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DOES RICARDIAN EQUIVALENCE HOLD?
THE RELATIONSHIP BETWEEN PUBLIC AND
PRIVATE SAVING IN SPAIN

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This paper aims to test the validity of the Ricardian proposition for the Spanish economy in two different frameworks: a) in traditional structural consumption equations and, b) in consumption functions stemming from 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. Moreover, we provide some evidence of consumers becoming increasingly Ricardian with the level of government indebtedness as it may trigger sustainability concerns. In terms of policy implications, these results would suggest that until 2007 fiscal policy in Spain enjoyed some room of manoeuvre to exert its countercyclical role. The sovereign debt crisis has exhausted such margin.

JEL classification codes: E62, E21, H30
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I. 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. 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. 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. Nevertheless, the extent to which consumers behave in relation to the provisions of Ricardian equivalence may have important policy implications in real economies as it may condition the effectiveness of discretionary fiscal policy measures. Moreover, in Ricardian economies public deficits should not affect the current account balance in that public and private saving are perfect substitutes and, accordingly, national saving as a percentage of total income should be stable. In turn, a high share of financially constrained agents or malfunctioning of credit channels make economies depart from the Ricardian proposition, thereby increasing the effectiveness of fiscal policy.

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. This analysis gains special relevance in the case of Spain; in the 1997-2007 period, the net borrowing of the whole economy has deteriorated by more than 10 percentage points of GDP, registering historical highs. Such worsening is largely attributed to the increasingly widening current account deficit. In parallel, the general government balance has registered a remarkable improvement over the same period, from a deficit of 6.5% of GDP in 1995 to a surplus of 2.2% of GDP in 2007. Despite this, it has been claimed in some quarters that fiscal policy should have been tighter in order to avoid such marked worsening of the current account. However, the validity of this statement is closely linked to consumers' response to fiscal policies which is deemed to be conditioned, inter alia, by the functioning of credit markets, the share of credit-constrained consumers or the level of the public debt ratio.

By contrast, since the outbreak of the Great Recession and the accompanying financial crisis, public finances in Spain have deteriorated sharply to register a historically high deficit of 11.1% of GDP in 2009, while steeply increasing public debt has breached the 60% of GDP threshold. However, the brisk deterioration of the external balance observed until 2007 has reverted significantly during the financial crisis. Between 2008 and 2011 the share of financially constrained agents has rocketed, as the unemployment rate has more than doubled (standing well

above 20%) while more and more firms and consumers are stifled by the credit crunch. In principle, these conditions would move the economy away from the Ricardian proposition, thereby raising fiscal multipliers and making fiscal policies more effective. However, insofar as public debt sustainability is at stake, the higher the public debt ratio the more Ricardian are consumers expected to become (Nickel and Vansteenkiste 2008). This would imply that fiscal stimulus packages should lose effectiveness as public finances deteriorate.

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.

As for the rest of the paper, section II explains very simply the Ricardian proposition and the assumptions thereof to illustrate the rationale of the tests used. Next, section III reviews the different approaches proposed in the literature, and followed in this paper, to test the validity of the Ricardian proposition. Section IV explains the data and Section V presents our econometric results. Finally, Section VI offers some conclusions.

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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 in absolute value 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.
[2] The former EU-15.

II. 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. All that matters is the present-value of the government spending path, which is understood as reducing permanent income. Consequently, tax or debt financing of a given public expenditure path is immaterial for consumption decisions as public debt does not constitute net wealth for households. For this reason, the Ricardian equivalence proposition is also known as the debt neutrality hypothesis.

As 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. Thus, public and private saving become perfect substitutes and national saving as a percentage of total income should be stable. In terms of policy implications, the main conclusion would then be that the general government balance by itself should not affect the current account balance. Fiscal policy shocks should translate into responses of private saving of the same size but with opposite sign, leaving the current account unaffected.[4]

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[3] See Ricardo (1817).

[4] 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.

The Ricardian equivalence proposition is derived under very restrictive assumptions. In particular, it 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. 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.[5] But there are other important reasons such as liquidity constraints, distortionary taxes rather than lump-sum ones, or uncertainty about future taxes and income.[6] Thus, in practical terms the most relevant question is to assess how important departures from Ricardian equivalence are (Blanchard and Fischer 1989, Seater 1993).

III. Empirical attempts to test Ricardian equivalence in the literature

A. Traditional tests

Earlier attempts to test the empirical validity of the Ricardian equivalence hypothesis relied on the estimation of a consumption function with disposable income and public debt as regressors. In 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. In particular,

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

Kochin (1974) estimates the effects of public deficits on private consumption in the United States for the period 1952-1971 and rejects the strong version of the Ricardian hypothesis.[7]

However, this approach cannot be taken as a conclusive test for the neutrality hypothesis, but as an attempt to measure the wealth effect of public deficits/debt on consumption within a Keynesian framework. In addition, this specification suffers from serious simultaneity and identification problems in that consumption, disposable income and government balance are closely linked to the economic cycle. Hence, Buiter and Tobin (1979) consolidate the entrepreneurial sector with households. Under the Barro neutrality assumption, the relevant income for consumption decisions is y-g, where y is total income and g government spending. Accordingly, they propose to include total income before taxes, the government balance and transfers net of taxes.[8] 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, whereas the weak version of this hypothesis would be accepted if only the coefficients of transfers net of taxes and the government balance were equal. Conversely, consumers would be Keynesian if the coefficient of the government balance was non-significant and consumption depended only on 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 includes in his specification national income, net wealth, corporate retained earnings, interest paid on government debt and public debt. Therefore, under the "standard" approach the private sector is assumed to ignore government spending, 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

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[7] The strong version of the Ricardian hypothesis is associated with unit coefficients for both disposable income and government balances, whereas a lower coefficient for government balances than for disposable income would imply that the Ricardian proposition would not hold. Nonetheless, 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.

[8] Another possibility is to disaggregate net transfers into transfers strictly speaking and government receipts, mainly tax-revenue. This is the specification adopted by Raymond and González-Páramo (1987) or Fuster (1993) in the case of Spain.

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.

B. Testing Ricardian equivalence in the Blanchard model

The main shortcoming of the previous approaches is their potential misspecification by omitting relevant variables or by including redundant ones. This problem can partially be solved by relying on consumption equations derived directly from the Euler first order conditions of the consumer's intertemporal optimization problem (Seater 1993). Moreover, 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. The Blanchard model implies the following consumption function:

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

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

$$a_t = (1+r)a_{t-1} + y_t - c_t . \quad , \tag{2}$$

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.

Interestingly, the Blanchard specification can easily be modified in order to
allow for the presence of liquidity constrained households. Accordingly, (1) can
be rewritten as

$$c_t = \lambda y_t + \alpha \left[(1+r)a_{t-1} + (1-\lambda)\sum_{j=0}^{\infty}\left(\frac{1-\mu}{1+r}\right)^j E_t y_{t+j} \right] \, , \tag{3}$$

where λ is the proportion of liquidity-constrained consumers. Hence, in this
framework, consumers are Ricardian if $\mu = 0$ and $\lambda = 0$. On the contrary, consumers
would not be Ricardian if any of both conditions did not hold.

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

$$c_t = (1+r)\left[(1-\alpha) + \frac{1}{1-\mu}\right]c_{t-1} - (1-\alpha)\left(\frac{(1+r)^2}{1-\mu}\right)c_{t-2} + \lambda y_t -$$
$$-\left(\frac{1+r}{1-\mu}\right)(\alpha\mu + \lambda(2-\alpha-\mu))y_{t-1} + \lambda(1-\alpha)\left(\frac{(1+r)^2}{1-\mu}\right)y_{t-2} + \varepsilon_t \, , \tag{4}$$

$$c_t = \left(\frac{1+r}{1-\mu}\right)(1-\alpha(1-\mu))c_{t-1} - \alpha\mu\left(\frac{(1+r)^2}{1-\mu}\right)a_{t-2} + \lambda y_t - \left(\frac{1+r}{1-\mu}\right)(\lambda-\alpha(\lambda-\mu))y_{t-1} + \varepsilon_t \, , \tag{5}$$

$$c_t = \left(\frac{1+r}{1-\mu}\right)(1-\alpha)c_{t-1} - \alpha\mu\left(\frac{(1+r)}{1-\mu}\right)a_{t-1} + \lambda y_t - \lambda\left(\frac{1+r}{1-\mu}\right)(1-\alpha)y_{t-1} + \varepsilon_t \quad , \tag{6}$$

C. The Aschauer test

An alternative test for the Ricardian proposition is due to Aschauer (1985). He
models the intertemporal optimization problem of a representative agent's effective
consumption, which can be defined as

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

where θ represents the degree of substitution between private and public consumption,[9] 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:

$$c_t = \delta + \beta c_{t-1} + \eta(L)g_{t-1} + \phi(L)dp_{t-1} + \varepsilon_t \,, \tag{7}$$

$$g_t = \gamma + \xi(L)g_{t-1} + \omega(L)dp_{t-1} + v_t \,,$$

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

$$\delta = \alpha - \theta\gamma \,, \quad \eta_i = \begin{pmatrix} \theta(\beta - \xi_i) & i = 1 \\ -\theta\xi_i & i = 2,3,...n \end{pmatrix}, \quad \phi_j = -\theta\omega_j \quad j = 2,3,...n \,. \tag{8}$$

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

IV. The data

We use quarterly data covering the period 1980:1–2011:4. Private consumption, gross total income and gross disposable income, as well as the private consumption

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[9] 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.

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. 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 estimate 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.

Under Ricardian equivalence total national saving as a percentage of GDP should be constant in that public and private saving would become perfect substitutes. Figure 1 shows that total gross saving as a percentage of GDP remained broadly stable over the period 1980–2007, whereas during the crisis, since 2008, it has displayed a declining trend. After a period of relative stability, private and public saving have followed opposite trends after EMU accession.

Figure 1. Private and public saving
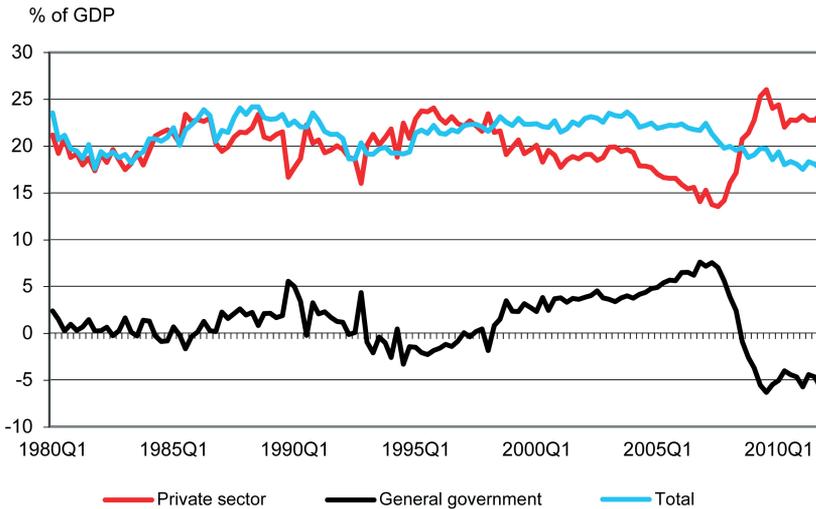
V. Econometric results

A. Results from traditional tests

In view of the various empirical methodologies, we followed an eclectic approach and tested the Ricardian hypothesis in the different specifications explained in section III. We tested such hypothesis for both total (cpr) and non-durable (cpr^{nodur}) private consumption as dependent variables in turn. For the sake of brevity only the estimates for non-durable private consumption are presented in the main text. In fact, non-durable private consumption is more often used as the dependent variable as durable consumption behaviour is much closer to private investment. In any case, the results regarding total private consumption will also be described in the main text, while the corresponding estimates can be found in the online appendix.

As for the test proposed by Buiter and Tobin, we estimated (9), both for total and non-durable private consumption as dependent variables. We also ran regressions including households' private wealth as an additional regressor. As our series are I(1), ECM models were estimated in two steps.[10]

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 ntr_t + \alpha_3 gb_t + u_t \quad , \tag{9}$$

Table 1 shows that income (y) coefficients are always significant and stand around 0.7 for the non-durable consumption specifications (around 0.8 with total consumption). The long-term coefficients of the fiscal variables, government balance and net transfers (gb, ntr), are positive and significant in the specification without private wealth, whereas they turn out to be negative when private wealth is included as a regressor. The long-term coefficient of private wealth (wh_{-1}) is negative and significant, which admittedly is quite counterintuitive, although its absolute value is close to zero. This might be due to the fact that this measure of households' wealth can be somewhat limited as it does not comprise other relevant elements such as retained corporate profits.[11] The short-term coefficients display the expected positive sign though.

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[10] 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 (see Gregory and Hansen 1996). Nevertheless, the relevant statistics for structural breaks turned out to be non-significant.

[11] Table 2 for the Kormendi test shows that the coefficient of net wealth is positive when controlling for these other potentially relevant elements.

Table 1. Buiter-Tobin test with non-durable private consumption (*cpr^nodur*): Two-step ECM estimation

	Sample 1980Q1-2011Q4		Sample 1980Q1-2007Q4	
Cointegration equation				
y	0.77***	0.67***	0.72***	0.65***
	(0.01)	(0.02)	(0.02)	(0.02)
gb	0.13***	-0.34***	-0.13	-0.37***
	(0.04)	(0.08)	(0.11)	(0.08)
ntr	0.28***	-0.42***	0.09	-0.52***
	(0.05)	(0.12)	(0.08)	(0.08)
wh_{-1}		-0.003***		-0.004***
		(0.001)		(0.0003)
Short-term dynamics				
ECM_{-1}	-0.06**	-0.05*	-0.12***	-0.16***
	(0.02)	(0.03)	(0.03)	(0.05)
Δcpr^{nodur}_{-1}	0.13	-0.02	0.01	-0.08
	(0.09)	(0.09)	(0.09)	(0.09)
Δy	0.25***	0.18***	0.25***	0.21***
	(0.04)	(0.04)	(0.05)	(0.05)
Δgb	0.12**	0.08*	0.01	-0.02
	(0.05)	(0.05)	(0.05)	(0.05)
Δntr	0.02	0.01	-0.03	-0.06
	(0.05)	(0.05)	(0.05)	(0.05)
Δwh_{-1}		0.003***		0.003***
		(0.001)		(0.001)
Constant	232.90***	241.25***	312.42***	248.83***
	(54.99)	(52.20)	(64.07)	(60.03)
R^2	0.37	0.45	0.32	0.39
Nº obs.	126	126	110	110
Wald tests				
$y = ntr$; $gb=0$ (Keynesian)	575.10***	504.45***	911.58***	595.28***
$y = gb = ntr$ (Ricardian)	365.17***	325.22***	120.53***	363.42***
Chow test: break in 2008Q1	6.03***	9.71***		

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

The neutrality hypothesis was tested by means of Wald tests, with both sets of specifications yielding largely the same results. Ricardian equivalence is clearly rejected in all cases. Weak neutrality only seems to hold in the equation for total private consumption without private wealth. In the other cases it does not seem to hold either, in that the coefficients of the government balance and net transfers either display unexpected negative signs or they are very different. On the other hand, the "Keynesian hypothesis" is rejected in all cases too, as the coefficient of taxes net of transfers turns out to be very different from the income one and the coefficient of the government balance is significant (except for the specification for total private consumption that includes lagged wealth).

The advent of the financial crisis in 2008 and the concomitant economic collapse has led to a deep credit crunch and triggered high unemployment rates. These elements have contributed to increasing the share of financially constrained agents in the economy to extraordinarily high levels and can bias the results of the analysis towards rejection of the Ricardian proposition. The Chow tests in Table 1 show evidence of a structural break. Hence, we estimated the same equations for the subsample 1980-2007. These are shown in the right panel of Table 1. Despite the structural break suggested by the Chow test, the estimates with either of the two subsamples are rather similar and both the Keynesian and the Ricardian hypotheses are comfortably rejected in all cases.

Table 2 presents the results corresponding to the Kormendi (1983) approach, where the original specification has been enlarged to account for possible non-linear effects of public debt on consumption. Some authors argue that the higher government indebtedness, the higher degree of anticipation of future taxes by consumers, thereby becoming increasingly Ricardian with the level of public debt.[12] Thus, we estimated

$$c_t = \alpha_0 + \alpha_1 y_t^{tot} + \alpha_2 y_{t-1}^{tot} + \alpha_3 g_t + \alpha_4 w_t + \alpha_5 tr_t + \alpha_6 t_t + \alpha_7 re_t + \alpha_8 gint_t + \alpha_9 pd_{t-1}$$
$$+ \alpha_{10} pd_{t-1} * \Delta pdratio_{t-1} + u_t \ , \tag{10}$$

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[12] See Nickel and Vansteenkiste (2008)

where y^{tot}_t is total national income, g_t government expenditure, w_t total net wealth (as opposed to private wealth, *wh,* in Table 1), t_t taxes paid, tr_t transfers, re_t retained earnings, $gint_t$ interest payments, pd_t public debt and $pd*\Delta pdratio$ is an interaction term between the public debt ratio and its change. Equation (10) is estimated in levels and first differences, and includes an interaction between the level of public debt and the change in the debt-to-GDP ratio as in Afonso (2008).[13]

The results for total private consumption and non-durable consumption are very similar. As expected, the coefficients of income and wealth are positive and significant. This is also the case for transfers, although they are only significant in the specifications in levels. The coefficients of public expenditure are negative and significant in all cases. Retained earnings, public debt and the interaction terms also have negative coefficients, although they are only significant in the specifications in levels. Taxes and interest payments present unexpected signs in both cases (positive and negative, respectively) which are only significant in the specifications in levels. As in the previous case, both the Ricardian and the "standard" (Keynesian) approaches are rejected.

As in the Buiter-Tobin case, the Chow tests suggest that a structural break could have taken place as of 2008 mainly due to the tighter financial constraints prevailing during the crisis. Hence, equation (10) was re-estimated for the sub-sample 1980:1–2007:4, both in levels and in first differences. The different specifications yield qualitatively similar results. The Keynesian hypothesis is rejected in both cases, whereas the Ricardian hypothesis is rejected only with the variables in levels. The same results are obtained with total private consumption. These results are consistent with the idea that the Spanish economy has become "less Ricardian" during the crisis.

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[13] The same specification has been estimated with the same interaction term but only when the debt-to-GDP ratio increased. This specification offered similar results.

Table 2. Kormendi test with non-durable private consumption (cpr^{nodur})

	Sample 1980Q1-2011Q4		Sample 1980Q1-2007Q4	
	Levels	First differences	Levels	First differences
y^{tot}	0.31***	0.16***	0.41***	0.15***
	(0.05)	(0.05)	(0.04)	(0.05)
y^{tot}_{-1}	0.06	0.06*	0.18***	0.12***
	(0.05)	(0.03)	(0.04)	(0.03)
g	-0.22***	-0.11**	-0.03	0.0004
	(0.07)	(0.05)	(0.06)	(0.06)
w_{-1}	0.002***	0.002**	0.001**	0.001*
	(0.0005)	(0.001)	(0.003)	(0.001)
tr	0.40***	-0.05	0.03	-0.06
	(0.09)	(0.05)	(0.07)	(0.05)
t	0.16***	0.12***	-0.02	0.02
	(0.03)	(0.04)	(0.04)	(0.05)
re	-0.20***	-0.001	-0.46***	-0.004
	(0.05)	(0.07)	(0.05)	(0.08)
$gint$	-0.39***	0.23	-0.33***	-0.02
	(0.07)	(0.21)	(0.09)	(0.21)
pd_{-1}	0.02***	-0.02	0.003	0.003
	(0.003)	(0.02)	(0.003)	(0.02)
$pd_{-1}*\Delta pdratio_{-1}$	-0.001**	0.0000	-0.0002	-0.0004
	(0.0002)	(0.0003)	(0.0002)	(0.0004)
Constant	17282.81***	242.21***	9552.148***	187.12**
	(1216.98)	(64.61)	(1047.33)	(85.27)
R^2	0.999	0.503	0.999	0.454
N^o obs.	123	123	107	107
Wald tests				
y=tr=-t=-re=gint; g=0 (Keynesian)	126.90***	25.36***	299.97***	18.52***
t=re=gint=pd=0 (Ricardian)	105.39***	13.96***	279.37***	0.45
Chow test: break in 2008Q1	17.54***	2.46***		

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively. The structural break Chow test follow a $F(11,101)$ distribution.

In sum, traditional tests largely reject the Ricardian equivalence proposition. However, the estimated models reject the Keynesian hypothesis too. Rejection of both extreme cases could be consistent with the view that consumers, although discounting future tax behaviour, do so only in part. This might be mainly explained by consumers' horizons being shorter than governments' ones. As a matter of fact, the presence of finite horizons is the main reason claimed by Cardia to reject Ricardian equivalence.[14] The estimates in Table 2 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. In this regard, the higher the level of public debt, the sooner households expect tax hikes.

B. 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 III, the specifications employed allow for two main sources of rejection of the Ricardian proposition, notably finite consumers' horizons and liquidity constraints. Table 3 presents the unrestricted Maximum Likelihood estimation of consumption equations (4), (5) and (6). In this case, the variables have been expressed in real per-capita terms. As in the previous sub-section, these equations are estimated for both the whole sample from 1980:1 to 2011:4 and the restricted sample covering only until 2007:4.

The Euler equation-based tests in Table 3 confirm the results derived from the structural consumption functions. The neutrality hypothesis (the joint hypothesis of $\mu = \lambda = 0$), as well as the individual hypotheses of infinite horizons ($\mu = 0$) and lack of liquidity constraints ($\lambda = 0$), are comfortably rejected in all cases. Again, the specification with total private consumption yields similar results.

The Chow tests indicate the existence of a structural break as of the first quarter of 2008. Thus, as in the previous subsection, we re-estimated our models for the sample covering up to 2007:4. In the restricted sample, the hypotheses of infinite

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

horizons, absence of liquidity constraints and the joint hypothesis of Ricardian equivalence are always rejected, in the last two cases at the 1% significance level. However, for total private consumption the hypothesis of infinite horizons can be rejected neither in specification (5) nor in (6). On the other hand, it is important to bear in mind that the coefficients of the stock of assets (a_{t-i}) are zero or close to in Models (5) and (6), 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 the previous sub-section.

The estimates in Table 3 have been obtained under the assumption of constant interest rates. Models (4), (5) and (6) have been re-estimated considering time-varying interest rates. Again, these models were estimated by Maximum Likelihood. Table 4 shows these results. In general, the coefficients are more significant than those in Table 3 and with the expected signs. According to these estimates, the Ricardian proposition and the absence of liquidity constraints are rejected in all cases again, whereas the hypothesis of infinite horizons cannot be rejected in Model (4) only. Only with total private consumption is the hypothesis of infinite horizons ($\mu = 0$) accepted in all cases, which would imply that the rejection of the Ricardian proposition would be mainly due to the existence of liquidity constraints. 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.

In the restricted sample, the hypotheses of infinite horizons and the absence of liquidity constraints, as well as the joint hypothesis of Ricardian equivalence are rejected in all cases. The same holds when total private consumption is used as the dependent variable.

Table 3. Blanchard-based tests with non-durable private consumption (cpr^{nodur}) — constant interest rates

	Model (4)		Model (5)		Model (6)	
	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4
cpr^{nodur}_{t-1}	1.07***	0.75***	0.94***	0.84***	1.00***	1.00***
	(0.09)	(0.09)	(0.03)	(0.04)	0	0
cpr^{nodur}_{t-2}	-0.10	0.16*				
	(0.09)	(0.09)				
y_t	0.18***	0.24**	0.19**	0.18**	0.21**	0.15**
	(0.04)	(0.05)	(0.04)	(0.04)	(0.10)	(0.05)
y_{t-1}	-0.02	0.02	-0.14*	-0.06	-0.21	-0.15
	(0.06)	(0.05)	(0.05)	(0.05)	(-)	(-)
y_{t-2}	-0.14**	-0.19**				
	(0.05)	(0.05)				
a_{t-1}					0.00	0.00
					(0.00)	(0.00)
a_{t-2}			-0.00*	0.00		
			(0.00)	(0.00)		
LR tests						
$\mu = 0$ (χ_2^2)	20.35***	26.07***	9.11**	14.61***	8.03**	14.35***
$\lambda = 0$ (χ_2^2)	26.20***	31.60***	18.64***	16.10***	27.06***	24.04***
$\mu=\lambda= 0$ (χ_3^2)	31.80***	40.89***	35.13***	25.00***	34.28***	24.73***
Chow test: 2008Q1	6.37***		5.53***		5.60***	

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively. The structural break Chow test follow a F(16,104) distribution.

Table 4. Blanchard-based tests with non-durable private consumption (cpr^{nodur}) — time-varying interest rates

	Model (4)		Model (5)		Model (6)	
	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4	Sample 1980Q1-2011Q4	Sample 1980Q1-2007Q4
cpr^{nodur}_{t-1}	1.01***	0.62***	0.98***	0.82***	0.98***	0.97***
	(0.10)	(0.10)	(0.04)	(0.05)	(0.01)	(0.01)
cpr^{nodur}_{t-2}	-0.04	0.22***				
	(0.10)	(0.10)				
y_t	0.45***	0.51***	0.44***	0.43***	0.43***	0.40***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
y_{t-1}	-0.40**	-0.21**	-0.43***	-0.30***	-0.43	-0.40
	(0.06)	(0.06)	(0.05)	(0.05)	(-)	(-)
y_{t-2}	-0.03	-0.19**				
	(0.06)	(0.06)				
a_{t-1}					0.00*	0.00**
					(0.00)	(0.00)
a_{t-2}			0.00*	0.00*		
			(0.00)	(0.00)		
LR tests						
$\mu=0$ (χ_2^2)	3.42	25.03***	6.52**	44.32***	7.34**	45.12***
$\lambda=0$ (χ_2^2)	88.92***	112.57***	87.17***	81.98***	87.11***	82.65***
$\mu=\lambda=0$ (χ_3^2)	88.94***	117.78***	95.52***	112.58***	97.10***	113.89***
Chow test: 2008Q1	8.84***		6.32***		6.26***	

Notes: Standard errors in parentheses. The symbols *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively. The structural break Chow test follow a $F(16,104)$ distribution.

Finally, the Aschauer test (system 7) that models consumer's effective consumption, including private consumption (c_t) and public expenditure (g_t), is presented in Table 5. The likelihood-ratio test shows that the set of hypotheses (8) defining Ricardian behaviour are rejected with the whole sample. 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. Nevertheless, the Ricardian proposition is not rejected with the sample until

2007:4 (the same holds for total private consumption). Both results are consistent with the hypothesis that the Spanish economy has become "less Ricardian" during the crisis, most likely due to the brisk rise in financially constrained agents.

Table 5. Aschauer test with non-durable private consumption (cpr^{nodur})

	cpr^{nodur}_{t-1}	g_{t-1}	g_{t-2}	dp_{t-1}	dp_{t-2}	δ/γ
			Sample 1980Q1-2011Q4			
Unrestricted model						
cpr^{nodur}_{t}	0.96***	0.03	0.03	0.09**	-0.05	0.04**
	(0.02)	(0.13)	(0.10)	(0.03)	(0.03)	(0.02)
g_{t}		1.01***	-0.09	-0.02	0.05**	0.01**
		(0.09)	(0.09)	(0.02)	(0.02)	(0.00)
Restricted model						
cpr^{nodur}_{t}	0.93***	-0.16	-0.01	0.06**	0.00	0.05
	(0.01)	(-)	(-)	(0.02)	(-)	(-)
g_{t}		1.00***	-0.01	0.03**	0.00	0.01**
		(0.06)	(0.06)	(0.01)	(0.02)	(0.00)
LR test of restrictions:	$\chi^2_4 = 13.41$***					
			Sample 1980Q1-2007Q4			
Unrestricted model						
cpr^{nodur}_{t}	0.98***	0.06	0.00	0.01	0.01	0.01
	(0.02)	(0.12)	(0.13)	(0.03)	(0.03)	(0.02)
g_{t}		0.93***	0.06	0.03	0.01	0.01**
		(0.10)	(0.10)	(0.02)	(0.02)	(0.01)
Restricted model						
cpr^{nodur}_{t}	0.96***	0.05	0.04	0.03	0.01	0.03
	(0.01)	(-)	(-)	(0.03)	(-)	(-)
g_{t}		0.98***	0.02	0.01	0.01	0.01**
		(0.06)	(0.06)	(0.01)	(0.01)	(0.00)
LR test of restrictions:	$\chi^2_4 = 5.10$					

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

VI. Concluding remarks

In this paper, we test the validity of the Ricardian proposition for the Spanish economy in two different frameworks: a) in traditional structural consumption equations and, b) in consumption functions stemming from Euler equations. 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. 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 in real economies, notably due to liquidity constraints, distortionary taxation, uncertainty about future taxes and income and especially the presence of finite horizons. While we provide evidence that the Ricardian hypothesis did not hold before the outbreak of the Great Recession, the sharp increase of the share of financially constrained consumers since 2008 seems to provide further arguments for the rejection of such proposition.

However, our results are still consistent with some degree of substitution between public and private saving, which suggests that the departure from the neutrality proposition might not be too large. Finally, we find some support to the hypothesis 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, although its effectiveness might be limited. This was true until 2007. However, the financial markets' concerns about the sustainability of Spanish public finances during the crisis have exhausted the margin of manoeuvre of fiscal policy and leave the government with no other option than to consolidate public finances even if this implies a pro-cyclical fiscal tightening.

References

Afonso, Antonio (2008), Euler testing Ricardo and Barro in the EU, *Economics Bulletin* 5: 1–14.

Argimón, Isabel (1996), El comportamiento del ahorro y su composición: Evidencia empírica para algunos países de la Unión Europea, Estudios Económicos 55, Banco de España.

Aschauer, David (1985), Fiscal Policy and aggregate demand, *American Economic Review* 75: 117–128.

Barro, Robert J. (1974), Are government bonds net wealth?, *Journal of Political Economy* 82: 1095–1117.

Barro, Robert J. (1979), On the determination of the public debt, *Journal of Political Economy* 87: 940–971.

Blanchard, Olivier J. (1985), Debt, deficits, and finite horizons, *Journal of Political Economy* 93: 223–247.

Blanchard, Olivier J. and, Stanley Fischer, (1989), *Lectures on Macroeconomics*, Cambridge, MA, MIT press.

Blinder, Alan S., and Angus Deaton (1985), The time series consumption function revisited, *Brookings Papers on Economic Activity* 2: 465–511.

Buiter, Willem H., and James Tobin (1979), Debt neutrality: a brief review of doctrine and evidence, in G.M. Von Furstemberg, editor, *Social security and private saving*, Cambridge, MA, Ballinger Publishing Company.

Cardia, Emanuela (1997), Replicating Ricardian equivalence tests with simulated series, *American Economic Review* 87: 65–79.

Estrada, Ángel, José L. Fernández, Esther Moral, and Ana V. Regil (2004), A quarterly macroeconometric model of the Spanish economy, Working Paper 0413, Banco de España.

Evans, Paul (1988), Are consumers Ricardian? Evidence for the United States, *Journal of Political Economy* 96: 983–1004

Evans, Paul (1993), Consumers are not Ricardian: evidence from nineteen countries, *Economic Inquiry* XXXIII: 534–548.

Feldstein, Martin, and Douglas W. Elmendorf (1990), Taxes, budget deficits and consumer spending: some new evidence, *American Economic Review* 80: 589–599.

Fiorito, Riccardo, and Tryphon Kollintzas (2004), Public goods, merit goods, and the relation between private and government consumption, *European Economic Review* 48: 1367–1398.

Fuster Pérez, María L. (1993), La hipótesis de equivalencia ricardiana: Un análisis empírico en los países de la Comunidad Europea, *Investigaciones Económicas* 17: 495–506.

García, Agustín, and Julián Ramajo, (2002), Los efectos de la política fiscal sobre el consumo privado: nueva evidencia para el caso español, Papeles de Trabajo 13/02, Instituto de Estudios Fiscales.

Gregory, Allan W., and Bruce A. Hansen (1996), Residual–based tests for cointegration in models with regime shifts, *Journal of Econometrics* 70: 99–126.

Haque, Nadeem U. (1988), Fiscal policy and private saving behaviour in developing countries, *International Monetary Fund Staff Papers* 35: 316–335.

Hayashi, Fumio (1982), The permanent income hypothesis: estimation and testing by instrumental variables, *Journal of Political Economy* 90: 895–916.

Himarios, Daniel (1995), Euler equations test of Ricardian equivalence, *Economics Letters* 48: 165–171.

Kochin, Levis A. (1974), Are future taxes anticipated by consumers? Comment, *Journal of Money Credit and Banking* 6: 63–70.

Kormendi, Roger C. (1983), Government debt, government spending, and private sector behaviour, *American Economic Review* 73: 994–1010.

Kormendi, Roger C., and Philip G. Meguire (1986), Government debt, government spending, and private sector behaviour: Reply, *American Economic Review* 76: 1180–1187.

Leiderman, Leonardo, and Assaf Razin (1988), Testing Ricardian neutrality with an intertemporal stochastic model, *Journal of Money, Credit and Banking* 20: 1–21

Marchante, Andrés J. (1993), Consumo privado y gasto público: Evidencia para la economía española, *Revista de Economía Española* 1: 125–149.

Modigliani, Franco, and Arlie Sterling (1986), Government debt, government spending and private sector behaviour: Comment, *American Economic Review* 76: 1168–1179.

Nickel, Christiane, and Isabel Vansteenkiste (2008), Fiscal policies, the current account and Ricardian equivalence, Working Paper Series 935, European Central Bank.

Ricardo, David (1817), On the principles of political economy and taxation, in
    P. Sraffa, editor, *The works and correspondence of David Ricardo*, volume 1
    (1951), Cambridge, Cambridge University Press.

Raymond, José L., and José M. González–Páramo (1987), ¿Son equivalentes deuda
    pública e impuestos? Teoría y evidencia, *Papeles de Economía Española* 33:
    365–392.

Seater, John J. (1982), Are future taxes discounted?, *Journal of Money Credit and
    Banking* 14: 376–389.

Seater, John J. (1993), Ricardian equivalence, *Journal of Economic Literature* 31:
    142–190.

Seater, John J., and Roberto S. Mariano (1985), New tests of the life cycle and tax
    discounting hypotheses, *Journal of Monetary Economics* 15: 195–215.

Zivot, Eric, and Donald W. K. Andrews (1992), Further evidence on the Great
    Crash, the oil price shock, and the unit root hypothesis, *Journal of Business &
    Economic Statistics* 10: 251–270.