

ASSESSING RICARDIAN EQUIVALENCE

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ABSTRACT

This paper reviews the literature on Ricardian equivalence. This hypothesis may be interpreted as a generalisation to the short and the long run of the theories which put no weight on the real effects of public policies on aggregate demand. We argue that Ricardian equivalence relies on both permanent income hypothesis and the fulfilment of the intertemporal government budget constraint. The theoretical literature emphasises several reasons for departures from this hypothesis. However, the empirical literature is inconclusive. When Ricardian equivalence is tested in a life-cycle framework the hypothesis is usually rejected, while when the empirical analysis is based on optimising models, it is usually accepted.

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In point of economy, there is no real difference in either of three modes: for twenty millions in one payment, one million per annum for ever, or 1,200,000 for 45 years, are precisely the same value; but people who pay taxes never so estimate them, and therefore do not manage their private affairs accordingly. We are too apt to think that war is burdensome only in proportion to what we are at the moment called to pay for it in taxes, reflecting on the probable duration of such taxes.

D. Ricardo (1820, pp. 186-87)

1. Introduction

Since Barro (1974) questioned whether government bonds are net wealth or not, a great deal of literature has explored this topic both on the theoretical and the empirical grounds. If the answer to the Barro question is no, changes in the composition of government expenditure finance have no real effect on consumption. Then, the phrase “Ricardian equivalence” means that taxes and debt have the same effect on private consumption. In different words, debt is said to be neutral with respect to consumption.

Buchanan (1976) was the first who pointed out the close relationship between the Barro proposition and previous work made by David Ricardo in the eighteen century and proposed to call it *Ricardian equivalence*. Ricardo discussed whether it is preferable to finance a war via new government debt or via an temporary tax. He argued that in fact there is no choice between them, since debt is just deferred taxes. O'Driscoll (1977) noted that Ricardo actually rejected this proposition and proposed to name it *Ricardian nonequivalence*. In the same line, Feldstein (1982) called it *pre-Ricardian equivalence* in the sense that it was claimed by people before Ricardo, and then falsified by him. None of these other labels has been successful in the literature. In the modern economic thought the fact that the means of funding government expenditure are indifferent has been raised before Barro by other scholars: Patinkin (1965), Bailey (1971), and Kochin (1974).¹ However, this literature is closely related to the work of Barro.

To some extent the Ricardian equivalence hypothesis is a generalisation to both the short and the long-run of the theories which put no weight on the real effects of public policies on aggregate demand. Conventional economic analysis on government debt and

¹ Probably, the closest theoretical benchmark to Ricardian equivalence is the Modigliani-Miller (1958) theorem in which, under the conditions of perfect markets, no tax subsidies, and no bankruptcy rules and costs, firms are indifferent among the means of financing (equity and loan). These conditions are quite close to those required for Ricardian equivalence to hold. Rather surprisingly, Modigliani is one of the strongest opponents to this equivalence when related to fiscal policy.

deficit usually maintains that deficit-financed tax cuts raise disposable income and then stimulate aggregate demand at least in the short-run and then has a negative effect in the long run. However, this idea has been challenged, pointing out that rational consumers perceive an increase in deficit in the short term as an increase in taxes in the future, so they discount future taxes leaving private consumption unchanged, even in the short run. The two most important surveys on this topic (Bernheim, 1987; Seater, 1993) conclude with opposite findings. Simple vote counting and a meta-analysis performed by Stanley (1998) provides strong empirical evidence against the proposition, and Elmendorf and Mankiw (1999), with a Salomonic judgement, maintain that the results are inconclusive. While a considerable body of econometric evidence does not support debt neutrality, many authors think that data demonstrate that Ricardian equivalence holds in a mild version due to the fact that the econometric specification of the tests is incorrect and biased against Ricardian equivalence. In this paper we try to overcome these contrasting results. The conditions underlying Ricardian equivalence are clearly too restrictive, so it is useful to understand whether it holds as an approximation in the real world or it is too far from it. In doing so we distinguish between the different approaches, trying to assess the causes and the relevance of these various results. A particular emphasis is given to stochastic approaches.

The “golden age” of the literature on Ricardian equivalence was the eighties, a period in which the high level of budget deficit was one of the main policy concern. As long as the subsequent policies adjusted this disequilibrium, this can be seen as one of the practical effects of the debate surveyed here. At the beginning of the years 2000 budget deficits cause much less concern than before, and in the US the disagreement is on either reducing taxes on the current generation or retiring part of the public debt to lower the burden of the debt on future generations. Indeed, Ricardian equivalence may still shed light on some recent phenomena. For example, the dramatic decrease in saving experienced by the US economy in the last twenty years may be, at least partially, explained in the light of Ricardian equivalence. Since government expenditure steadily decreased, households perceived it as a relief in taxation and then in higher future wealth. The “expansionary fiscal contractions” experienced in the 90’s by some small European countries may be explained by Ricardian effects of a reduction in the present value of future taxes needed to repay an high level of government debt.

In this paper we emphasise the convergent role of the permanent income hypothesis, and more in general of stochastic models, and the intertemporal government budget constraint

in determining the Ricardian result. The structure of the paper is as follows: Section 2 contains the basic model of Ricardian equivalence, Section 3 provides a discussion of the issue of the intertemporal government budget constraint. In Section 4 the main reasons for departures from debt neutrality proposition are analysed. Section 5 reviews empirical results and discusses some econometric problems that affect them. A closer look is devoted on econometric evidence on the Italian case. Section 6 concludes.

2. The Ricardian equivalence theorem

In the Barro model consumers have finite lives and care about the welfare of their descendants, providing them with positive bequests. Thus, they behave *as if* they have infinite lives, and provided that the government cannot postpone indefinitely the repayment of the bonds issued, the repayment and the interests that consumers receive are equal to the sum of the principal and taxes levied to pay interest. The reduction in government savings is completely offset by an increase in private savings, leaving unchanged national savings. In this view government bonds are not net wealth.

It is crucial, to obtain debt neutrality, that the shift from taxes to bonds would fund a given pattern of government expenditure. If the tax cut was associated to a reduction in government expenditure by the same amount, the real effect would be an increase in consumption. The effect would be the same if the government announce a future reduction in its expenditure, leaving taxes unchanged. It should be emphasised that the mechanism at work in this case is that permanent income increases, in the first case because the reduction in taxes is immediate, in the second because consumers would expect the reduction at some time. In addition, as Bohn (1992) points out, if government spending was endogenously determined, as a result of a tax cut consumers would expect a reduction in government spending. This happens because a government that cares about welfare trades off marginal increases in spending in publicly provided goods against marginal reductions in consumption. Since distortionary taxes increase the cost of publicly provided goods, Ricardian consumers expect a reduction in government spending and do not reduce their consumption.

Consider the problem of a family wishing to maximise its utility in the infinite horizon case. The utility function and the budget constraint are, respectively²:

$$\int_{t=0}^{\infty} u(c_t) e^{-\theta t} dt ,$$

$$c_t + \dot{a}_t + na_t = w_t + ra_t - \tau_t ,$$

where c_t is real consumption, w_t is the real wage, a_t and \dot{a} are the holding and the variation of financial assets, τ_t are taxes, n is the rate of growth of the number of member of the family, r is the real interest rate and θ is the rate of time preference. Integrating the instantaneous budget constraint, the intertemporal budget constraint is:

$$\int_{t=0}^{\infty} c_t R_t dt = a_0 + \int_{t=0}^{\infty} w_t R_t dt - \int_{t=0}^{\infty} \tau_t R_t dt , \quad (1)$$

where a_0 is the initial holding of financial assets and $R_t = e^{-(r-n)t}$ is the discount factor. To understand Ricardian equivalence we consider two cases: in the first there is no government debt and the budget is balanced in each period of time, in the second we allow for government budget deficits and surpluses.

In the case of no borrowing, government expenditures equals taxes ($g_t = \tau_t$), and all financial assets consist of capital ($a_t = k_t$). The intertemporal budget constraint is:

$$\int_{t=0}^{\infty} c_t R_t dt = k_0 + \int_{t=0}^{\infty} w_t R_t dt - \int_{t=0}^{\infty} g_t R_t dt . \quad (2)$$

As in the case of no government, the Keynes-Ramsey rule³ determines the rate of interest that, through the marginal productivity condition, determines capital per head and output per head. Output is therefore independent of g . As a result, a steady state increase in government expenditure will have no effect on capital or output per head, and must be reflected in an equal fall in consumption.

In the case of borrowing, we assume that the government remains solvent, which implies that it obeys to the No-Ponzi game rule:

² All the real variables are in per head terms.

$$b_0 + \int_{t=0}^{\infty} g_t R_t dt = \int_{t=0}^{\infty} \tau_t R_t dt , \quad (3)$$

where b and g are respectively is government debt and expenditure. This rule tells us that extra government spending will always be financed by higher taxes at some point in time: deficits are just deferred taxes. Now plug (3) into (1), and we obtain the same equation (2). As long as the intertemporal budget constraint and the Keynes-Ramsey rule are the same, consumption is totally unaffected by government deficits.

In addition to the previous crucial conditions mentioned, dynastic families and fulfilment of the intertemporal government budget constraint, other important hypotheses have to be met to obtain debt neutrality: capital markets must be perfect, that is anyone may borrow any amount of money at the same borrowing rate of the government, and taxes must be non distortionary, that is they are lump-sum. All these conditions have been attacked because of their lack of realism. We postpone the discussion of these conditions, and of other causes for departures from Ricardian equivalence, to the next Sections. Before analysing them, we concentrate on a generalisation of the Ricardian result in the long-run.⁴ Smetters (1999) sets up an overlapping generations model in which there are two types of agents: high and low patient types (the formers discount the future much more than the latters). This heterogeneity is consistent with the fact that many households are not linked in household-level data sets, but intergenerational transfers might represent a large fraction of the capital stock, the wealth distribution is unequal, and wealthy people bequeath a large proportion of their lifetime income. Let \hat{r} be the steady-state interest rate of the economy without intergenerational transfers, and let r^* be the intergenerational rate of time preferences for high patient agents, the results may be summarised as follows:

1. the necessary and sufficient conditions for steady-state bequests to be operative for high patient agents is: $\hat{r} > r^*$;
2. under the previous operative condition, $\hat{r} = r^*$, the long-run capital intensity is neutral to debt regardless the share of high patient agents;
3. even if the operative condition does not hold, steady-state bequests are operative for high patient agents. Hence, Ricardian equivalence fails in the short-run if the share of low patient agents is positive;

³ The Keynes-Ramsey rule, $\dot{u}'_t / u'_t = \theta + n - r$, provides the optimal allocation of consumption over time.

4. however, under the operative condition, low patient agents save assets for a flat productivity profile if these agents are selfish “enough”.

Although powerful, these results can be seen as a restatement of the most shared view within the profession of the short-run effectiveness of fiscal policy, while in the long-run the system converges to the old equilibrium. Indeed, these results contradict one of the most important consequences of Ricardian equivalence, that is no effectiveness of fiscal policy even in the short-run. In the same line, we find the results of Mankiw (2000) who builds a model in which individuals with intergenerational consumption smoothing – called savers – and individuals that are unable to save – spenders.⁵ The focus here is on intragenerational rather than intergenerational differences. With respect to the debt neutrality issue, temporary tax cuts have large effects on demand, since spenders track on current income. In the long run government debt does not crowd out capital, since extra consumption by spenders reduces investments and then increases the marginal product of capital and the interest rate. The higher interest rate induces savers to save more until the marginal product of the capital equals the savers’ rate of time preference, which is the steady-state Ricardian condition.

Once Ricardian equivalence holds, government bonds become a completely unimportant issue: neither their level, nor their form affect the economy in any manner. Indeed no reason seems to be left for governments to issue bonds. However, Barro (1979) finds a reasonable explanation for debt. There are three starting points: first, government expenditure is not constant over time but has a cyclic behaviour. Second, changes in the marginal rate of taxation distort the behaviour of individuals, and the dead-weight loss is increasing as the average tax rate increases. Third, transactions costs associated with tax collection are increasing when the tax rate increases. Therefore, a policy that would modify the marginal rate of taxation according to the changes in government expenditures would have high distortionary effects and would increase the dead-weight losses of taxation. Issuing bonds when the current government expenditure is higher than its normal level, and retiring them when it is lower, would smooth the marginal rate of taxation over time reducing the relevant losses.

It is interesting to compare the Ricardian vision of public debt with the neo-classical one. In the Diamond (1965) OLG model, individuals are rational, have finite lives, plan only over their own life-cycle, do not leave any bequests, and markets are cleared. For a given

⁴ Other studies in this field include, Carmichael (1982), Aiyagari (1989), and Daniel (1993).

programme of government expenditure, a shift in taxes to future generations leads to an increase in net wealth, stimulating consumption and savings. However, as private saving does not rise enough to offset the decline in government saving, national saving declines. In a closed economy, the interest rate goes up and reduces investments.⁶ In the Ricardian world an increase in expected taxes reduces consumption, while the interest rate and the national saving remain unchanged.

3. The intertemporal government budget constraint

As individuals, governments face an intertemporal budget constraint (IGBC, thereafter). Accordingly, they can run for a short to medium term a big amount of deficit, but in the long run it is assumed that they cannot play a Ponzi game.⁷ Following the previous discussion, as long as the government obeys to the IGBC, Ricardian equivalence may hold. If the government issues one-period debt, the real value of the outstanding debt b_t , in the discrete-time version, evolves according to:

$$b_{t+1} = (1+r)b_t + g_t - \tau_t - s_t, \quad (4)$$

where r is the real, constant interest rate, g_t is the real government expenditures net of interest, τ_t is real tax revenues, $s_t = (M_{t+1} - M_t) / P_t$ equals real revenue from seignorage when M_t is the nominal supply of high powered money, and P_t is the price level. Taking the expected values of (4) and solving through iterations, we obtain the IGBC:

$$b_t = -E_t \sum_{j=0}^{\infty} (1+r)^{-(j+1)} (g_{t+j} - \tau_{t+j} - s_{t+j}) + \lim_{j \rightarrow \infty} E_t (1+r)^{-(j+1)} b_{t+j+1}, \quad (5)$$

⁵ This distinction rests on three stylised facts: consumption smoothing is not perfect, many people have net worth near zero, and bequests are one of the most important factors in growth accumulation.

⁶ In a small open economy, capital inflow will be induced, and through an appreciation of the real exchange rate, there will be a deterioration of the current account, increasing foreign indebtedness. Thus, there is a reduction in welfare of future generations.

⁷ Charles Ponzi (1877-1949) raised a considerable amount of money promising a high rate of interest (50% for 45 days, 100% for 90 days). As long as new lenders were attracted by these returns, he was able to repay previous debt with their money and so on. In eight months he ended up with 10 millions dollars of certificates and 14 millions dollars of debt.

where $E(\cdot)$ denotes the expectation operator conditional information on time t . From the second term of the right-hand side of eq. (5), we impose the transversality condition:

$$\lim_{j \rightarrow \infty} E_t (1 + r)^{-(j+1)} b_{t+j+1} = 0. \quad (6)$$

When the growth rate of the economy (the sum of the rates of population growth and technical progress) exceeds the interest rate, the government can permanently postpone the repayment of debt and then no generation has to pay any portion of the debt left by previous generations. In the opposite case, the behaviour of the debt to GDP ratio would be explosive. Feldstein (1976) uses this reasoning to contradict Ricardian equivalence. In particular, he distinguishes two cases. The first one has been described above but is weakened by the fact that there is no empirical evidence supporting that the growth rate of the economy is greater than the interest rate over a long period of time. When $r > \gamma$ Feldstein suggests to consider the after tax rate (r_N) and not the gross rate of interest, r , since the government can use the proceeds of taxation of the interest on the debt to finance the deficit. However, it is not sure that r_N exceeds g in the reality. In addition he argues that even if $r_N > \gamma$, the fraction γ/r_N of each year's interest payments can be financed by additional debt creation. This fraction do not need to be funded and then represents net wealth for an infinite sequence of consumers. Therefore, only in the case of a static economy (i.e., $\gamma = 0$) the present value of future taxes equals the present value of the debt itself.

In contrast to the second argument, Barro (1976) argues that although when $r \leq \gamma$ the previous analysis may be true, in general this is not a counter-argument for Ricardian equivalence. If we suppose that there is an initial debt equal to $B(0)$ that grows at a rate g , then $B(t) = B(0)e^{\gamma t}$, and then the amount of bond needed to finance the debt is $dB/dt = \gamma B(t)$. Taxes levied at time t are the amount needed to finance interest payments net of debt finance, $rB(t) - \gamma B(t)$. These future taxes are discounted by the interest rate r and their present value is:

$$\int_0^{\infty} (r - \gamma)B(t)e^{-rt} dt = (r - \gamma)B(0) \int_0^{\infty} e^{-(r-\gamma)t} dt = B(0). \quad (7)$$

Hence, the present value of the future taxes coincides with the amount of the initial debt issues for any growth rate γ , with $\gamma < r$. Therefore even in a growing economy government bonds are not net wealth.

4. Departures from Ricardian equivalence

Several criticism have been opposed to Ricardian equivalence on the ground of its theoretical foundations. Most of them attack the conditions that needed to be met because they seem too restrictive with respect to the real world. We believe that the major theoretical objection is the *reductio ad absurdum* of the model, suggested by Bernheim and Bagwell (1988). They observe that in the Barro framework all families are linked together both in vertical and horizontal ways and then each individual belongs to many dynastic groupings. These linkages make neutral all redistributive policies, and distortionary taxes are equivalent to lump-sum taxes. Even prices have no role in the allocative process. Since this extreme neutrality is not observed in reality, the basis of the model is severely undermined.

A reason of departure from Ricardian equivalence is that the consumers' discount rate is greater than the government interest rate on debt. Blanchard (1985) provides an useful framework in which finite lives are a source of this. Each individual has a constant probability of death, p , then each generation decreases at that rate, and the population is constant. There is no operative bequest motive in the economy: each consumer has a contract with an insurance company such that the company receives their wealth on death for a premium paid to the consumer (annuity). If the insurance company makes zero profits the premium will be p . The key differences to the previous infinite life model are that the discount rate of utility is $\theta + p$, and that the effective rate of interest is $r + p$, because of annuity payments. If utility is logarithmic, human wealth is:

$$H_t = \int_{t=0}^{\infty} (Y_t - T_t) e^{-(r+p)t} dt, \quad (8)$$

or

$$\dot{H}_t = (r + p)H_t - Y_t + T_t. \quad (9)$$

If the government cuts taxes in period $t = 0$ by an amount ΔT financed by borrowing, then at time $t = s$ it has to increase taxes to pay off the principal plus the accrued interest, by an amount of $\Delta T_s = \Delta T e^{rs}$. The effect on human wealth is:

$$\Delta H_t = \Delta T - \Delta T_s e^{-(p+r)s} = \Delta T(1 - e^{rs} e^{-(p+r)s}) = \Delta T(1 - e^{-ps}), \quad (10)$$

which is greater than 0 if $p > 0$.^{8,9} Thus any deficit financing, which is equivalent to shifting the path of taxes into the future, will lead to a change in human wealth. Some of the tax burden will be shifted on to future generations. Evans (1991) shows that for realistic parameters of the economy, the Blanchard's model behaves in a Ricardian way, regardless whether households are perfectly connected to future households, and regardless of whether they have access to perfect capital markets. Building on the Blanchard model, Buitert (1988) extends its implications to the case in which population grows at a constant rate n , and labour-augmenting technical change occurs at a constant rate π . He shows that $\beta \equiv p + n = 0$, where β is the birth rate, is the necessary and sufficient conditions for debt neutrality to hold. The reasoning is that the expected flow of resources for the currently alive generation grows at an exponential rate $n - p$. Government can cut taxes to currently alive agents and also to those yet to be born. Their resources exponentially grow at a $\pi + n$ rate. Since $n \equiv \beta - p$, the excess of the growth rate of government resources over the growth rate of the resources of those currently alive is β . This conclusion is met in the ideal case of non-distortionary taxation.

Bernheim *et al.* (1985) and Kotlikoff *et al.* (1990) point out that altruism is not the only bequest motive. Parents can strategically use their bequests in order to elicit their care when they are old and if their children's behaviour is not satisfactory for them, parents can reduce or even withdraw bequests for their descendants. A necessary and sufficient condition for bequests to be operative is proved by Weil (1987). Parents should love their children "enough", that is the intercohort discount factor applied by parents to their heirs' utility must not be smaller than a threshold level which depends on the discrepancy between the steady state interest rate. Bequests are not operative in the no-debt economy, when the economy without bequest motive is dynamically inefficient. Therefore, Ricardian equivalence cannot be applied to a wide range of overlapping generations models. Andreoni (1989) points out

⁸ In case of infinite life, $p = 0$, $e^0 = 1$, then there are no effects on human wealth.

that in a Ricardian world consumption of the descendants acts as a public good within the family. If people enjoy making bequests, the warm-glow effects will always dominate altruism, and debt will have a Keynesian effect. Suppose that the utility function of the parents is $U_p = U_p(x_p, x_h, b)$, depending on their own consumption and on that of their descendants, and on the size of the bequests. On the other hand, the utility of heirs depends only on their own consumption $U_h = U_h(x_h)$. Parents are impurely altruistic, while the heirs are purely altruistic with respect to their own consumption. Therefore, a redistribution from children (more altruistic) to parents (less altruistic) will reduce the private supply of the public good (the consumption of the heirs). Parents will not perfectly substitute bequests for debt, hence they will keep some wealth for themselves.

The third reason is that if the borrowing interest rate is bigger than the lending one, consumers will spend some of the money arising from a tax rate because the government gives them terms of exchange between current and future consumption which makes them better off than the market interest rate. This is also true for borrowing constrained consumers, people unable to borrow at the current interest rate. If there is a tax cut they can increase their current consumption (constrained by their inability to borrow against the future income) and pay more taxes in the future. In this case the government allow them to do what the credit market prevent them, and in this way they can smooth consumption all over their life increasing their utility.¹⁰

Uncertainty on future income is another reason for the failure for Ricardian equivalence. According to Feldstein (1988), even in an economy in which altruism is the only bequest motive, taxes are lump-sum and there is no uncertainty on the date of individual's death, when future earnings are uncertain, bequests also are uncertain. Therefore, consumption rises more in response to an increase in current disposable income than to an equal present value increase in the disposable income of the next generation. Strawczynski (1995) shows that because of income uncertainty and precautionary savings, Ricardian equivalence may fail. If parents leave no bequests because of poverty (when marginal utility is sensitive to extra consumption), the transfer given by the tax cut reduces precautionary

⁹ Evans (1993) interprets p as a measure of how current generation fills disconnected from future household.

¹⁰ Hayashi (1987) proves that neutrality holds in presence of some borrowing constraints arising from adverse selection in the credit market, and Yotsuzuka (1987) demonstrates that it is in the interests of financial intermediaries to impose these constraints that lead to debt neutrality. In contrast, Barnheim (1987) maintains that these Ricardian results are obtained under too strict conditions.

savings and boosts consumption. These results are obtained under the assumption that the third derivative of the utility function is positive.

Related to the previous point, bounded rationality is a cause of failure of Ricardian equivalence. Consumers are supposed to make rational forecasts on their future income, to distinguish between permanent and temporary changes both in taxes and deficits, and to rapidly adjust to changes both in nominal and real variables. Such calculations require a large amount of information and a sophisticated ability to compute that are not usually possessed by consumers. If just a part of the consumers are uninformed on the level and the behaviour of the public debt, Reiter (1999) shows that Ricardian equivalence may not hold, unless they can ascertain the pattern of government debt from other variables that are perfectly correlated with it.

Distortionary taxation is another source of non-equivalence between taxes and debt. Barro acknowledges distortionary taxation as the major cause of deviation from Ricardian equivalence, but only with second-order effects. The point that distortionary taxation is a major source of failure for debt neutrality is strongly made by Abel (1986). In a representative consumer economy with increasing marginal estate tax rates, an increase in the lump-sum tax leads to a reduction in aggregate consumption. This arises because consumers are driven into lower marginal estate tax brackets and thus face a decrease in the price of their heirs' consumption. This relative price change leads to a decrease in current consumption. In addition, violation of Ricardian equivalence arises more generally under any non-linear tax on wealth or capital income. However, a non-linear tax on labour does not necessarily destroy debt neutrality. Trostel (1993) allows for distortionary taxation in a model of individual intertemporal optimisation. Structural deficit finance causes Keynesian-like effects even though government bonds are not perceived as net wealth. A temporary substitution of debt for taxation increases consumption, work, and output initially and in the long-run reduce them.

Some authors link distortionary taxation to uncertainty (Chan, 1983; Barsky *et al.*, 1986; Kimball and Mankiw, 1989). They argue that in an environment where future labour income is uncertain, the marginal propensity to consume out of a deficit financed tax cut is significantly positive if future taxes are proportional to income. Taxes provide insurance to consumers by reducing the variance of after tax future income. Barsky *et al.* (1986) call this sort of insurance "risk-sharing effect", that reduces the precautionary saving of consumers, thus boosting consumption. A partial restatement of Ricardian Equivalence in an uncertain environment is provided by Hansen (1996). He considers a three period model in which both

income and the timing of taxes are uncertain. The tax cut is experienced in the first period, but consumers do not know *ex ante* when the government would collect taxes, and at which rate. In this environment results on Ricardian equivalence are ambiguous, and the ultimate outcome depends on the relative magnitude of the risk-sharing and risk-creating effects associated with the collection of future taxes. Busu (1996) considers an environment where future income is uncertain and the income tax is proportional. Using a hybrid non-expected utility functional, he shows that the size of the risk-sharing effect depends on the relative strengths of income and information effects caused by a debt financed tax cut. For a moderate degree of risk aversion, Ricardian equivalence may be a reasonable approximation.

Another cause of non neutrality is the existence of childless families (Tobin and Buiter, 1980). If the bequest motive is altruism, families without children do not have any concern for taxes levied on future generations and so they will alter their consumption behaviour after a tax cut. Then, families with children realise that their offspring will be charged with a disproportionate burden and decide to leave higher bequests, but these higher bequests may not completely offset the higher taxes, and Ricardian equivalence may not hold. In contrast, Barro (1989) argues that as long as there are families with a number of children greater than the average one, this effect is counteracted.

Endogenous fertility may lead a failure in Ricardian equivalence. Developing a model in which dynastic families derive utility from own consumption, the number of children borne, and the utility level of each child, Lapan and Enders (1990) show that, since the outstanding stock of government debt represents a tax on future children, individuals will choose to substitute own consumption and/or the net per head bequest for number of offspring. In this framework the method of government expenditure financing has real effects: an increase in government debt induces a decline in fertility and thus motivates an increase in the steady state value of the capital to labour ratio and consumption per capita.

In a recent contribution, Seigle (1998) shows that if the government acts as an intermediary between generations in the provision of defence, Ricardian equivalence may not hold. Defence expenditures protect bequests from being lost or confiscated in an international conflict that impels the full transferability from a generation to another. Therefore, increases in public debt to finance defence expenditure will not be fully offset by increases in savings. The main differences of this contribution from others are that both the tax and the expenditure structure are considered together, and the government provides a particular service and not costless intergenerational transfers, in form of social security.

5. Econometric evidence

Ricardian equivalence has been tested in several ways: using the aggregate consumption function, estimating the consumption Euler equation, studying interest rates, trade deficit with respect to deficit changes and other ways. In this Section we firstly focus on aggregate consumption, the most widely used way to test for Ricardian equivalence. Secondly, we analyse evidence derived from consumption Euler equation. Then we review the evidence found applying recent advances in time series analysis. In the fourth subsection, evidence based on experimental and micro-data are considered. In the fifth subsection econometric evidence on the intertemporal government budget constraint is discussed. Finally, the focus is on the Italian case.

Tests on Ricardian equivalence are affected by several methodological problems. Probably the main one is endogeneity: deficit, government expenditure, income and interest rates may all be determined simultaneously. Another methodological issue is treatment of trend, if it is deterministic or random: in the former case it is proper to include time as an explanatory variable; in the latter it is necessary to first difference data before regression. Failure in following the correct methodology leads to biased toward debt neutrality and inconsistent estimates.

4.1 Testing aggregate consumption

Tests on aggregate consumption are the most common in the empirical literature. Three main different methodologies have been applied to test for debt neutrality in the context of private consumption: life-cycle hypothesis, permanent income hypothesis, and the “consolidated approach”. In general these ways of testing lead to opposite results (in general unfavorable to Ricardian equivalence the first, in favour the second and the third one). The most used econometric technique is OLS and in some cases, to overcome endogeneity, 2SLS is applied. There is a small number of studies applying instrumental variables (such as lagged taxes and lagged income, money growth, statutory tax rates) to overcome endogeneity. Bernheim (1987) pointed out that the choice of these instruments is questionable because they may not be exogenous.

Among tests based on the life-cycle hypothesis, Feldstein (1982), is recognised as one of the most influential. His regression is the following:

$$C_t = a_0 + a_1Y_t + a_2W_t + a_3SSW_t + a_4G_t + a_5T_t + a_6TR_t + a_7D_t + e_t, \quad (11)$$

where C is total consumer expenditure, Y is current income, W is the market value of privately owned wealth, SSW is the value of future social security benefits, G is government expenditure, T is tax revenue, TR is government transfers to individuals, and D is the overall net debt. His analysis covers the period 1930-1977 and uses IV estimation. If Ricardian equivalence holds there is a set of expected signs and values such that: are $a_4 < 0$, because an increase in government spending is counteracted by a decrease in wealth as taxpayers in future periods. A change in taxes has no effect when the levels of government spending and debt are held constant. Therefore an increase in taxes lowers the level of public debt and consumer spending remain unchanged, $a_5 = 0$. A current increase in transfers has the same effect of a reduction in taxes: households have more income, but also higher future tax liability, then $a_6 = 0$. The coefficient of SSW captures a direct intergenerational transfer: if $a_3 = 0$ current households save to completely compensate future generations for their extra tax burden. Finally, since the value of wealth includes government debt, the Ricardian view implies that a separate debt variable should have a negative coefficient that is equal in magnitude to the one of the total wealth variable, i.e., $a_7 = -a_2$. In this specification income is defined as total national income, a measure that includes corporate retained earnings and makes no adjustment for taxes and transfers. Although this measure is closest to the spirit of Ricardian equivalence, and has been used in some econometric studies in this field, Feldstein maintains that it is not the correct way to model consumer behaviour. An important feature of this study is the inclusion of social security wealth¹¹ in the consumption function. In a Ricardian world taxes financing social security benefits are a liability that, over an infinite future, has the same value of the benefits. Then, this kind of future benefit will not raise current consumption. In contrast, other studies have shown that its coefficient is positive and of the same magnitude of the one of conventional wealth. Since the expected signs and magnitudes are not the estimated ones, Feldstein claims that its results strongly rejects

¹¹ SSW is defined as the actuarial present value of the social security benefits for which existing workforce and their descendants would become eligible at the age of 65.

Ricardian equivalence. However, his confidence intervals are quite uncustomary, and his results have to be viewed with some caution.

Seater and Mariano (1985) specify tests for Ricardian equivalence in terms of the permanent income hypothesis. The estimated consumption function is the following:

$$C_t = a_0 + a_1 Y_t^* + a_2 (Y_t - Y_t^*) + a_3 G_t + a_4 (G_t - G_t^*) + a_5 AMTR_t + a_6 RS_t + \quad (12)$$

$$+ a_7 RL_t + a_8 T_t + a_9 TR_t + a_{10} D_t + a_{11} SSW_t + u_t$$

where Y^* is permanent income, Y is current income, $AMTR$ is a measure of marginal tax rate, RS and RL are respectively short and long real after-tax interest rates, T is tax revenue, TR is transfers to individuals, D is the market value of government debt, and SSW is social security wealth. The expected coefficients are: $a_2 = 0$ because temporary variations from permanent income have no effects on consumption, $a_8 = a_9 = 0$ because a tax-cut (or an increase in transfers) is matched by more saving to pay for the future tax burden without effect on current consumption, $a_{10} = 0$ because government debt is not net wealth, $a_3, a_4 < 0$ because government spending crowds-out private spending, $a_5 < 0$ because of the distortionary effects of taxation, $a_6, a_7 < 0$, because higher interest rates substitute current with future consumption. The analysis covers the time-span 1931-1974. The estimated values of the coefficients directly related to Ricardian equivalence (i.e., T , TR , D , and SSW) are not significant, and then debt neutrality cannot be rejected. The two new specifications of this approach lead to different results: the marginal tax rate variable is highly significant, while the decomposition of Y and G into permanent and transitory component seems not to have important effects on consumption. Using a similar reasoning, Cebula *et al.* (1996) dichotomise the total budget deficit into a structural (exogenous) and cyclical (endogenous) components. The former is hypothesised as expected and planned deficit, whereas the latter is unpredictable. Instrumental Variables estimation finds that the structural deficit elicit increased saving but cyclical one do not. Then, there is partial support to Ricardian equivalence. The distinction between expected and unexpected changes in fiscal policy in a forward-looking model is crucial, because only unexpected changes matter.

Kormendi (1983) presents a different framework, called “consolidated approach”, which leads to the strongest evidence in favour of debt neutrality. According to Kormendi, the “standard approach” involves an asymmetric set of assumptions on how the private sector perceives fiscal policy. Indeed, current-period taxes are assumed to be fully perceived, while

current-period government spending is implicitly ignored. Nevertheless the stock of public debt is included in the stock of private wealth. In taking their decisions on consumption, agents “consolidate” income coming from ownership of private firm and from their claims to government provided goods and services. The regression is:

$$C_t = a_0 + a_{11}Y_t + a_{12}Y_{t-1} + a_2GS_t + a_3W_t + a_4TR + a_5TX_t + a_6RE_t + a_7GINT_t + u_t, \quad (13)$$

where Y is net national product, W is wealth, GS is government expenditures on goods and services, TX is taxes, TR is transfers, RE is corporate retained earnings, and $GINT$ is government interest payments on the outstanding debt. Under the “standard approach” we have $a_2 = 0$, because the private sector ignores government spending, $a_5, a_6 < 0$ because private consumption depends on permanent disposable income, and interest payments on government debt are seen as an increase in income, $a_7 > 0$. Under the “consolidated approach” $a_2 < 0$ because government spending has a negative effect on private consumption, the choice of the tax/debt financing leaves private consumption unchanged ($a_5 = 0$), retained earnings are perceived as private saving, the return of which accrues to individuals through their ownership in corporations ($a_6 = 0$), and $a_7 = 0$ because the government interest payments on its stock of outstanding debt are anticipated. His estimations, based on the period 1930-1976, conclude that an increase in taxes does not affect consumption, while an increase in government expenditure does reduce consumption, a result that is consistent with the “consolidated approach” and with Ricardian equivalence.

Kormendi’s results have been extensively criticised. Modigliani and Sterling (1985) point out that changing the method of deflating government private sector expenditures, of measuring real government interest payments, including more lags and formulating the model in levels and not in rate of change, Kormendi’s results are reversed. Modigliani and Sterling (1990) claim that the previous results do not take into account temporary taxes, distorting the results against the life-cycle approach. In addition, they criticise the estimation in differences, claiming that the variables in the consolidated approach specification are cointegrated. Feldstein and Elmendorf (1990) maintain that the war period should be excluded because shortages, rationing and patriotic appeal caused an increase in private saving able to match the deficit-financed defence expenditure. In addition, the rejection of Ricardian equivalence is robust to different econometric techniques, such as OLS and AR(1), undertaken to deal with serial correlation, and instrumental variables applied to reduce endogeneity.

An analysis that maintains how inconclusive are the econometric estimations based on aggregate consumption is the one done by Cardia (1997). She replicates previous tests with simulated series for consumption, wealth, government expenditures, government debt, and tax revenue. The estimates obtained are close to those obtained using actual data. However, the coefficients of both tax and government expenditures are not robust and are misleading. For example, although distortionary taxation has important effects on consumption, Ricardian equivalence cannot be rejected. With finite horizons, changes in lump-sum taxes do not have remarkable effects on consumption, but Ricardian equivalence can be rejected.

Some considerations are needed in order to evaluate these econometric results. It turns out that the results are quite sensitive to the specification of the regression function. One might question whether an empirical specification that is not based on an optimising model is a good tool to test for Ricardian equivalence. Indeed, if the former is based on a specification that entails some form of rational expectation formation, the results support debt neutrality. The life-cycle approach, with its emphasis on assets that consumers hold, seems incompatible with Ricardian equivalence. In this approach, choices over the intertemporal pattern of consumption are made once forever. In the permanent-income approach, individuals distinguish between expected and unexpected components of some economic variables, and reformulate their consumption plans accordingly. The capability to perceive each source of income and cost seems a necessary condition for Ricardian equivalence to hold. The permanent income hypothesis is usually linked to rational expectations, a condition hard to be fulfilled by real consumers, even if they are not synonymous.

Econometric evidence obtained through the previous models is not based on specifications of consumption that nests Ricardian equivalence and any other alternative. The formulation of the debt neutrality proposition made by Blanchard (1985) has given the opportunity for a well theoretically grounded empirical testing. Evans (1988) provides the following specification:

$$C_t = (1 + \mu)(1 - \alpha)C_t + \alpha(\rho - \mu)A_{t-1} + u_t, \quad (14)$$

where ρ is the constant real rate of return, μ is the rate at which consumers discount wealth, α is the marginal propensity to consume out of wealth, C is consumption, and A is the stock of non-human wealth. If consumers are Ricardian $\rho = \mu$ and the coefficient on wealth is zero, if $\rho < \mu$ the coefficient on wealth is negative. Therefore, the model nests Ricardian equivalence

and an alternative non-Ricardian hypothesis. Estimating the previous equation, Evans (1988) finds insignificant coefficient on A_{t-1} and concludes that evidence cannot reject debt neutrality. In contrast, Graham and Himarios (1996), using a better approximation of the market value of wealth, find strong non-Ricardian results. Evans (1993) estimates a discrete version of the model with cross country data and finds that consumers are unlikely to be Ricardian.

Although appealing, the deviation of Ricardian equivalence deriving from finite horizons is found to have poor effects by Hubbard and Judd (1986), Ponterba and Summers (1987), and Jaeger (1993). Also the departure from debt neutrality due to liquidity constraints finds little evidence. Faruqee *et al.* (1997) in a life-cycle model find that they have a smaller effect on consumption than the one of life-cycle income. In spite of the fact that he identified a large number of credit-constrained consumers, Rickerbie (1997) suggests that in the US the proportion of these consumers is not significant enough to affect the tests for equivalence. Perelman and Pestieau (1993) attempt a qualitative analysis of the determinants of Ricardian equivalence. They find that that it is positively related to savings rate, optimism, income inequality, participation of the aged and social democracy. Debt neutrality is negatively related to average income level, population growth, financial regulation and inheritance taxation.

4.2 Euler equation tests

Considerations made in the previous subsection are clearer if we consider tests based on Euler equations. The Euler equation is the set of first-order conditions arising from consumer's intertemporal maximisation problem. It takes the form:

$$u'(C_{t+1}) = (R/\delta)^i u'(C_t), \quad (15)$$

where R is the market interest rate, and δ is the rate of time preference. Tests conducted along this line support Ricardian equivalence (Evans, 1988; Haque, 1988; Haug, 1990). Himarios (1995) finds that evidence based on restricted specification are subject to misspecification and then has to be taken with caution. The major source of misspecification is failure to take into account liquidity constraints. Indeed, this is a problem closely related to this methodology. Based on a theoretical neoclassical specification, Euler equations cannot take into account issues related to other economic methodologies (e.g., rigidities arising from Keynesian

models). Another empirical problem is that parameters estimated through the Generalised Method of Moments on aggregate data, such as Euler equations, are not stable over time. A possible solution might be looking for “deep parameters” based on the analysis of microeconomic data, and then solve the macroeconomic model calibrating it with these data and then confronting the simulated data to the real ones.

One study that combines utility maximising individuals with a government sector in order to examine Ricardian equivalence is Aschauer (1985). The model specified is based on rational expectations, where individuals derive utility from government consumption as well as private consumption. More formally, agents maximise with respect to effective consumption, C_t^* , defined as the weighted sum of government and private consumption, $C_t^* = C_t + \theta G_t$, where θ describes a constant marginal rate of substitution between private and government consumption. Assuming also a quadratic instantaneous utility function, Aschauer derives the following consumption function combined with a forecasting equation for government consumption:

$$C_t = \alpha + \beta C_{t-1} + \theta G_t^e + u_t, \quad (16)$$

$$G_t = \gamma + \varepsilon(L)G_{t-1} + \omega(L)D_{t-1} + v_t. \quad (17)$$

This forecasting equation uses past values of government consumption and deficits to make predictions of government consumption. Plugging (17) into (16) and we find the following set of cross-equation restrictions:

$$\begin{aligned} \delta &= \alpha + \theta\gamma \\ v_i &= \begin{cases} \theta(\beta - \varepsilon_i) & \text{for } i = 1, \\ -\theta\varepsilon_i & \text{for } i = 2, \dots, n \end{cases} \\ \mu_j &= -\theta\omega_j \quad \text{for } j = 1, \dots, m. \end{aligned} \quad (18)$$

Aschauer’s interpretation of these cross-equation restrictions is then that if they do not hold, debt has an impact on private consumption which differs from the impact justified from the observed predictive power that debt has for future levels of government consumption.

The central role of θ in order to achieve identification of this model can also be seen in the cross-equation restrictions, that all will become unidentified if θ is set to zero. In the

estimation, it is therefore vital to test if θ is actually significantly different from zero, which Aschauer concludes it is, and the point estimate indicates that a dollar spent on government consumption is worth approximately twenty cents of private consumption in utility terms. Furthermore, Aschauer concludes that he cannot reject the joint hypothesis of rational expectations and Ricardian equivalence at conventional levels of significance.

4.3 VAR estimations

In the last fifteen years a growing number of papers applied the new advances in time series econometrics. Most economic variables, such as GDP, consumption and the price level, are not stationary. Since they are usually integrated, in regressions involving the levels of these data, the standard significance tests were usually misleading. In particular, the conventional t and F test would tend to reject the hypothesis of no relationship when, in fact there might be one. This may bias the results against Ricardian equivalence, when we state as null hypothesis that there is no relationship between government debt and consumption. The implications of unit roots in macroeconomic data are, at least potentially, profound. If a structural variable is $I(1)$, shocks to it will have permanent effects, with rather serious reconsideration of the analysis of macroeconomic policy.

Leiderman and Razin (1988) formulate a stochastic model enabling them to evaluate the effects of both finite horizons and credit constrained consumers. In addition, the framework allows for substitutability between private and public consumption and treats explicitly the degree of durability of aggregate consumption. They estimate the model by non-linear least squares using monthly Israeli data covering the period 1980-1985, based on Blanchard's (1985) framework, where all individuals face a probability γ to survive ($\eta = 1 - p$, where p is the death rate in Blanchard's model) to the next period. They focus on consumption expenditure (X_t) as a flow into a stock of consumption goods (C_t), and it is from this stock that consumers derive their utility. Formally, individuals maximise expected utility according to:

$$\begin{aligned} \max_c E_t \sum_{\tau=0}^{\infty} (\eta\delta)^{-\tau} U(c_{t+\tau}) & \quad (19) \\ \text{s.t.} \quad c_t &= (1-\phi)c_{t-1} + x_t \\ x_t &= b_t + y_t - (R/\eta)b_{t-1} \end{aligned}$$

$$\lim_{t \rightarrow \infty} (\gamma / R)^t b_t = 0,$$

where $U(\cdot)$ is the instantaneous utility function, c_t and x_t are the per capita stock and flow of consumption goods (capital letters then represent the aggregates over households of the same variables). Moreover, the stock of consumption goods is depreciating with ϕ in each period. Labour income is y_t and assumed to be exogenous, and $R = 1 + r$, where r is the constant interest rate. The subjective discount factor is δ , and finally, b_t are bonds issued by agents. The last line is the no-Ponzi game assumption. In addition to the utility maximising individuals with access to a perfect capital market, the authors allow for a part of the population $(1 - \pi)$ to be liquidity-constrained according to $X_{c,t} = Y_{c,t} + v_t$, so that they use all of last period's income for consumption expenditure, except for a stochastic term v_t . Aggregate consumption expenditure is then:

$$X_t = \pi X_{u,t} + (1 - \pi) X_{c,t}, \quad (20)$$

where $X_{u,t}$ comes from unconstrained individuals who solve the maximisation problem in (19). For the empirical implementation they also specify first order autoregressive processes for income (Y), taxes (T), and government consumption (G) in the last part of the empirical investigation. The maximisation problem is also modified to allow for substitution between private and public consumption, where government consumption is assumed to substitute for private consumption with a factor q , i.e. a dollar of government consumption is worth θ dollars of private consumption. The interesting feature of this approach is that it estimates deep parameters that appear as critical assumptions in the derivation of the equivalence hypothesis; the death rate, $1 - p$, and the fraction of liquidity constrained individuals, $1 - \pi$, should both be equal to zero according to the standard assumptions used to derive debt neutrality. In other words, the authors have allowed for two potential sources for deviations from debt neutrality, and investigate whether or not data support these standard assumptions made in Ricardian models. The result is that they cannot reject debt neutrality.

Khalid (1996) extends the previous study and analyses a panel of 21 developing countries applying Full Information Maximum Likelihood¹² covering the period 1960-1988.

¹² FIML is a method which efficiently deals with simultaneity problems.

In 12 cases he was not able to reject Ricardian equivalence and in 5 cases he assessed that liquidity-constrained individuals are the main cause of failure of this hypothesis. However, the results show that public spending is a poor substitute for private consumption. Leachman (1996) find that there is a weak cointegration between private saving and government debt. Thus, consumers form expectations in a non rational way. Applying multicointegration, Ghatak and Ghatak (1996) found no evidence for debt neutrality in the Indian case. In order to discriminate between expected and unexpected and temporary and permanent changes, Becker (1997) employs a VAR model with cointegrating constraints represented as a common trend model with both stochastic and non-stochastic trends. This methodology allows to distinguish between expected and unexpected behaviour of economic variables. He finds some support to the Ricardian hypothesis but also some deviations from its predictions. However, these differences do not support the Keynesian view but that of expansionary fiscal contractions. Bernheim (1987) pointed out that VAR models are very parsimonious and omit a large amount of information, so that a portion of the deficit innovation may be expected. VAR forecasts may substantially differ from expectations based on well-publicised institutional information that individuals actually use, creating a bias in favour of Ricardian equivalence.

4.4 Micro evidence

Ricardian equivalence has a strong microeconomic content. The ineffectiveness of fiscal policy is the result of individual choices to save more in the current period to sustain the burden of future increased taxation. However the empirical literature has focused on macroeconometric evidence rather than on the microeconometric one. A few examples represent exceptions to this.

Allers *et al.* (1998) conducted a survey in the Netherlands on the knowledge of the government's indebtedness and on the behaviour in response to fiscal policy stance. Individuals showed little knowledge about the size of the most important fiscal policy indicators (government debt and deficit levels). Only 30% of respondents gave a fairly correct answer. This finding cast some doubt on one of the crucial assumption of Ricardian equivalence, that is, individuals are perfectly aware of government indebtedness and they take the government debt level into consideration when deciding the level of their personal savings. When directly asked, only 12% of respondents answered that they do save more to be

able to pay higher taxes in the future when debt increases today. These results are substantially consistent among groups defined by age, education, income, and employment status, showing a little tendency to more awareness as their level increases. However, they do not change with having or not offspring. It is worth pointing out that these results may be biased upwards, as in the survey lower classes were a bit less represented with respect to the national average.

Changes in labour supply as a reaction to future changes in taxes are considered by Conway (1999). If workers perceive that current deficits implies future taxes, they should consider them when formulating their expectations about future net wages. If they expect future taxes to be higher, they may intertemporally substitute their labour supply working more now and less in the future. She studies a cross-section of labour data for the year 1980 for each U.S. state. The choice of the state level rather than the federal one is motivated by the fact that most states constitutions mandate a balanced government budget in the medium-run, while the federal government has no explicit constraint and may also rely on seigniorage. The results of the empirical analysis show that deficits in states that heavily rely on income taxation increase current labour supply, whereas deficits in states that do not rely on income taxes decrease current labour supply. A one dollar increase in the income tax-financed deficit results in a 5-hour increase in labour supply, a result consistent with Ricardian equivalence. However, these results must be taken with some cautions. The statistical significance of the key coefficient varies considerably as the variables included in the specification change, and the coefficients of asset and income are often insignificant.

Another source of microeconomic evidence is given by experiments. Cadsby and Frank (1991) designed a experiment in a overlapping generation model context in which two groups play the game for eight years and each year is made up by three periods, and the two groups overlap in the medium period. In the first period, the current generation has to allocate a given endowment between certificates and savings. In the second period a further endowment, which represents government deficit, may be allocated to that players. They then decide between certificates and savings. In this case savings represent the bequests left to the future generation. The future generation received a endowment and the bequests and allocate this sum between certificates and savings. An amount equal to the second endowment given to the first generation is then subtracted. In the third period the second generation may only buy certificates. To link the two generations a multiplicative and a square-root utility functions were used. The experiments examined both expansionary and contractionary fiscal

policies. Whenever the theory predicted a positive bequest, outcomes close to those predicted by Ricardian equivalence occurred, with some allowance for learning. However, the environment of the experiment is too much controlled for the departures from Ricardian evidence previously analysed, then this result is not surprising. More comprehensive experiments are needed in this field to give a fairer judgement.

4.5 Evidence on the intertemporal government budget constraint

The analysis of this issue has been carried on using cointegration. The rationale for this method in this case is that if revenue and government spending are non-stationary series, and if they are cointegrated, i.e. there is a linear combination of the two series which is stationary (Engle and Granger, 1987), they do not drift apart and then the government obeys to its intertemporal budget constraint. Another methodology (Hamilton and Flavin, 1986) studies the stationary properties of the stock of public debt. If the debt series is stationary, the debt is sustainable, otherwise the IGBC is not fulfilled. As mentioned before, the fulfilment of the IGBC is a key assumption for Ricardian equivalence to hold. An important issue regards whether or not interest payments should be included in the constraint. McCullum (1984) argued that a constant, positive deficit (excluding interest payments) cannot be financed entirely by bond sales; however, a constant positive deficit inclusive of interest payments can. Although the most part of the studies follows this approach, Trehan and Walsh (1988) show that the IGBC implies that government expenditures inclusive of interest, tax receipts and seignorage be cointegrated. However, the condition is in fact stronger, requiring that the deficit inclusive of interest be stationary.

Although many studies support the sustainability of government debt, the results are controversial. Hamilton and Flavin (1986) and Trehan and Walsh (1988), for the period 1960-1981 and 1890-1986 respectively, find that US data are consistent with the IGBC. Hakkio and Rush (1991) examine US data for the period 1950-1988 and found that revenue and government spending are cointegrated. However, when they restrict the analysis to the period 1968-1988, they find that the series are no longer cointegrated and then the government has changed its policy on debt solvency. Wickens and Uctum (1993) take a different approach and analyse the issue in terms of balance of payment identity solved forward. The framework allows for endogenous rather than exogenous primary deficit. The sufficient condition to satisfy the IGBC is that the largest absolute root in the VAR be less in value than one plus the real exchange rate adjusted for output growth. The consequence would be that the trade deficit

should exhibit a wealth effect so that the net national indebtedness increases there is an improvement in the trade deficit. Then, higher government debt reduces the primary deficit. This would occur if government debt is regarded by the private sector as net wealth. Using US data for the period 1970-1988, they find that despite the large current account deficit, the loss of national wealth may act as an automatic corrective enabling the US to avoid defaulting. Since the time spans of the two last studies are quite short, we believe that they are not suitable for time-series analysis and then that these results are not significant.

Bohn (1998) argues that between primary surplus and debt can be obscured by war-time and cyclical fluctuation. As a result, an univariate regression of the first on the second would not find a significant correlation between the two: even if it is impossible to reject a unit root, this test leads to inconsistent and misleading results. He find that for 1916-1995 the primary surplus is an increasing function of the debt to GDP ratio. In addition, when one controls for war-time and cyclical fluctuations, an autoregressive model shows that the debt to GDP ratio is mean-reverting. Under weak conditions, a positive (at least linear) response of primary surpluses to the debt to GDP ratio implies that the IGBC is satisfied.

Leachman (1996) jointly tests for the IGBC and the consumers' one. Changes in government spending and tax revenue are cointegrated and changes in tax receipts and debt are not. This means that fiscal variables are not multicointegrated.¹³ Thus, it does not exist a deeper level of cointegration between government spending and taxes, which is expected if the government obeys to the IGBC. Recalling that in Section 4.2 we have reported that, according to Leachman, consumers are not Ricardian, then Ricardian equivalence fails because of both the private and the public sector. Also Becker (1997) jointly address the intertemporal problem of consumers and government. Although he rejects the stronger version of the IGBC, the results support the hypothesis that in the long-run the government budget is balanced.

A small piece of literature that is closely related to this is the one concerning the causal relationship between government expenditure and government revenue. If an increase in expenditure is followed by an increase in taxes, a so-called "spend-and-tax" policy, the

¹³ If the two series are $I(1)$, have no trend and cointegrated such that a linear combination of them, z_t , is $I(0)$, then

it follows that: $Q_t = \sum_{j=0}^t z_{t-j}$, where q_t will be $I(1)$. If q_t and x_t are cointegrated, then x_t and y_t will be

multicointegrated and q_t and y_t will be also cointegrated. In that q_t is a function of x_t , y_t and their lags, multicointegration implies long run relationships at two different levels between just two series.

government budget is balanced in the long-run and then one of the main reason for Ricardian equivalence to hold is again fulfilled. This line, theoretically supported by Peacock and Wiseman (1979), find empirical evidence by Anderson *et al.* (1986), Van Furstenberg *et al.* (1986), and Bohn (1991). Other scholars (Friedman, 1972; Buchanan and Wagner, 1977) view government expenditure as adjusting to any level of government receipts. This view is empirically supported by Manage and Marlow (1986) and Ram (1988). In addition, another piece of evidence do not see any causal relationship between the two fiscal variables, but they are simultaneously determined (Musgrave, 1966; Meltzer and Richard, 1981). Support to this view is found by Owoye (1995). Indeed the results of this strand of literature are quite inconclusive because they are sensitive to different specifications used (Granger Causality, VAR and ECM tests) and then are unable to cast any light on the issue of debt neutrality.

4.6 Evidence on Ricardian equivalence in Italy

Econometric evidence on Ricardian equivalence in Italy is studied in a few papers. Modigliani *et al.* (1985) provide the first estimation and find that debt has a huge wealth effect and that an increase in 4% of public deficit over the GNP, induces a reduction in national saving of nearly the same amount (3,4%) on an overall reduction in national saving of 9%. The estimated function is the following:

$$C_p = 0.035 + 0.596 Y_d + 0.047 W - 0.238 DEF + 0.024 D, \quad (21)$$

(2.98) (17.75) (7.49) (3.18) (0.48)

where C_p is private consumption, Y_d is disposable income, W is wealth including government debt, D is government debt net of central bank and foreign holding and DEF is the inflation adjusted government deficit, and t -statistics are in parentheses. We believe that this is a quite incomplete regression. It excludes some important regressors such as taxes and government expenditure. The use of only disposable income implies the strong restriction that the coefficients of income and taxes are equal, an assumption that is rejected by some empirical studies (e.g., Kormendi, 1983). In addition, this specification neglects problems related to permanent and temporary components of fiscal variables and income, and a measure of distortionary taxation, that may be relevant in the empirical assessment of Ricardian equivalence.

Based on a specification that entails the same variables of the previous study adding lagged one values of each of them, Croda (1992) implements a Bayesian approach. The

methodology starts from specifying prior estimates of the coefficients of a Keynesian, a life-cycle and a Ricardian consumption function. The results turn out to be very sensitive to prior beliefs, and then an agnostic conclusion is reached.

Rossi (1989) criticises the Modigliani *et al.* (1985) results on the ground of econometric methodology. He maintains that the value of the Durbin-Watson statistics would imply first-order dependence and not auto-correlation of order one as argued by the authors. This leads to misspecification. As a consequence, it is necessary to estimate a dynamic model. The restricted form is the following:

$$C_{p,t} = 0.002 + 0.342 Y_{d,t} - 0.0002 W_t - 0.355 DEF_t + 0.066 D_t + 0.563 C_{p,t-1}, \quad (22)$$

(0.37) (7.89) (0,004) (5.83) (2.76) (7.24)

where the variables are the same of the previous model. These results are consistent with the debt neutrality hypothesis, since the coefficient of government deficit is negative and, in absolute value, close to the that of disposable income. In their reply, Modigliani *et al.* (1989) modify the specification acknowledging the fact that current income is an unsatisfactory proxy for the effect of permanent income on consumption and use an improved and extended data set for the period 1950-1985. They obtain the following function on the basis of an AR(1) specification:

$$C = 0.047 + 0.48 YD + 0.17 YD_{-1} - 0.17 DEF - 0.15 DEF_{-1} + 0.022 W + 0.10 D, \quad (23)$$

(4.7) (10.9) (3.2) (-2.0) (-1.7) (3.2) (4.4)

where the variables are the same of the first specification. According to the authors, Ricardian equivalence is still strongly rejected.

Modigliani and Jappelli (1987) consider a time span from 1860 to 1982 and test the Ricardian equivalence proposition against the life cycle hypothesis re-formulated in terms of “limited horizon” for inflation. Both theories share the same formulation of the consumption function, implying a reduction in consumption due to an increase in the deficit. However, the coefficients of consumption are different: in the Ricardian approach the coefficient of government expenditure is close to minus the one of the disposable income and the coefficient of debt is minus that of wealth. In contrast, in the other approach both are close to zero. According to the estimated saving function it is possible to reject the Ricardian proposition and to accept the other. The estimated effect of the deficit on consumption is between 1/3 and

2/5 of the propensity to consume and that consumption responds to interest payment on national debt more than to other transfers, provided that they are adjusted for the expected inflation. The results are robust to different subperiods. Modigliani (1990) estimates the saving function for the period 1962-1988 with three different methodology: OLS, first-order autoregressive, and instrumental variables. The instruments used for disposable income and public saving are current and lagged public expenditure, lagged taxes, government debt at the beginning of the period and a temporal trend. The results are quite similar among the different specifications. The coefficient of disposable income is between 0.4 and 0.5. There is a significant negative effect of the wealth to income ratio of about -0.03, while the effect of the debt stock is small, negative and non significantly different from 1. The impact of public saving on national saving is high, as the effect of expected inflation. The coefficient of the inflation-adjusted value of government debt is always negative and significant in the majority of the estimations. Of the overall reduction in national saving 2/3 of the fall is due to the increase in government debt and 1/3 is due to the reduction of private saving. Rossi and Visco (1994) use a non-nested testing procedure for the period 1954-1990. They find that 1/3 of the decline in private saving occurred in the period may be attributed to the rise in the net social security wealth to income ratio. This result contradicts Ricardian equivalence.

Other econometric evidence supports the Ricardian approach. Nicoletti (1988) estimates the growth rate of consumption as a function of the expected real interest rate, the wealth to consumption ratio and the income to wealth ration both lagged one period, both the expected and the unexpected growth of net labour income, and the growth rate of public consumption. The main result, for the period 1961-1985, is that the debt neutrality hypothesis could not be rejected and there is a virtually complete discounting of future taxes. Fuster-Perez (1993), applying SURE analysis to a panel of European countries, found that in the Italian case public debt has a strong balanced effect over private saving and, although the specification of the Ricardian consumption function is not accepted, the Keynesian formulation is even further away from the estimated specification. Onofri (1987) specifies the aggregate consumption function applying definitions of income and financial wealth which partially take into account the variation of the purchasing power of the income and wealth, a “perception” of interests, public debt as income and net wealth decreasing when the public debt stock grows. The results indicate that income from interests has a smaller effect on consumption than the non-interest income and the difference between them grows as the

public debt grows. In addition, bonds have a wealth effect on consumption, but they decrease when public debt grows.

6. Conclusions

The debate on Ricardian equivalence has been very strong. Some authors strongly believe in it, others dismiss it as a *theoretical curiosum*. The debate on Ricardian equivalence had a prominent position in the economic literature up to the end of the eighties. At that time the profession showed a consistent view against this hypothesis (roughly speaking one third of the scholars supported it, while two thirds opposed it) and the debate has come to an end sometimes interrupted by some occasional articles. However, we have tried to demonstrate that this debate is far from having achieved a univocal conclusion, and a new wave of work, mainly empirical but also theoretical, is needed in the field. Even if it is difficult to believe that there is a one-to-one relationship between tax-cuts and increase in the size of bequests, optimising individuals appear to follow Ricardian equivalence, at least in an approximate way. Indeed, debt neutrality is nothing but a consequence of some widely used concepts and methods in modern macroeconomics. We think that more refined econometric – in particular along the line of stochastic models - work may cast some more light on the field. Still the *onus* of the proof lies on those who support debt neutrality.

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