Δgb	0.10*	0.07	0.10*	0.06
	(0.06)	(0.05)	(0.06)	(0.06)
Δntr	0.02	0.03	0.01	-0.003
	(0.05)	(0.05)	(0.05)	(0.05)
Δwh_{-1}		0.004***		0.002***
		(0.001)		(0.001)
Constant	288.38	251.99	2082.45***	1843.128***
	(418.60)	(456.68)	(641.90)	(656.83)
R^2	0.47	0.56	0.46	0.50
Nº obs.	110	110	110	110
Wald tests				
y = ntr; gb=0 (Keynesian)	200.66***	20.15***	1086.83***	126.18***
y = gb = ntr (Ricardian)	29.65***	0.33	235.19***	37.52***

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

We tested the neutrality hypothesis in the VECM (by means of Likelihood ratio tests) and in the single ECM[17] (Wald tests) specifications, with both sets of estimations yielding largely the same results[18]. Ricardian equivalence is clearly rejected for non-durable consumption. It is also rejected for total private consumption except when wealth is included as regressor in the single ECM specification. However, the Ricardian hypothesis should not be accepted on the basis of such estimation in that the non-significant adjustment coefficient in the ECM reveals some misspecification. As Table 6 shows, weak neutrality does not seem to hold either, in that the coefficients of the government balance and net transfers displays sometimes unexpected negative signs but mostly because they are not significant.

17. See Table 6. In this case, the significance of the coefficients of long-term residuals also rejected the null hypothesis of no cointegration except in one case.

18. The single ECM specification was also estimated in two steps, leading to similar results to those in Table 6.

On the other hand, the "Keynesian hypothesis" is also rejected in almost all cases despite the coefficient of the government balance is broadly non-significant, especially in the one-step ECM estimations (Table 6). Thus, rejection of the Keynesian hypothesis seems to be mainly due to the coefficient of taxes net of transfers being also non-significant and very different from the income one.

Table 7: Buiter-Tobin test (expanded). One step estimation

	cpr	cpr	cpr^{nodur}	cpr^{nodur}
Cointegration equation				
y	1.10***	1.11***	0.76***	0.74***
	(0.22)	(0.18)	(0.05)	(0.05)
t	-0.22	-0.58	0.05	0.10
	(0.23)	(0.55)	(0.07)	(0.12)
tr	-1.14	-0.56	-0.73***	-0.67***
	(0.83)	(0.60)	(0.26)	(0.26)
gb	-0.003	0.25	-0.18	-0.21
	(0.40)	(0.44)	(0.15)	(0.15)
wh_{-1}		0.001		-0.001
		(0.002)		(0.001)
Short-term dynamics				
ECM_{-1}	-0.14**	-0.12**	-0.32***	-0.32***
	(0.06)	(0.06)	(0.07)	(0.07)
Δcpr_{-1} / Δcpr^{nodur}_{-1}	0.31***	0.22**	0.17**	0.13
	(0.10)	(0.09)	(0.08)	(0.08)
Δy	0.26***	0.22***	0.27***	0.25***
	(0.06)	(0.05)	(0.05)	(0.05)
Δt	-0.02	-0.04	-0.01	-0.002
	(0.05)	(0.05)	(0.04)	(0.05)
Δtr	-0.05	-0.01	-0.09	-0.08
	(0.09)	(0.08)	(0.09)	(0.09)
Δgb	0.07	0.06	0.06	0.04
	(0.06)	(0.06)	(0.06)	(0.06)
Δwh_{-1}		0.004***		0.002**
		(0.001)		(0.001)
Constant	-338.66		1563.40**	1476.00**
	(500.86)		(627.09)	(654.28)
R^2	0.50	0.57	0.50	0.53
Nº obs.	110	110	110	110
Wald tests				
gb=tr=-t (weak neutrality)	5.14*	4.05	12.19***	9.39***
y=gb=tr=-t (Ricardian)	46.57***	7.26*	341.57***	53.34***
y =tr=-t ; gb=0 (Keynesian)	271.11***	37.58***	1571.33***	162.37***

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

Table 8: Kormendi test

	Levels		First differences	
	cpr	cpr^{nodur}	cpr	cpr^{nodur}
y^{tot}	0.47***	0.39***	0.20***	0.18***
	(0.04)	(0.03)	(0.05)	(0.05)
y^{tot}_{-1}	0.18***	0.18***	0.08**	0.09***
	(0.04)	(0.03)	(0.03)	(0.03)
g	-0.11	0.07	-0.09	-0.08
	(0.11)	(0.07)	(0.06)	(0.06)
w_{-1}	0.000	-0.000	0.002***	0.002**
	(0.001)	(0.000)	(0.001)	(0.001)
tr	-0.11	0.01	-0.02	-0.04
	(0.12)	(0.10)	(0.06)	(0.06)
t	0.17***	0.01	0.10**	0.08*
	(0.05)	(0.05)	(0.04)	(0.04)
re	-0.36***	-0.39***	-0.03	-0.05
	(0.08)	(0.05)	(0.09)	(0.09)
gint	-0.25	-0.46***	0.04	0.02
	(0.15)	(0.10)	(0.20)	(0.19)
pd_{-1}	0.007*	0.005**	-0.02**	-0.01
	(0.004)	(0.002)	(0.01)	(0.01)
Constant	6719.51***	8518.37***	233.11***	245.42***
	(1992.76)	(1184.85)	(71.21)	(67.61)
R^2	0.999	0.999	0.55	0.47
Nº obs.	111	111	110	110
Wald tests				
y = tr=-t=-re=gint; g=0 (Keynesian)	156.31***	226.56***	31.87***	27.31***
t=re=gint=pd=0 (Ricardian)	94.00***	198.94***	14.92***	9,03*

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

The estimation of equation (7), with taxes and transfers separately, led to similar results. Table 7 presents these estimations for both total and non-durable private consumption expenditure. As in previous cases, given the non-stationarity of the series we allow for the possibility of cointegration and estimate one-step ECMs accordingly. In fact, the coefficients of long-term residuals are always significant, rejecting the null hypothesis of no cointegration. Except transfers in the non-durable consumption specifications (and in these cases with unexpected signs), the fiscal variables are not significant, pointing to rejection of the neutrality proposition. Indeed, such proposition, in its weak and strong versions, is formally rejected by the Wald tests in almost all cases. Specifically, neutrality in its weak form cannot be rejected for total private consumption when wealth is included as a regressor. Similarly to previous tests, the Keynesian model is also rejected due to the sizeable difference between the coefficients of taxes and total households' income.

Following Kormendi (1983), Table 8 presents our estimations in levels and in first differences of equation (8). Again, the coefficients of total income are positive and significant

regardless the specification. For the rest of the coefficients, the results are more mixed. As for the specification in levels, the coefficients of fiscal variables are largely non-significant except the coefficient of taxes in one case, which displays an unexpected positive sign. Moreover, the coefficients of retained earnings are negative, whereas those of public debt are positive. In both cases coefficients are significant. The specification in first differences offers some striking results, though. Namely, apart from the coefficients of income and wealth, the only significant ones are those of taxes and public debt, and in both cases with unexpected signs.

Table 9: Kormendi test with interaction with changes in the debt-to-GDP ratio (levels)

	cpr			cpr^{nodur}		
y^{tot}	0.45***	0.45***	0.45***	0.39***	0.39***	0.39***
	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
y^{tot}_{-1}	0.19***	0.18***	0.20***	0.18***	0.18***	0.18***
	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
g	-0.07	-0.08	-0.12	0.06	0.06	0.06
	(0.13)	(0.13)	(0.12)	(0.08)	(0.08)	(0.08)
w_{-1}	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
tr	-0.09	-0.06	-0.09	0.01	0.01	0.01
	(0.12)	(0.13)	(0.12)	(0.10)	(0.10)	(0.10)
t	0.14**	0.15**	0.16***	-0.000	0.000	0.000
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
re	-0.37***	-0.37***	-0.36***	-0.40***	-0.40***	-0.40***
	(0.08)	(0.08)	(0.08)	(0.05)	(0.05)	(0.05)
gint	-0.28*	-0.30*	-0.23	-0.46***	-0.46***	-0.45***
	(0.16)	(0.17)	(0.16)	(0.11)	(0.12)	(0.11)
pd_{-1}	0.008*	0.009*	0.007*	0.005*	0.005*	0.004*
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
dpd-gdp	-0.001***			-0.000		
	(0.000)			(0.000)		
dpd-gdp1		-0.001**			-0.000	
		(0.000)			(0.000)	
dpd-gdp2			-0.001*			-0.000
			(0.001)			(0.000)
Constant	7383.04***	7142.87***	6988.07***	8374.10***	8357.41***	8376.73***
	(2165.14)	(2177.88)	(2079.43)	(1332.83)	(1302.44)	(1250.93)
R^2	0.999	0.999	0.999	0.999	0.999	0.999
Nº obs.	107	107	107	107	107	107
Wald tests						
y=tr=-t=-se=gint; g=0 (Keynesian)	160.32***	161.52***	132.51***	212.93***	221.08***	205.04***
t=re=gint=pd=0 (Ricardian)	116.49***	114.16***	100.63***	198.14***	204.95***	188.52***

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

In any case, both sets of specifications led again to rejection of the Ricardian proposition mainly due to the significance of the public debt and tax coefficients and the non-significance of public expenditure. Furthermore, despite the latter, the Wald tests led to the rejection of the "standard" (Keynesian) approach too. This is due to the sizeable difference between the coefficients of fiscal variables and income. In this case, ECM one-step coefficients are not presented because the large number of coefficients led to multicolinearity problems and near-singular variance-covariance matrix that hampered the estimation.

The effects of public debt on consumption may be non-linear in the sense that higher government indebtedness would lead consumers to anticipate future higher taxes. If so, one could conclude that consumers would become increasingly Ricardian as public debt went up. In order to test this hypothesis, equation (8) is augmented to account for interaction effects between the level of public debt and changes in the debt-to-GDP ratio, as follows:

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 y_{t-t} + \alpha_3 g_t + \alpha_4 w_t + \alpha_5 tr_t + \alpha_6 t_t + \alpha_7 re_t + \alpha_8 g\,int_t + \alpha_9 pd_{t-1} + \alpha_{10} pd_{t-1} * \Delta pdratio_{t-1} + u_t \quad (8')$$

where pd*Δpdratio is the aforementioned interaction term. Equation (8') was estimated in levels and three possibilities for the interaction term were considered: first, the interaction between the level of public debt and changes in the debt-to-GDP ratio as such; second, the same as in the previous case but only when the debt-to-GDP ratio increased; and third, the interaction of the level of public debt with a dummy that takes value 1 if the debt-to-GDP ratio increases and 0 otherwise, in line with Afonso (2008). The results in Table 9 are very similar to those in Table 8: the coefficients of fiscal variables are largely non-significant except the coefficient of taxes in total private consumption specifications, although with an unexpected positive sign; the coefficients of retained earnings and interest payments are usually negative and significant; the coefficients of public debt are always positive and significant at the 10% significance level and, finally, as expected, the interaction coefficients are negative, although only significant in total private consumption specifications. As in the previous case, both the Ricardian and the "standard" (Keynesian) approaches are rejected.

The process of gradual openness Spain has been immersed in stepped up in the last decade. This factor might have affected consumption patterns by providing wider financing opportunities. We took into account this element and included the volume of net foreign assets as an additional regressor in the previous specifications. However, this variable was not significant and its inclusion did not alter the results in Tables 4 to 9.

In sum, all the tests based on structural consumption equations presented in this sub-section reject the Ricardian equivalence proposition. However, the estimated models reject the Keynesian hypothesis too. As a result, rejection of both extreme cases could be consistent with the view that consumers, although discounting future tax behaviour, they only do it in part. This might be mainly explained by consumers horizons being shorter than governments' ones. As a matter of fact, consumers having finite horizons is the main reason claimed by Cardia to reject Ricardian equivalence[19]. The estimates in Table 9 might be consistent with this hypothesis. They also seem to provide some support, although weak, to the hypothesis of non-linear effects of public debt on consumption in the sense of consumers becoming increasingly Ricardian the higher government indebtedness is.

19. Cardia (1997) uses simulated series and tests Ricardian equivalence in a model that nests the Ricardian hypothesis in a non-Ricardian one.

In this regard, the higher the level of public debt, the sooner households expect to be confronted with higher taxes[20].

4.4 Results from Euler-type consumption equations

As in the previous sub-section, the neutrality hypothesis was tested in three alternative specifications. As explained in section 3, the specifications employed allow for two main sources of rejection of the Ricardian proposition, notably finite consumers' horizons and liquidity constraints. Table 10 presents the unrestricted Maximum Likelihood estimation of consumption equations (12), (13) and (14). As in the previous subsection, the three specifications are estimated for both total and non-durable private consumption. In this case, the variables have been expressed in real per-capita terms.

Table 10: Euler equations tests

	Model (12)		Model (13)		Model (14)	
	cpr	cpr^{nodur}	cpr	cpr^{nodur}	cpr	cpr^{nodur}
c_{t-1}	1.75***	1.37***	1.07***	0.97***	1.02***	1.02***
	(0.22)	(0.20)	(0.05)	(0.04)	(0.05)	(0.01)
c_{t-2}	-0.72***	-0.38***				
	(0.22)	(0.20)				
y_t	0.19	0.26**	0.20	0.25	0.24	0.22**
	(0.12)	(0.10)	(0.13)	(0.10)	(0.12)	(0.10)
y_{t-1}	0.06	0.07	-0.26*	-0.19	-0.24	-0.22
	(0.14)	(0.12)	(0.12)	(0.10)	(-)	(-)
y_{t-2}	-0.27**	-0.31**				
	(0.12)	(0.10)				
a_{t-1}					-0.00	-0.00
					(0.00)	(0.00)
a_{t-2}			-0.00	-0.00		
			(0.00)	(0.00)		
LR tests						
μ=0 (χ^2_2)	6.06**	14.20***	1.85	2.03	1.26	2.03
λ=0 (χ^2_2)	6.29**	13.04***	2.58	6.19**	4.64*	7.04**
μ=λ=0 (χ^2_3)	6.32*	14.20***	6.16	7.12*	5.57	7.11*

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

The Euler equation-based tests in Table 10 are less conclusive than those on structural consumption functions. While the neutrality hypothesis is rejected for non-durable consumption, the results are more mixed for total private consumption. In particular,

20. In this regard, our results are consistent with the findings in Nickel and Vansteenkiste (2008) in that Ricardian equivalence does not seem to hold for low-debt countries. In particular, Nickel and Vansteenkiste (2008) show that low debt EU countries tend to show a Keynesian behaviour in that they find a positive relationship between fiscal balances and the current account. However, this relationship weakens as public debt increases, turning non-significant in very high debt countries. This result is interpreted as consumers becoming increasingly Ricardian with the level of public debt.

Ricardian equivalence is rejected with both versions of Model (12), specified on the basis of current and lagged values of consumption and income. In this case, the hypotheses of infinite horizons and lack of liquidity constraints are rejected. In turn, the hypothesis of infinite horizons (μ=0) cannot be rejected in Model (13), whereas absence of liquidity constraints and the joint hypothesis of $\mu = \lambda = 0$ are rejected again, but only in the case of non-durable consumption. Consequently, the hypothesis of debt neutrality does not seem to hold either. A similar picture emerges from Model (14). In this case, however, the hypothesis of absence of liquidity constraints is also rejected at the 5% significance level in the total private consumption specification. It is worth noting that when the joint hypothesis of $\mu = \lambda = 0$ is rejected, in most cases rejection only takes place at the 10% significance level. Moreover, it is important to bear in mind that the coefficients of wealth are zero or close to in Models (13) and (14), which in principle would be in accordance with the fulfilment of the Ricardian proposition. Therefore, these apparently contradictory results might suggest that, despite its rejection, the departure from the neutrality proposition might not be too large. Such implication would be in line with the results obtained in sub-sections 4.2 and 4.3.

Table 11: Euler equations tests (time-varying interest rates)

	Model (12)		Model (13)		Model (14)	
	cpr	cpr^{nodur}	cpr	cpr^{nodur}	cpr	cpr^{nodur}
c_{t-1}	0.94***	0.84***	0.97***	0.89***	1.00***	0.99***
	(0.13)	(0.12)	(0.05)	(0.04)	(0.01)	(0.01)
c_{t-2}	0.06***	0.10***				
	(0.14)	(0.12)				
y_t	0.69***	0.66***	0.60***	0.52***	0.57***	0.49**
	(0.14)	(0.11)	(0.13)	(0.10)	(0.12)	(0.10)
y_{t-1}	-0.43**	-0.30**	-0.55***	-0.39***	-0.58	-0.48
	(0.16)	(0.12)	(0.13)	(0.10)	(-)	(-)
y_{t-2}	-0.24**	-0.26**				
	(0.15)	(0.12)				
a_{t-1}					0.00	0.00**
					(0.00)	(0.00)
a_{t-2}			0.00	0.00**		
			(0.00)	(0.00)		
LR tests						
μ=0 (χ^2_2)	4.90*	11.88***	3.03	11.98***	3.76	13.33***
λ=0 (χ^2_2)	24.90***	33.98***	21.62***	27.73***	21.45***	27.86***
$\mu=\lambda$=0 (χ^2_3)	25.10***	35.56***	27.65***	38.32***	28.48***	39.67***

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

The estimates in Table 10 have been obtained under the assumption of constant interest rates. Models (12), (13) and (14) have been re-estimated considering time-varying interest rates. Again, these models were estimated by Maximum Likelihood. Table 11 shows these results. In general, the coefficients are more significant than those in Table 10 and with the expected signs, except for the coefficients of wealth. According to

these estimates, the Ricardian proposition would be rejected in all cases. In the case of total private consumption infinite horizons (μ=0) is accepted in two out of the three cases. Hence, rejection of the neutrality hypothesis would be mainly due to the rejection of absence of liquidity constraints. In the case of non-durable consumption, both hypotheses are rejected at the 1% significance level. However, the same apparent contradiction detected with constant interest rates emerges again: the coefficients of wealth are almost zero, which, in principle, would be in accordance with the Ricardian proposition. As in the previous case, this result is interpreted as the deviation from the neutrality hypothesis being relatively limited.

Finally, the Aschauer's approach [system (15)] that models consumer's effective consumption, including public expenditure, is presented in Table 12. The likelihood-ratio test shows that the set of hypotheses (16) defining Ricardian behaviour are rejected. However, despite rejection of the neutrality proposition in this context, the problem of this test is that the alternative to Ricardian behaviour is not specified in the model.

Table 12: The Aschauer test

	c_{t-1}	g_{t-1}	g_{t-2}	dp_{t-1}	dp_{t-2}	δ / γ
			Unrestricted model			
c_t	1.036***	0.050	-0.115	-0.018	-0.000	-0.018
	(0.020)	(0.118)	(0.115)	(0.035)	(0.036)	(0.016)
g_t		0.923***	0.068	-0.036	0.083**	0.016**
		(0.098)	(0.098)	(0.029)	(0.030)	(0.006)
			Restricted model			
c_t	1.014***	0.037	-0.034	0.008	-0.022	-0.021
	(0.001)	(-)	(-)	(0.013)	(-)	(-)
g_t		0.899***	0.104	-0.027	0.069**	0.007
		(0.082)	(0.082)	(0.024)	(0.028)	(0.005)
LR test of restrictions: χ^2_4 = 13.62 [Pval. = 0.01]						

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

In sum, the results in this sub-section broadly lean toward rejection of the Ricardian hypothesis, especially when non-durable consumption is taken as the dependent variable. The tests are not entirely conclusive, though. In fact, two of the specifications based on the Blanchard's model with total private consumption and constant real interest rates failed to reject the neutrality proposition. Nevertheless, the estimates suggest that the departure from such proposition might not be too large.

4.5 Our results in context

Our results lean toward rejection of the Ricardian proposition in Spain. As highlighted above, such result is far from surprising in that debt neutrality is only obtained under very tight theoretical conditions that do not seem to hold in real economies. Specifically, liquidity constraints, distortionary taxation, uncertainty about future taxes and income and especially the presence of finite horizons are responsible for the rejection of the Ricardian

equivalence hypothesis. In particular, all the tests carried out over different structural consumption functions reject the Ricardian proposition. In turn, although less clearly and depending on the functional form, the tests on consumption equations stemming from Euler conditions also tend to reject the hypothesis of debt neutrality. However, our results seem to support the existence of some degree of substitution between public and private saving, which could be consistent with the view that consumers, although discounting future tax behaviour, they only do it in part. Therefore, the departure from the Ricardian proposition might be limited from an empirical point of view.

Our conclusions are in accordance with earlier studies that include Spain in their tests. Specifically, Fuster (1993) estimates a consumption function similar to (7) for the largest five EU countries, with her conclusions varying depending on the country. In the case of Spain, the strong version of the Ricardian proposition is rejected, although the results point to the private sector offsetting partially higher public deficits. Likewise, Argimón (1996) accomplishes a very comprehensive study for a set of EU countries and addresses this problem from different angles. Her results are mixed too depending on the approach and the country, although in the case of Spain, the Ricardian hypothesis tends to be rejected by the data. In turn, Marchante (1993) finds that public consumption in Spain exerts a non-significant effect on private consumption, whereas significant effects of taxes net of transfers are detected, thereby rejecting Ricardian equivalence. Raymond and González-Páramo (1987) also obtain evidence against both versions of the Ricardian hypothesis for Spain, e.g. strong and weak, with a model nesting both as well as the Keynesian alternative, basically equation (7). By contrast, García and Ramajo (2002), with Spanish data for the period 1955-2000, gets evidence in favour of partial debt neutrality, rejecting the strict Ricardian and Keynesian alternatives. Finally, Afonso (1998), from Euler-type consumption equations and using panel data over the period 1970-2006 for the EU-15 countries, gets evidence against the hypothesis of debt neutrality. Interestingly, he finds that the higher government indebtedness, the more Ricardian consumers become, also in line with our results.

As for other countries, empirical studies are especially numerous in the case of the USA. Here, the evidence is more mixed. While Barro (1979), Kochin (1974), Seater (1982), Kormendi (1983), Aschauer (1985), Seater and Mariano (1985), Kormendi and Meguire (1986) or Leiderman and Razin (1988) obtain evidence supporting the Ricardian hypothesis (although sometimes in its weak version), Buiter and Tobin (1979), Blinder and Deaton (1985), Modigliani and Sterling (1986), Feldstein and Elmendorf (1990), Evans (1993) or Himarios (1995) among others get the opposite result.

5 Concluding remarks

The Ricardian equivalence states that the way public spending is financed does not affect households' consumption decisions in that public debt does not constitute net wealth for households. A natural consequence is that the decision between tax or debt financing of a given public expenditure path is immaterial for total national saving in that what really matters is the present value of the whole public expenditure path. Accordingly, this proposition implies that public and private saving are perfect substitutes. Theoretically, the Ricardian proposition only holds under very tight assumptions, notably equal length of households' and governments' horizons (typically infinite time horizons for the latter), absence of liquidity constraints, non-distortionary taxes and lack of information asymmetries among others. However, these conditions are difficult, if not impossible, to observe in real economies, which may lead to deviations from the Ricardian equivalence hypothesis.

In this paper, we test the validity of the Ricardian proposition for the Spanish economy from three different approaches: a) by testing its theoretical implications on the stability of national saving and the relationship between fiscal and current account balances, b) by carrying a number of tests on different structural consumption equations and, c) by testing this hypothesis in consumption functions stemming from the Euler equations of a Blanchard-type model. In all cases, the strong version of the Ricardian proposition is rejected with structural consumption equations. The tests on Euler-based consumption equations offer similar results, though they are less conclusive; while the neutrality hypothesis is rejected for non-durable consumption, the evidence for total private consumption is mixed. These results, in accordance with earlier studies, appear quite sensible given that the necessary conditions for the fulfilment of the Ricardian hypothesis do not seem to hold. However, our results are still consistent with some degree of substitution between public and private saving: total national saving is found to be stationary, whereas private and public saving are both I(1) with opposite trends. Despite no cointegration vector between them is found, this might suggest that the departure from the neutrality proposition might not be too large. Finally, we find some support, although admittedly weak, to the hypothesis of non-linear effects of public debt on consumption in the sense of consumers becoming increasingly Ricardian the higher government indebtedness is. In terms of policy implications, our results would suggest that there is some room for fiscal policy to exert its countercyclical role in the case of Spain. However, the effectiveness of such a policy might be limited in a context of rising debt ratios triggering sustainability concerns and making consumers increasingly Ricardian.

Appendix A: Construction of quarterly fiscal variables

The quarterly fiscal variables, except public consumption, are not directly available and it became necessary to interpolate the official annual national accounts data. In general, the interpolation method was achieved by using the Denton method in second relative differences with relevant indicators. The indicators were usually the quarterly concept corresponding to the annual one, on a national accounts basis, obtained by the Statistical Department of the Bank of Spain from official data of budgetary execution relevant for each item. It is worth noting that these quarterly concepts obtained directly from budgetary execution were used as indicators instead of being incorporated directly because the quarterly series were not always fully compatible with the national accounts annual official figures. Accordingly, the method employed corrects the levels of official data of budgetary execution, but preserves the quarterly dynamics unaltered. The remaining paragraphs describe the detailed procedure followed for the most important items.

In particular, the quarterly compensation of employees and the gross operating surplus (which by definition is consumption of fixed capital in the general government sector) were interpolated using as indicators the quarterly compensation of employees and the gross operating surplus, respectively, of non-market services (of which the general government sector is by far the most important one) of the quarterly national accounts. The correlation between the growth rates of the annual series and the annual growth rate of the indicator was perfect.

Indirect taxes net of subsidies received by the general government were obtained by subtracting those corresponding to the rest of the world from indirect taxes net of subsidies of the whole economy. The latter two are provided on a quarterly basis by the INE. However, the quarterly data for indirect taxes net of subsidies of the rest of the world is available only since 1995. Beforehand, the indicators used were transfers to the European Union plus the VAT resource for resources and current transfers from EAGGF-guarantee for subsidies. These indicators captured reasonably well the evolution of the national accounts data in that their correlations were 0.92 and 0.97, respectively.

As for direct taxes, the indicator used in the interpolation procedure was obtained from monthly data of budgetary execution on a national accounts basis since 1999. These data are extended with the quarter-on-quarter growth rates of a four-term non-centred moving average of direct taxes on a national accounts basis estimated by the Statistical Department of the Bank of Spain. Again, the correlation between the growth rates of the annual series and the annual growth rate of the indicator was 1.

As in the case of direct taxes, social contributions and social transfers were interpolated by using their corresponding quarterly indicators on a national accounts basis obtained by the Statistical Department of the Bank of Spain, with almost perfect correlation between the indicators and the official annual series.

The case of property income received was different in that interpolation was not necessary, given that this series coincides with the estimated one by the Statistical Department of the Bank of Spain.

Finally, public investment was interpolated since 1998 using the Construction Industry Production Index for public works released by the INE as indicator. Before 1998 the

indicators used for the interpolation were central government plus social security investment and tenders of public works of the state and local governments. In this case, the correlation with the annual series was 0.88.

Appendix B: Relationship between net lending/net borrowing and gross fixed capital formation

Tables B.1 and B.2 show the unit root tests on the gross fixed capital formation and the net lending/net borrowing, respectively, of the different institutional sectors. In all cases, the null of one unit root cannot be rejected, whereas the hypothesis of two unit roots is clearly rejected.

Table B.1: ADF tests on gross fixed capital formation

		I(1) vs. I(0)	
	t_{α}	$t_{\alpha*}$	$t_{\alpha**}$
ig_t *(general government.)*	0.17	-3.01*	-2.87
ips_t *(private sector)*	0.74	-1.54	-2.04
$ihous_t$ *(households)*	0.82	0.09	-2.49
$itot_t$ *(total)*	0.83	-0.65	-1.64
		I(2) vs I(1)	
ig_t *(general government.)*	-11.49**		
ips_t *(private sector)*	-15.42**		
$ihous_t$ *(households)*	-11.04**		
$itot_t$ *(total)*	-14.21**		

Note: The symbols *, ** and *** denote rejection of the null hypothesis of existence of one unit root at the 10%, 5% and 1% significance levels, respectively.

Table B.2: ADF tests on net lending/net borrowing

		I(1) vs. I(0)	
	t_{α}	$t_{\alpha*}$	$t_{\alpha**}$
ng_t *(general government.)*	-1.60	-2.11	-3.49*
nps_t *(private sector)*	-0.73	-0.60	-2.04
$nhous_t$ *(households)*	-1.56	-1.81	-3.44
$ntot_t$ *(total)*	0.06	-0.57	-1.59
		I(2) vs I(1)	
ng_t *(general government.)*	-14.17**		
nps_t *(private sector)*	-11.09**		
$nhous_t$ *(households)*	-14.54**		
$ntot_t$ *(total)*	-12.34**		

Note: The symbols *, ** and *** denote rejection of the null hypothesis of existence of one unit root at the 10%, 5% and 1% significance levels, respectively.

Given that total net lending/net borrowing and total gross fixed capital formation are both I(1), stationarity of national saving should imply a cointegration vector (1,-1) between both. Table B.3 confirms this intuition. In principle, this result would be in accordance with one of the implications of Ricardian equivalence, notably stationarity of total gross saving. Nevertheless, such accordance does not necessarily imply the fulfilment of the Ricardian hypothesis, as shown in the paper.

Table B.3: Johansen cointegration test between gross fixed capital formation and net lending/net borrowing

Nº coint. Eq.	LR_{max}	5% crit. value	Trace	5% crit. value
r=0	19.59***	14.1	21.99***	15.41
r=1	2.39	3.76	2.59	3.76

Cointegration Vector	**$itot_t$**	**$ntotg_t$**	**Constant**
	1	-1.02	21.169

ECM	Const.	Coint. eq_{t-1}	$\Delta itot_{t-1}$	$\Delta itot_{t-2}$	$\Delta ntot_{t-1}$	$\Delta ntot_{t-2}$	$\Delta ntot_{t-3}$	$\Delta ntot_{t-4}$
$\Delta itot_t$	1.01***	0.05	-0.40***	0.10	-0.07	-0.12	-0.15**	-0.17***
	(0.06)	(-)	(0.09)	(0.09)	(0.06)	(0.06)	(0.06)	(0.06)
$\Delta ntot_t$	5.61***	-0.26***	0.08	0.03	-0.18**	-0.11	-0.01	0.06
	(1.36)	(0.06)	(0.15)	(0.14)	(0.09)	(0.09)	(0.09)	(0.08)

H_0: Cointegration vector = (1,-1)	χ_1^2= 0.02	P Value= 0.88

Notes: Standard deviations in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

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Alcalá, 522; 28027 Madrid
Telephone +34 91 338 6363. Fax +34 91 338 6488
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