Ricardian Equivalence in the 21st Century

(a European Experience)

Abstract: *This thesis is a contribution to the discussion on Ricardian equivalence and can be split in two parts. The first part is theoretical, where the focus lies on the economical theory behind Ricardian equivalence and it takes a look at a selection of existing research. The second part is empirical, where with the help of a consumption function based on Stanley (1998), I test whether Ricardian equivalence holds for eleven European countries, both euro and non-euro countries. The findings are mixed; Ricardian equivalence is rejected in the majority of the countries. Nevertheless for some countries Ricardian equivalence holds.*

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I - Introduction

Economic theory tells us that governments can make use of fiscal policy in order to stimulate economic growth in times of economic downfall. Governments can make tax cuts in order to increase the perceived wealth of the nation's households and thus increase their consumption budgets. In consequence the new consumption budget leads to an increase in aggregated demand and capital accumulation and as a result this leads to an increase of economic growth. This theory is also known as Keynesians theory.

A more controversial story is told by the Ricardian equivalence theorem. This theorem tells us that fiscal policy is not an appropriate tool to make use of with the incentive to stimulate economic growth. The reasoning behind this statement is that the households are viewed as being rational and thus realize that the tax cuts made by the governments today, will have to be paid back some given time in the future. In advance to these payments, households increase their current savings instead of increasing their consumption, hence making the fiscal policy ineffective.

In light of the recent economic crisis, Ricardian equivalence raises an interesting question as most governments altered fiscal policies in order to fight this crisis and stimulate economic growth. Due to the changed policies, government spending and inevitably the budget deficits increased. If Ricardian equivalence holds in these countries, the households alter their own spending patterns and consequently increase their savings, resulting in making the policy changes ineffective. But has such an event occurred? The main purpose of this thesis is to research whether or not empirical evidence supports Ricardian equivalence in Euro-area countries.

The relevance of this paper is found in two points. The first point is mentioned above concerning the current situation in Europe. The second point of relevance is that this thesis is another contribution to the existing research on Ricardian equivalence and another contribution in reaching a clear answer on the question whether or not Ricardian equivalence holds.

The thesis exists of two parts. The first part, respectively sections two and three, highlights the economic background of Ricardian equivalence. Emphasis is placed on the general idea; the assumption; and critique of the theorem. Furthermore, I look into earlier research that has been done on Ricardian equivalence, with special interest for research done in Euro-area

countries. The second part, respectively section four and five, focuses on the research that has been done in favor for this thesis. In this part attention is given to the data and methodology that I use in order to make this research possible and the results of the research are published. Finally, section six concludes.

II – Economical Background

In the year 1820 the English economist David Ricardo wrote the following quote in his article *"Funding System"*:

> "*Suppose a country to be free from debt, and a war to take place, which should involve it in an annual additional expenditure of twenty millions. There are [two] modes by which this expenditure may be provided; first, taxes may be raised to the amount of twenty millions per annum, from which the country would be totally freed on the return of peace; or secondly, the money might be annually borrowed and funded; in which case, if the interest agreed upon was 5 percent, a perpetual charge of one million per annum taxes would be incurred for the first year's expense, from which there would be no relief during peace, or in any future war; of an additional million for the second year's expense, and so on for every year that the war might last. At the end of twenty years, if the war lasted so long, the country would be perpetually encumbered with taxes of twenty million per annum. . . .*
>
> *In point of economy, there is no real difference in either of the models; for twenty millions in one payment [and] one million per annum for ever are precisely of the same value.*[1] "

With the quote mentioned above, Ricardo laid down the base for what is now known as the Ricardian equivalence theorem. In 1974, Robert Barro formulated this theorem when he published his article *"Are Government Bonds Net Wealth?"*. In his article, Barro argues against the general view that government debt increases the perceived wealth of households. Alternatively Barro comes to the conclusion that there is no theoretical foundation for looking at government debt as a component of perceived household debt. Arguments for a negative wealth effect are as liable and credible as arguments for a positive effect, thus the most probable effect is a neutral one.

[1] Ricardo, D., "Funding System", *Works and Correspondence*, Volume 4: 185-186.

The model that Barro uses is based on the overlapping-generations model of Samuelson (1958)[2]-Diamond (1965)[3] with physical capital. The model assumes that there are two generations present in the economy (old and young), of equal size and identical in terms of characteristics (tastes and productivity). Households live for two periods (young and old), but only work and earn wage during their youth. Nevertheless the households hold assets during both periods of their life, on which interest is being earned. The amount of assets hold when old contributes to the bequest for the new generation, this bequest is motivated by a concern for the new generation. Other assumptions are; (1) the bequest cannot be negative; (2) the government does not demand commodities nor provide services and (3) government debt is equal to zero.

Barro then assumes that the government issues a certain amount of debt by distributing government bonds. As a result this debt issuing increases the available recourses for the current generations while the future generations have to be paid back this issued debt. This makes it possible for the current generation to increase their consumption, but Barro argues that if the current generation chooses to leave a bequest behind for the future generations this increase in consumption does not happen. If the current generations have decided that they leave a bequest behind, even when the government did not issue the debts, it indicates that it was already possible for current generations to increase their consumption by lowering the height of the bequest. However as the current generation determined that making this shift was not optimal, which means that after the distribution of the government bonds it is not optimal to make this shift in resources. The only change that is being made is the height of the bequest. What is important is that households act as if they lived infinitely, as a result of the intergenerational transfers which connect current and future generations.

Ricardian equivalence can be explained with a Ramsey model[4]. The model assumes; (1) infinitely lived households; (2) no uncertainty present and (3) no market imperfections. The

[2] Samuelsen, P. A., 1958. "An Extract Consumption-Loan Model of Interest with or without the Social Contrivance of Money", *Journal of Political Economy*, 81, no. 1, pp, 1-27.

[3] Diamond, P. A., 1965. "National Debt in a Neoclassical Growth Model", *American Economic Review*, 60, pp. 1126-1150.

[4] The Ramsey model is a neo-classical growth model that differs from the Solow model as the savings rate is assumed to be endogenous. As result the saving rate may differ in the steady state. A second implication is that the outcome is Pareto optimal, due to the endogeneity of the saving rate and due to the infinite planning horizon of the households in the model.

household's budget restriction and the budget restriction are respectively shown in equation (1) and (2):

$$\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt \;\leq K(0) + \; D(0) + \int_{t=0}^{\infty} e^{-R(t)}\, [W(t) - T(t)]dt \; (1)$$

$$\int_{t=0}^{\infty} e^{-R(t)}\, G(t)dt \;\leq -D(0) + \int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt \; (2)$$

Here *C(t)* is consumption at time *t*, *W(t)* is labor income, *T(t)* is taxes and *G(t)* denotes the government's real purchases. *K(0)* and *D(0)* are the quantities of capital and government bonds at time 0, the interest rate is $\int_{\tau=o}^{t} r(\tau)d\tau$ leading $e^{-R(t)}$ to be the value of a unit of output at time *t* discounted back to time 0. If the brackets in equation (1) are removed, equation (1) transforms into:

$$\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt \;\leq K(0) + \; D(0) + \int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt - \int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt \; (3)$$

Another assumption that has to be made is that the government satisfies its own budget restriction. The reasoning behind this assumption is that without it the government could let their wealth grow forever. With this assumption the present value of the taxes, $\int_{t=0}^{\infty} e^{-R(t)}\, T(t)dt$, equals the initial debt, *D(0)*, plus the present value of the government purchases, $\int_{t=0}^{\infty} e^{-R(t)}\, G(t)dt$. Substituting this fact into equation (3) results in the following budget restrictions for the households:

$$\int_{t=0}^{\infty} e^{-R(t)}\, C(t)dt \;\leq K(0) + \int_{t=0}^{\infty} e^{-R(t)}\, W(t)dt - \int_{t=0}^{\infty} e^{-R(t)}\, G(t)dt \; (4)$$

What can be observed in equation (4) is that only the quantity of government purchases matters. Whether the purchases are financed due to taxes or due to debt is irrelevant, households internalize the budget restriction of the government. This is as Ricardian equivalence tells us.

In order to hold in the real world, Ricardian equivalence makes some assumptions that have to be fulfilled;

- ***Households are rational*;** Rationality in economics assumes that households make the most optimal decision given their available information, utility

function and budget restriction. A rational decision is not only well reasoned, but also optimal to accomplish a specific goal. When households are rational, they take the current tax cut into consideration and realize that some point in the future the current tax cut is offset by an increase in the tax rate to facilitate the repayment of the incurred costs.

- ***Perfect capital markets;*** A perfect capital market is characterized by the following features; players have access to perfect and symmetric information; there are no distortions active such as: taxes, transaction costs and/or bankruptcy costs; households, firms and governments borrow at an equal interest rate; arbitrage opportunities are not possible; there are no liquidity constraints for borrowing. The last characteristic matters for Ricardian equivalence, when some households are faced with liquidity constraint and thus are restricted when borrowing. For these household, since they are constrained in their borrowing opportunities, the opportunity arises to increase their consumption when the government accumulates debt, and as a result Ricardian equivalence does not hold.
- ***Permanent income hypothesis holds;*** According to the permanent income hypothesis households prefer a more constant consumption pattern and budget over a more volatile consumption pattern and budget. Consumption decisions of households are not determined by their current income but by their real wealth. Households smooth their income by borrowing and saving according to their permanent income. The general idea behind this income smoothing is that households have a constant amount of disposable income during each period. Short-term changes in income have little to no effect on the consumption behavior of the households. With respect to Ricardian equivalence, the households realize that the change of fiscal policy is temporary and eventually is followed by a tax increase. Therefore, the real wealth does not change and thus consumption does not change either.
- ***Taxes are lump-sum;*** a lump-sum tax is a tax which taxes households by a fixed amount, regardless of their income. These taxes are regarded as efficient taxes, as they cannot be avoided and thus minimize the losses and the dead weight burden that taxes imply. The fact that lump-sum taxes cannot be avoided by the households is the reason why Ricardian equivalence assumes

this type of tax. Under a different tax regime, household have the opportunity to increase their current consumption, thus reduce savings[5].

- ***Households have the same planning horizon as the government;*** To be able to foresee the future tax payments, households do not only have to be rational, they also have to be able to foresee into the future over which they maximize their inter-temporal utility function. This maximization has to be done over the same horizon as the government, such that households fully anticipate to the future tax liability and alter their behavior with this anticipation taken into consideration. If the two planning horizons differ, the case can arise that the households do not take the tax liability entirely into consideration and thus do not alter their behavior by means they have to, leading Ricardian equivalence fail.
- ***Generations of households are connected by income transfers motivated by altruistic behavior;*** Barro realized the fact that households do not live forever and due to this finite life of households, one could argue that households do not response as predicted by Ricardian equivalence. This as households might not live to see the altered tax rate and repayments take place and therefore would be able to increase their consumption instead of raising their savings. In order to deal with this fact, Barro makes the assumption that households are altruistic and that the different generations are connected by income transfers. The current generations care for the welfare of their descendants and therefore they do not increase their consumption when governments lower the tax rates. Instead current households transfer income (by means of a bequest) to the future generations so that future generations do not bear the burden of the future tax increase.

Being a controversial theory as Ricardian equivalence it is no surprise that it is a subject of critique and doubt. One of the first economists who question the idea behind the theory was

[5] Reasoning underlying this statement is that when taxes are not lump-sum but paid as a fraction of income, tax liabilities in the future are larger as income tends to increase overtime. The increased taxes in the future will lead to an income transfer from the future to the present, thus reducing saving

David Ricardo itself. Ricardo was uncertain about the rational expectations[6] of households, as he wrote in the same article:

> *"But the people who paid the taxes never so estimate them, and therefore do not manage their private affairs accordingly. We are too apt to think that the war is burdensome only in proportion to what we are at the moment called to pay for it in taxes, without reflecting on the probable duration of such taxes. It would be difficult to convince a man possessed of £20,000, or any other sum, that a perpetual payment of £50 per annum was equally burdensome with a single tax of £1000."*

The critique on Ricardian equivalence comes from two directions. The first direction looks at the empirics and states that empirical evidence supporting Ricardian equivalence is scarce. The vast amount of the research performed on Ricardian equivalence rejects this theory, but nonetheless also evidence is found that Ricardian equivalence holds for certain countries. Due to this fact, there has not yet been reached a consensus on the question whether or not Ricaridan equivalence holds.

The second direction of critique is based on theoretical grounds and argues that the underlying assumptions are not realistic. One point of criticism is that Ricardian equivalence only holds if the lifespan of households is infinite. As this is not the case households do not live to see the future repayment plus the tax increase and in addition households do not take these events into account when looking at their consumption budget. It is as Keynes quoted: "In the long run, we are all dead". However, as Barro shows in his article *"Are Government Bonds Net Wealth?*[7]*"* households do not have to live forever, due to altruistic behavior households increase their saving to lower the burden on future generations.

This brings us to another assumption that has been subject to criticism, the assumption that households behave altruistically. Bernheim (1987) mentions that with realistic assumptions,

[6] Evans, Honkapohja & Mitra (2010) conclude in their working paper "Does Ricardian Equivalence Hold When Expectations are not Rational" that the assumption of rationality does not need to hold in order for Ricardian equivalence to hold. What is important is that the households optimize their expectations and alter these expectations due to an adaptive learning process. The idea behind this is that households understand the budget restriction of the public sector.

[7] The way Barro generates his finding has also received criticism. As Buchanan (1976) argues Barro neglects to compare the different effects of taxes and government debt. Furthermore, he argues that Barro falsely makes the assumption that public debt does not include any compensating effect on the economy and Barro fails to provide any empirical evidence. Lastly, Barro neglects the political consequences of Ricardian equivalence

on preferences, productivity growth and income distribution, parents choose to leave no bequest to their children[8]. However children can still support their parents, which lead Ricardian equivalence to hold as long as governmental policies do not alter this behavior. Another possibility is that due to altruistic behavior all households are connected into an interconnected network, in which the consumption of each individual depends on the total wealth and an increase in total wealth is divided among the total population. Any increase in bequest is divided among all contemporaries and the increase in consumption would be negligible. Current generations do not prefer any longer to make a bequest for future generations.

Seater (1993) raises the point that the altruistic behavior can work in both directions, from parents to their children and from children to their parents. If the bequests flow in both ways, there will be a cycling problem and Ricardian equivalence does not hold. Nevertheless, Seater mentions that the bequests from parents towards their children often exceed the opposite, therefore the cycling problem would not arise.

Seater argues that even if households with offspring behave altruistic, society exists also of households who have no offspring. These household do not care for the future tax liabilities and therefore increase their consumption instead of their savings, which means that Ricardian equivalence fails to hold. However Seater argues too, that the households with offspring realize that there are households without offspring and therefore increase their savings even more to offset the dissaving of childless households.

Another point of criticism on altruistic behavior is that the possibility exists that the bequests are not motivated by altruistic behavior but by strategic behavior or even entirely accidental. Strategic altruistic behavior arises when parents use bequests in order to receive attention from their children, when the parents do not receive enough attention from their children the bequest will not take place. Another case of strategic altruistic behavior arises when children make threats to reduce their welfare, when the bequest is not sufficiently high enough. By reducing their own welfare level, the children also reduce the welfare of their parents. Accidental bequests arise when parents die sooner than they had anticipated and therefore pass on their belongings. As one's lifetime is uncertain, there is a possibility of dying before the expected age.

[8] These assumptions however are not mentioned by Bernheim(1987)

Rationality is as well an assumption that has received some critique. Economists are no longer convinced that behavior is solely determined by rationality. When households need to make the decision, they also take norms, values, experiences and social opinions into account besides acting rational.

The assumptions of a perfect capital market and lump-sum taxes also do not seem to hold. Many households for instance face liquidity constraints and taxes are mostly progressive in nature. Both Bernheim and Seater argue that when there are households present in the economy which are faced with liquidity constraints and thus do not have the possibility to borrow, these households would increase their consumption when facing lower tax rates. Bernheim mentions that one dollar government debt can lead to an increase of consumption with 0.25 dollar given that twenty percent of the households face liquidity constraints. Another possibility which relates to the liquidity constraints are different borrowing rates for households and governments and even among households. When governments are able to borrow at a lower borrowing rate and substituted one dollar of tax reduction for one dollar of debt, households regard the present value of the tax reduction larger than the present value of the debt. Resulting in an increase in net wealth and Ricardian equivalence no longer holds.

Barro (1989) reacts on five points of criticism on Ricardian Equivalence. The first is the fact that households do not live forever. Barro acknowledges the fact that households die, resulting in the fact that the horizons, over which these households discount the expected tax increase are not infinite. Barro refers to the fact that households are connected by altruistic bequests between generations and that the bequest takes the discounted tax increase into account. The second point Barro responds to is the imperfect capital market and specially the imperfect loan markets. Barro argues that these imperfections do not have to be a reason to reject Ricardian equivalence, this only is the case when the government is more efficient in controlling the loan market than the private sector. Barro states that if the economy exists of two groups of households, both of equal size, who differ on their access to liquidity, one being liquidity constrained and the other being liquidity unconstrained. When the government files a tax cut it has different economic effects for both groups. For the liquidity constrained group, the tax cut increases their consumption possibilities. For the liquidity unconstrained group, the tax cut does not have any effect on their wealth and therefore they are willing to hold the extra debt.

Other points of criticism to which Barro reacts are; the uncertainty about future taxes and income; the timing of taxes; and full employment and Keynesian models. On the uncertainty about future taxes and income, Barro concludes that desired national savings tend to rise with a budget deficit in uncertainty about one's future disposable income increases and vice versa. This conclusion has been found by looking into a variety of research, research focused on lump-sum taxes (Chan (1983))[9] finds evidence in favor of Ricardian equivalence, a tax cut is followed by an increase in savings and a decrease in consumption. However research on the effects of income taxes finds evidence that do not support Ricardian equivalence. However it supports the view that uncertainty of future taxes leads to a high discount rate of these liabilities and therefore the present value of the tax cut exceeds the present value of the expected future taxes, thus consumption will increase. As about the timing of taxes Barro says that indeed departures away from Ricaridan equivalence can arise if the taxes are not lump-sum. If taxes are not lump-sum, the budget deficit changes the timing of taxes and the possibility arises that the tax cut could affect the households' incentives to work. However these results of those variations are also inconsistent with the standard views on budget deficits and their effect on economic growth. The former statement is supported by the following model, with the following assumptions: (1) a two period economy; (2) tax regime is an income tax; (3) a tax cut takes place in period one which will be offset by an increase in period two; (4) the public debt does not change. In period one, households are more motivated to work due to a lower income tax and less motivated to work in period 2. At the same time, savings rise in period one and fall in period two. And lastly on the point of unemployment and Ricardian equivalence, while an often heard comment on Ricardian equivalence is that the theory depends on full employment in order to hold, Barro denotes that in equilibrium models that include unemployment, no clear interplay exist between the presence of unemployment and the validity of Ricardian equivalence.

III – Existing Literature

Besides a lot of theoretical work and literature about Ricardian equivalence, the theorem is also a reason for numerous empirical research. In the following part attention is placed to a small sample of research out of the vast amount that has been done to this date. Special attention is placed on research that makes use of a sample set containing EMU-member

[9] Chan, L., 1983, "Uncertainty and the Neutrality of Government Financing Policy", *Journal of Monetary Economics*, 11, pp. 351-372.

countries. I discuss the following research; Den Broeder and Winder (1992); Evans (1993); Reitschuler and Cuaresma (2004); Pozzi (2004); Cuaresma and Reitschuler (2007).

Den Broeder and Winder (1992) test whether or not Ricardian equivalence holds in the Netherlands. In order to be able to formulate an answer to this question, Den Broeder and Winder test the hypothesis with two consumption functions. One based on the standard life cycle model which also has been used by Modigliani and Brumberg (1955)[10] and for the second function, the authors adopted the specification of Nicoletti (1988)[11]. The estimations of the first method show some evidence of Ricardian equivalence. However it should be noted that there are some drawbacks with the method, most critical is that modeling the expectations is not in line with the theory of Ricardian equivalence. The second model on the other hand finds clear evidence which rejected Ricardian equivalence. Testing shows that a deficit-financed tax cut of 1 guilder leads to an increase of consumption with 0.27 (0.68) guilder when the future tax liabilities were (not) taken into account. Den Broeder and Winder come to the conclusion that Ricardian Equivalence has a too extreme view on reality and that is has to be rejected. Nevertheless they also conclude that economic agents do not fully neglect the inter-temporal budget restriction of the government and some elements of Ricardian equivalence appear to hold.

Evans (1993) looks at OECD member countries to research whether Ricardian equivalence holds in those countries[12]. Evans tests the Ricardian model versus a stochastic variant of Blanchard's model[13]. The latter model can act as (1); a Ricardian model, where households have infinite horizons and all future generations are internalized or (2); a model where households have finite horizons and are not perfectly connected to future generations. This depends on the value of one of the parameters present inside the model. When the value equals zero, Blanchard's model equals the Ricardian model and when the value is positive, and the non-Ricardian model is in place. For testing Evans uses an aggregated consumption

[10] Modigliani, F. & R.E. Brumberg, 1955, "Utility Analysis and the Consumption Function", in: K. K. Kurihara (ed.), *Post-Keynesian Economics*, London.

[11] Nicoletti, G. 1988. "A Cross Country Analysis of Private Consumption, Inflation and the 'Debt Neutrality Hypothesis'", *OECD Economic Studies*, No. 11, pp. 44-87.

[12] Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Ireland; Italy; Japan; Luxembourg; the Netherlands; Norway; Sweden; Switzerland; United Kingdom and the United States.

[13] Blanchard, O. J., 1985, "Debt, Deficits, and Finite Horizons", Journal of Political Economy, April, pp. 223-247.

function with annual data over the period 1960 till 1988. Evans concludes that when testing the countries separately, the individual countries show weak evidence against Ricardian equivalence and these tests have in addition little power against alternatives that deviate from Ricardian equivalence. However, when the data is pooled, the evidence rejects Ricardian equivalence. After this finding Evans raises the question whether this rejection has important implications for tax policy and comes to the conclusion that the departure is small for short-lived tax cuts.

Reitschuler and Cuaresma (2004) base their research on 26 member countries[14] of the OECD. In order to conduct their research Reitschuler and Cuaresma make use of a model which has been proposed by Khalid (1996)[15]. Khalid's model takes into consideration that the economy exists of both liquidity-constrained and liquidity-unconstrained consumers. This model yields a closed-form solution for aggregate consumption as follows:

$$C_t = \lambda_0 + \lambda_1 C_{t-1} + \lambda_2 Y_{t-1} + \lambda_3 Y_{t-2} + \lambda_4 G_{t-1} + \lambda_5 G_{t-2} + \varepsilon_t \quad (5)$$

whereas the lambda's represent the structural parameters that are being estimated in order to perform the empirical analysis. The data covers the period 1960 till 2002 and is gathered on a yearly base. Estimation of the parameters happens by performing full information maximum likelihood tests. The outcomes of these likelihood ratio tests let Reitschuler and Cuaresma reject Ricardian equivalence for 16 out of the 26 countries. For 10 countries Reitschuler and Cuaresma cannot reject Ricardian equivalence, namely; Austria; Denmark; Germany; Greece; Ireland; Korea; Luxembourg; Norway; Spain and Switzerland. This leads Reitschuler and Cuaresma to the conclusion that Ricardian equivalence is highly a European phenomenon.

Pozzi, Heylen and Dossche (2004) empirical research is not based on testing for Ricardian equivalence directly, but tests are performed to see what the effect of government debt is on the excess sensitivity of private consumption to current disposable income for 15 to 19 member countries[16] of the OECD. When either a neutral or insignificant effect is found one

[14] Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Iceland; Ireland; Italy; Japan; Korea; Luxembourg; Mexico; the Netherlands; New Zealand; Norway; Portugal; Spain; Sweden; Switzerland; Turkey; United Kingdom and the United States.

[15] Khalid, A. M. 1996, "Ricardian equivalence: Empirical evidence from developing economies", *Journal of Development Economics*, Vol. 51, pp. 413-432.

[16] Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Ireland; Italy; Japan; the Netherlands; Norway; Portugal; Spain; Sweden; United Kingdom and the United States.

can argue that Ricardian equivalence holds, nonetheless the results from the empirical analysis showed that government debt has a positive effect on the excess sensitivity of private consumption. This result suggests that when governments have a high debt rate, Keynesian theory is more likely to hold over Ricardian equivalence.

Cuaresma and Reitschuler (2007) have another research on Ricardian equivalence and this time they empirically test the theorem for the EU-15 countries[17]. The idea is that, due to the fiscal rules Maastricht criteria and the Stability and Growth Pact implies, households in these member counties may have behaved as predicted by Ricardian equivalence. The model of the empirical analysis is based on the model by Khalid (1996). Due to the small number of observations in the data, Cuaresma and Reitschuler also use a model proposed by Andrews and Kim (2003)[18] to investigate whether a structural break is present in the parameters. When testing for Ricardian Equivalence with the first model, Cuaresma and Reitschuler find that they cannot reject the theory for Austria; Belgium; Denmark; Germany; Greece; Italy; Spain. When using the second model to test whether a structural break has happened during the period 1992 till 2001, only Denmark and Spain show no evidence of a structural break, the 13 other countries all reject the hypothesis of no structural break during at least one year in the sample. The conclusion Cuaresma and Reitschuler make after interpreting the results is that the Maastricht criteria can have caused a change in the behavioral parameters of the model. This finding implies that countries where Ricardian equivalence holds should refrain themselves from running expansionary fiscal policies when their deficits are over the 3 percent threshold.

IV – Methodology and data

When doing research on Ricardian equivalence, there are two methods of testing used frequently. Both methods take a different look at Ricardian equivalence. The first method tests whether tax cuts are perceived by the households as wealth, by looking at households' consumption functions. The second method looks at Ricardian equivalence from a whole different perspective, this method tests whether government deficits lead to a rise in interest rates.

[17] Austria; Belgium; Denmark; Finland; France; Germany; Greece; Ireland; Italy; Luxembourg; the Netherlands; Portugal; Spain; Sweden and United Kingdom.

[18] Andrews, D. W. K. & Kim, J. Y., 2005, "End-of-sample cointergration breakdown tests", Cowles Foundation Discussion Paper no. 1404/03, Yale University.

In this research I use the first method, the consumption functions. I prefer the first method over the latter method, since with the latter method a problem arises when dealing with open economies. With open economies discriminating between Ricardian equivalence and the perfect capital markets hypothesis becomes a problem. This is due to the fact that international capital flows equalize interest rates across countries and therefore the interest rate may remain unchanged even though consumers act Keynesian (thus increasing their consumption in responds to the budget deficit). The interest rate is unaltered when the deficit is financed by an inflow of foreign capital.

Now that the method of testing has been selected, the question arises how to test whether Ricardian equivalence holds. The tests performed will be based on a reduced-from consumption function. This is the same method that has been used in the research described in part III – Existing Literature. I prefer the reduced-form consumption method over the Euler equation-specification, as it is more easily obtained. The Euler equation approach is bound to some specific drawbacks, it (1) is often rejected by the data due to reasons that are unrelated to Ricardian equivalence and (2) requires several restrictive assumptions before being able to derive the equation. The benefit however is that the Euler equation is based on the inter-temporal optimalisation problem. Another reason for choosing the consumption function over the Euler equation is as Bernheim points out in his article[19] *"with the right income and wealth variables, and interest rates, (including expectations of future incomes and interest rates) "structural" consumption functions are completely consistent with the Euler equation approach under rational expectations".*

I use the following specification in order to test for Ricardian equivalence;

$$C_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 Y_{t-1} + \alpha_3 G_t + \alpha_4 TX_t + \alpha_5 GB_t + \alpha_6 TR_t + \varepsilon_t \quad (6).$$

[19]Page 314 of Bernheim, B. D. 1987. "Ricardian Equivalence: An Evaluation of Theory and Evidence", with three 'Comments' in: S. Fisher, *NBER Macroeconomics Annual 1987*, Vol. 2, MIT Press, Cambridge, Mass. pp 263-315.

In this equation, private consumption today is determined by; (1) (national) income today; (2) the one period lagged (national) income; (3) government expenditures today; (4) government tax revenue today; (5) the amount of government debt today and finally (6) government transfer payments to households today. Ricardian equivalence holds when $\alpha_4 = \alpha_5 = \alpha_6 = 0$.

This specification is based on the consumption function of Stanley (1998);

$$C_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 Y_{t-1} + \alpha_3 G_t + \alpha_4 W_t + \alpha_5 TX_t + \alpha_6 GB_t + \alpha_7 TR_t + \varepsilon_t \quad (7)$$

According to Stanley equation (7) is the standard consumption function for testing Ricardian equivalence[20]. Equation (6) differs from equation (7) by not taking human wealth into account. The reason for dropping human wealth is that it is a complex variable, not easily to be found as one variable. One might say that human wealth can be estimated by creating a proxy, however creating a good proxy is a difficult task and still the proxy would be likely to be point of discussion. Since Ricardian equivalence holds in equation (7) when $\alpha_5 = \alpha_6 = \alpha_7 = 0$ I do not use human wealth, as it does not affect the condition of Ricardian equivalence and therefore avoid any problems with estimating human wealth. In the table below I will give a description of each variable from equation (6).

Table 1 – Description of the variables of equation (6)

Variable	Description
C_t	Households consumption at time *t*.
Y_t	(National) income at time *t*.
G_t	Government expenditures at time *t*.
TX_t	Government tax revenue at time *t*.
GB_t	Government debt at time *t*.
TR_t	Government transfer payment to households at time *t*.

I use (national) income and taxes as a variable on itself, instead of taking them together as disposable income. The reason for this decision lies in Seater (1993), where Seater argues against the use of disposable income, since it constrains the coefficients of (national) income

[20] Stanley finds this equation during his meta-analysis of 28 empirical studies focused on Ricardian equivalence.

and taxes to have the same value. These restrictions however cannot be made without testing them first.

The dataset consists of eleven European countries; Belgium; Finland; France; Germany; Ireland; Italy; the Netherlands; Norway; Spain; Sweden and the United Kingdom. These countries have been chosen since they are a diverse mix between some of the largest countries and economies of Europe and some countries with high government debts. Nominal data is gathered over the period 1996[21] till 2010 on quarterly basis. However data on government debt is not available for most countries[22] until the year 2000, for these countries the dataset has a range of 2000 till 2010. In table 2 I give an overview of which data have been gathered. The data comes from the Eurostat[23] and OECD.Stat[24]. Most of the data comes from Eurostat and those data are gathered in per capita terms and are not seasonally adjusted. For France per capita data is not available, these data have been calculated by gathering the data per million and dividing them by the population size[25]. The data on transfer payments comes from OECD.Stat. This data is not available as quarterly data, therefore linear interpolation is used to transform the annual data in quarterly data.

In order to conduct the research, real data are formed by transforming the nominal data with the use of the Harmonized indices of consumer prices[26]. This price indices is available on the Eurostat database at monthly rates, where 2005 is used as base year and set equal to a hundred. Since the price indices are given at monthly rates, I calculate the average of each quarter.

[21] 1996 is the starting point of the dataset, since before this year data on the price indices was not available.

[22] Only Belgium, France and Italy have data on government debt available before the year 2000.

[23] Eurostat is the statistical office of the European Union.

[24] OECD.Stat is the statistical database of the OECD.

[25] The data on the population size has been gathered of the European Commission Ameco database. Only annual data is available in this database, therefore the missing quarters have been filled in by calculating the missing data between the years with linear interpolation.

[26] The HICP index used is the overall index excluding alcohol and tobacco, the reason for excluding alcohol and tobacco is that the sample includes countries with strict price regimes on these goods and thus price increases are not caused by economic reasons but by policy.

Table 2 – Description of the data

Variable	Data used
C_t	Final consumption expenditures of households
Y_t	Gross domestic product at market prices.
G_t	Final consumption expenditures of governments.
TX_t	The amount of tax revenue was not directly available, therefore a proxy is created by taking the sum of; (1) current taxes on income, wealth, etc., receivable; (2) value added taxes, receivable and added these to values up.
GB_t	Government consolidated gross debt.
TR_t	Social security contributions paid by government

Besides the data of table 2, data on private and public saving has been gathered from the European Commission Ameco database. Plotting both savings and comparing them gives some insight in where to find Ricardian equivalence[27].

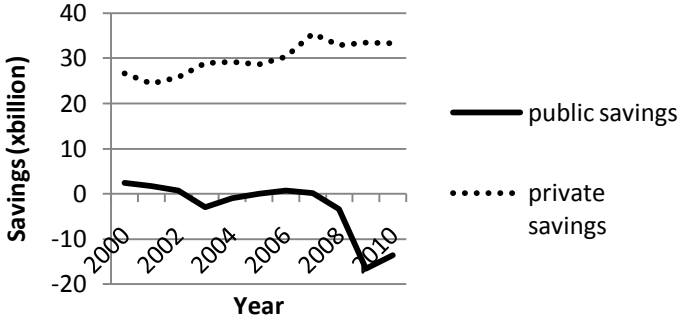
Two transformations are performed on the dataset, so I end up with 2 different datasets for testing. The first transformation I make is taking the logarithms of all variables. Since stationarity might be present in the dataset, I perform cointegration tests on the residuals of the regression to see whether a unit root is present. The second transformation made is taking the first difference between the logarithms. The reason for this transformation is that stationarity is probably not an issue anymore. In order to test for Ricardian equivalence, I estimate with Wald-tests the parameters of government debt, taxes and transfer payments to see whether these significantly differ from zero.

V - Results

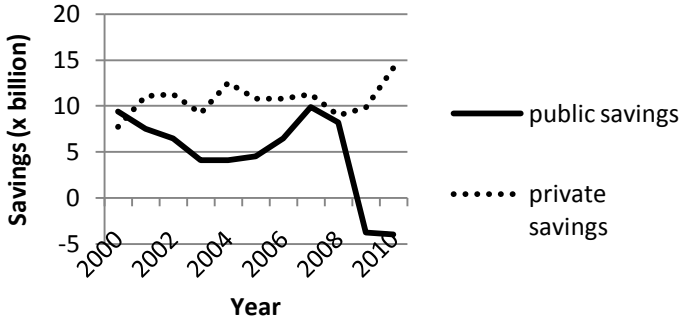
I first discuss the findings of the data analysis concerning the countries savings. To be able to make this analysis happen, I plot the net savings of both sectors in the same graph, so that one can see at a glance whether both are negatively related, which can imply Ricardian equivalence to hold. The graphs for the specific countries can be found below in graph 1-a till 1-l. On the y-axis the height of the savings in billions is displayed, the smooth line stands for the savings of the public sector, while the dotted line denotes the savings of the private sector.

[27] Another way of looking at Ricardian equivalence is by comparing the savings of the private and the public sector. Finding a negative relationship between the two amounts can imply that Ricardian equivalence holds.

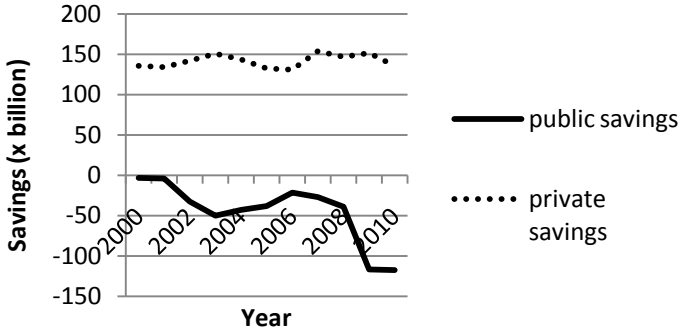
Graph 1-a: Belgium



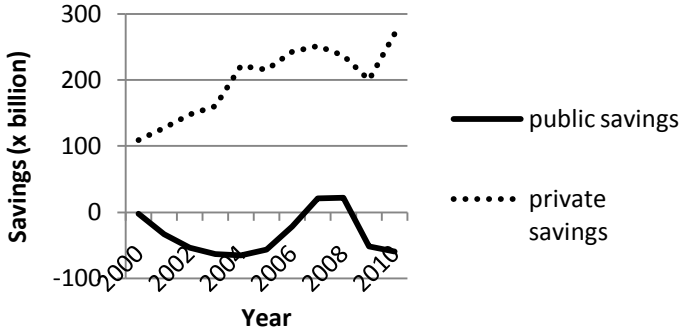
Graph 1-b: Finland



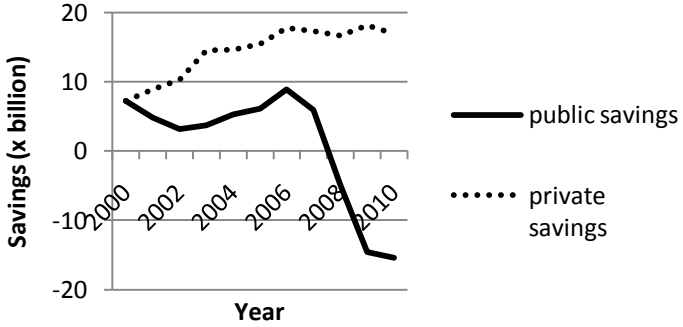
Graph 1-c: France



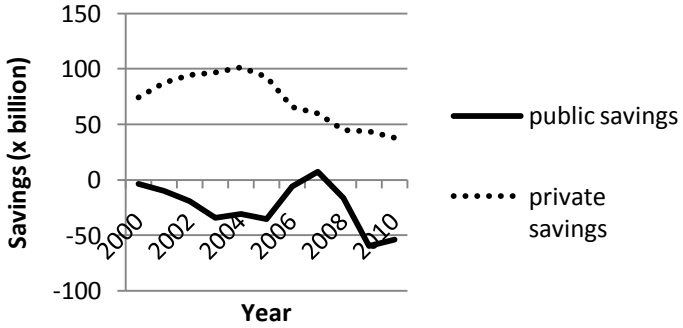
Graph 1-d: Germany



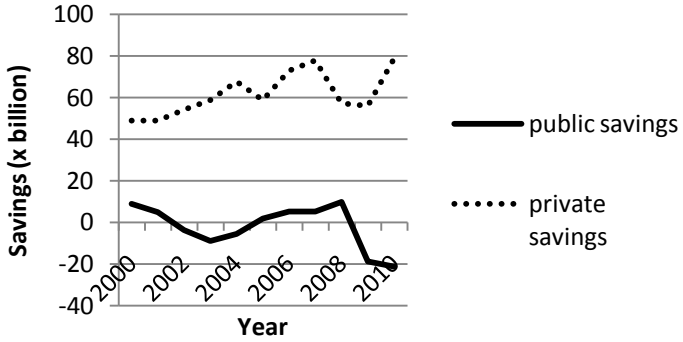
Graph 1-e: Ireland



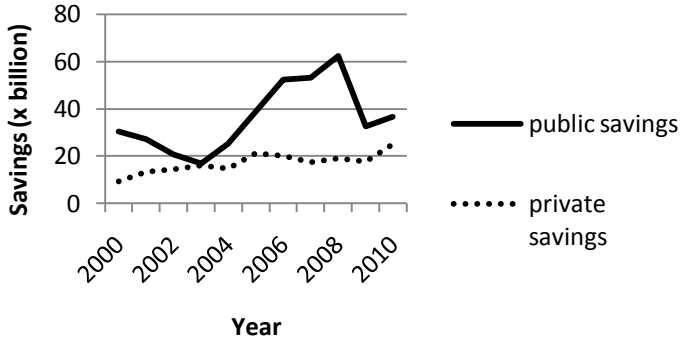
Graph 1-f: Italy

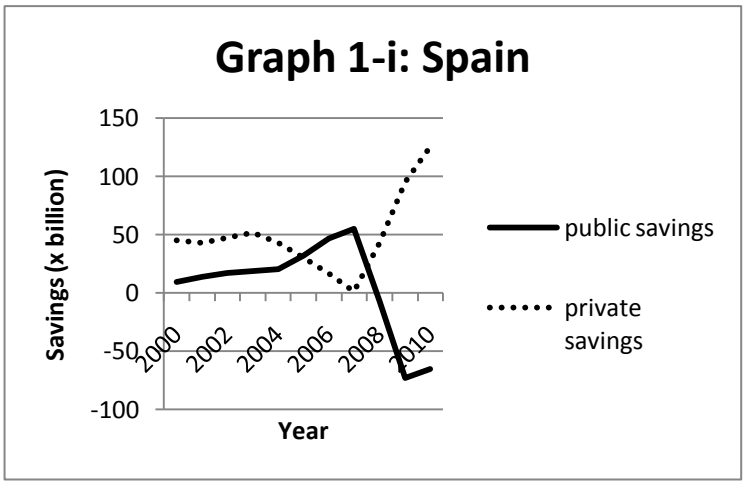


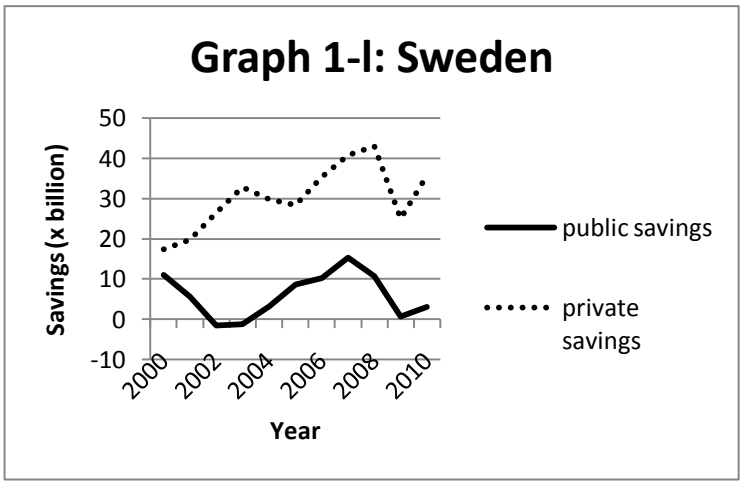
Graph 1-g: the Netherlands

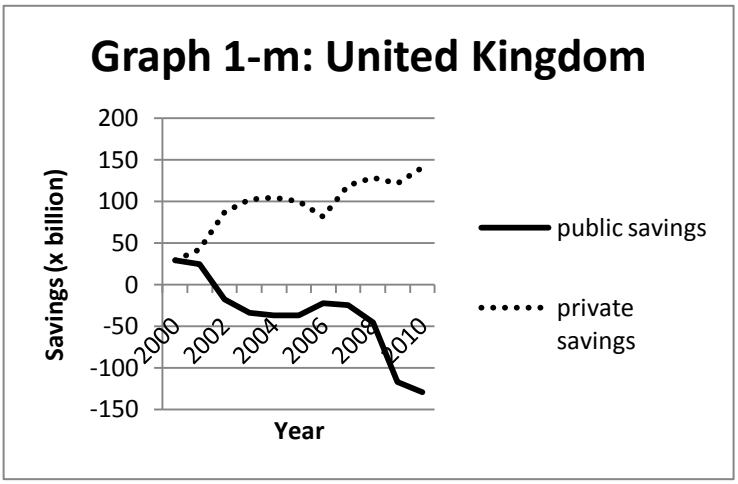


Graph 1-h: Norway









Looking at the different graphs, some things have to be mentioned. (1) In most countries the savings of the private sector exceed the savings of the public sector. (2) Looking at the relations between both net savings, it has to be noticed that no clear indication of Ricardian equivalence is present, there are some cases however which give a hint towards Ricardian equivalence. These cases are; Germany (early 2000's); the Netherlands (2000 till 2003); Spain (2007 and after); Sweden (2000 till 2002); United Kingdom (2001 till 2003 and 2009). During these cases one can see an increase in private savings, while public savings show a decrease, which can imply Ricardian equivalence to hold. Nevertheless it is not clear from the data that these negative savings of the central government are caused by policy incentives or by shocks, such as the last economic crisis. As a reaction on the economic downfall, governments start to increase their spending in order to keep the economy running. Ricardian equivalence does not hold here as the government action is not policy based but a reaction to a shock and the governments use expenditures instead of taxes. Policies revolving on expenditures cannot lead to Ricardian equivalence.

I now discuss the results from the research. First I discuss the results of the unit root tests, given in table 3. As second I discuss the results of the Wald-tests performed on the same data base, which are shown in table 4. Lastly I discuss the findings of the Wald-tests performed on the dataset with the first difference transformation, which findings are displayed in table 5.

Table 3 – Results of Unit-root tests equation (6)

Country	*# of lags*	*t-score*	*Prob.*
BE	0	-6.8359	0.0000***
DE	0	-6.9810	0.0000***
ES	7	-2.6687	0.0091***
FI	0	-7.0115	0.0000***
FR	9	-2.4542	0.0151**
IE	0	-6.7155	0.0000***
IT	1	-4.2973	0.0000***
NL	3	-2.1143	0.0346**
NO	5	-2.6409	0.0097***
SE	0	-6.4247	0.0000***
UK	5	-3.3391	0.0014***

I - Tests are performed with Eviews 7. II – an Augmented Dickey Fuller test has been the chose for performing the unit root tests. III – as for lag length, Akaike Info Criteria has been used. IV - *** (**) [*] stands for significance at respectively 1% (5%) [10%] level.

What can be seen in table 3 is that in all the cases cointegration is present when a significance level of 5% is used. When using a stronger significance level, like 1%, still 9 out of the 11 cases show evidence of cointegration. These findings indicate that the variables share a common stochastic drift and move in the same direction.

The Wald-tests of table 4 and 5 are performed on the parameters of the variables of government debt, tax payments and transfer payments and test whether the three of these together are equal to zero, implying Ricardian equivalence to hold. Looking at both tables the majority of the results that I find reject Ricardian equivalence, meaning that the parameters of government debt, tax payments and transfer payments significantly differ from zero. There are only two cases for which Ricardian equivalence cannot be rejected. These cases are the Netherlands and Spain in the dataset with the first difference approach, Ricardian equivalence is rejected with all levels of significance.

With special interest I look at the signs of the estimations for the coefficients of the taxes, since Ricardian equivalence does not seem to hold in most of the cases it is interesting to see which theory, with respect to taxes, is most likely to hold then. The evidence shows no clear answer; both positive and negative values have been found. This indicates that both Keynesian theory holds as well as non-Keynesian effects hold empirically.

About the other variables of the equation I can make the following statements; national income has in all the cases a positive influence on consumption, whereas the other variables (lagged values of national income; government expenditures; government debt; human wealth and transfer payments) show mixed influences. As with taxes both positive and negative values for the coefficients are found. These statements apply to both table 4 and table 5,

Table 4 – Results of equation (6) in logarithms

Country	Y_t	Y_{t-1}	G_t	TX_t	GB_t	TR_t	*Wald*
BE	0.7392 (0.1320)***	0.0374 (0.0883)	0.0956 (0.0627)	-0.0384 (0.0294)	0.1194 (0.0444)**	-0.0695 (0.0452)	30.3578 (3,41)***
DE	0.7090 (0.0945)***	-0.3045 (0.0836)***	0.1978 (0.0445)***	0.0467 (0.0305)	0.1108 (0.0372)***	0.0014 (0.0358)	23.6292 (3,37)***
ES	0.6160 (0.1455)***	0.7545 (0.2257)***	-0.1583 (0.0574)***	0.0233 (0.0256)	0.0466 (0.0620)	-0.0068 (0.0632)	6.0002 (3,36)***
FI	0.7557 (0.0564)***	0.0231 (0.0405)	0.1164 (0.0456)**	0.0396 (0.0257)	0.0803 (0.0286)***	0.0558 (0.0286)	66.2629 (3,35)***
FR	0.9798 (0.0626)***	-0.0589 (0.0195)***	-0.2543 (0.0551)***	0.0057 (0.0220)	0.1460 (0.0308)***	0.0536 (0.0338)	175.7429 (3,52)***
IE	0.0655 (0.1096)	0.4878 (0.0944)***	0.1764 (0.0993)*	0.1416 (0.0154)***	0.0035 (0.0262)	0.0201 (0.0256)	40.3652 (3,36)***
IT	0.4718 (0.1467)***	0.3019 (0.0847)***	-0.0351 (0.0370)	0.0069 (0.0244)	0.1383 (0.0459)***	-0.0248 (0.0442)	10.3284 (3,51)***
NL	0.5710 (0.1855)***	0.1763 (0.0961)*	0.1421 (0.1366)	-0.1046 (0.0418)**	-0.0140 (0.0622)	-0.0290 (0.0319)	4.0510 (3,36)**
NO	0.6523 (0.1730)***	-0.3935 (0.1175)***	0.4005 (0.1202)***	0.0198 (0.1373)	0.0846 (0.0383)**	-0.0145 (0.0617)	12.2418 (3,37)***
SE	0.4580 (0.1274)***	0.0940 (0.0339)***	0.3285 (0.0920)***	0.0439 (0.0762)	0.0643 (0.0458)	-0.0892 (0.0385)**	16.7928 (3,37)***
UK	1.2478 (0.0780)***	-0.2007 (0.0892)**	0.0173 (0.0495)	-0.1143 (0.01878)***	0.0319 (0.0253)	-0.0442 (0.0290)	103.2731 (3.36)***

I – Tests are performed with Eviews 7. II - *** (**) [*] stands for significance at respectively 1% (5%) [10%] level. III – for the parameters the values of the coefficients are given whereas the standard error is given between brackets. For the Wald test the F-statistic is given and between brackets the degrees of freedom.

Table 5 – Results of equation (6) in first differences

Country	Y_t	Y_{t-1}	G_t	TX_t	GB_t	TR_t	*Wald*
BE	0.7264 (0.1357)***	0.1386 (0.0940)	0.1023 (0.0645)	-0.0252 (0.0278)	0.1443 (0.0600)**	-0.0480 (0.0490)	25.4160 (3,40)***
DE	0.6951 (0.0899)***	-0.2861 (0.0878)***	0.1691 (0.0438)***	0.0553 (0.0310)*	0.0254 (0.0435)	0.0016 (0.0358)	25.9316 (3,36)***
ES	0.0611 (0.1884)	0.3258 (0.4403)	-0.0719 (0.0661)	-0.0528 (0.0309)*	-0.1581 (0.2260)	0.0569 (0.0641)	2.0173 (3,37)
FI	0.6913 (0.0538)***	-0.0939 (0.0510)**	0.0897 (0.0413)**	0.0128 (0.0227)	-0.0025 (0.0351)	-0.0405 (0.0458)	60.4505 (3,37)***
FR	1.0975 (0.1354)***	-0.0478 (0.0637)	-0.4110 (0.1221)***	0.0202 (0.0300)	-0.0633 (0.1089)	-0.0547 (0.0546)	24.7115 (3,53)***
IE	0.0557 (0.0970)	0.4900 (0.1005)***	0.1601 (0.1005)	0.1423 (0.0131)***	-0.0146 (0.0696)	0.0180 (0.0257)	41.3937 (3,35)***
IT	0.3657 (0.1540)**	0.2158 (0.1076)*	-0.0283 (0.0360)	0.0074 (0.0240)	0.2206 (0.1092)**	-0.0106 (0.0421)	4.7408 (3,49)***
NL	0.1182 (0.1582)	-0.1492 (0.1088)	0.1028 (0.1153)	-0.0704 (0.0289)**	-0.0898 (0.0803)	-0.0123 (0.0270)	2.0558 (3,36)
NO	0.5895 (0.1722)***	-0.4473 (0.1294)***	-0.1857 (0.2126)	0.1376 (0.1096)	0.1838 (0.1071)*	-0.1559 (0.0935)	10.0884 (3,37)***
SE	0.7365 (0.1327)***	0.0045 (0.0390)	-0.0248 (0.0989)	-0.0285 (0.0864)	0.0981 (0.0507)*	-0.0919 (0.0480)	25.0368 (3,35)***
UK	1.1866 (0.0789)***	-0.1306 (0.0877)	0.1442 (0.0655)	-0.1082 (0.0154)***	0.0772 (0.0382)*	-0.0208 (0.0419)	96.5598 (3,35)***

I – Tests are performed with Eviews 7. II - *** (**) [*] stands for significance at respectively 1% (5%) [10%] level. III – for the parameters the values of the coefficients are given whereas the standard error is given between brackets. For the Wald test the F-statistic is given and between brackets the degrees of freedom.

VI - Conclusion

Ricardian equivalence has received a lot of attention in both theoretical literature and empirical research as a result of its controversial predictions. Ricardian equivalence teaches that fiscal policy changes cannot be used by governments in order to stimulate economic growth as the households are rational and realize that these policy changes are temporary and therefore alter their behavior. Teaching so, the theory opposes the classical and Keynesian view, where fiscal policy changes alter economic growth

In order to test Ricardian equivalence, a consumption function has been used which looks similar to Stanley's standard consumption function and Wald-test and Augmented Dickey Fuller tests are performed on the datasets. The data is gathered from the Eurostat database over the period 1996 till 2010.

With respect to the question whether Ricardian equivalence holds or not, I find no clear answer in the results. In the majority of the cases Ricardian equivalence is rejected, nevertheless there are also two cases, the Netherlands and Spain, in which Ricardian equivalence cannot be rejected with the Wald-tests. Nevertheless when Ricardian equivalence is rejected, the results fail to provide a clear insight on which theory holds empirically, as the findings support both Keynesian as well as non-Keynesian effect.

These findings also have implications for the governments with respect to policy issues. In countries where Ricardian equivalence holds, governments cannot make use of shifts in taxes in order to stimulate economic growth and have to look for other means. Two possible means are (1); increasing government spending and (2); increasing human capital. These means also have their downsides, the increased government spending has to be paid back eventually and therefore a similar situation as Ricardian equivalence can arise, households increase their savings. The increase in human capital also has its downside, it does not work in the short run.

The same applies for countries where I find non-Keynesian effects, the reasoning nevertheless differs. In the situation of Ricardian equivalence lowering the taxes cannot be used as its effect on economic growth is neutral, the lowering of the taxes is offset by the increase of household savings. In the situation of non-Keynesian effect the lowering of taxes has a negative effect on economic growth. Governments of countries which results show Keynesian effects can make use of taxes to stimulate economic growth. Consumers will increase their consumption instead of their savings.

Since the results show no complete evidence of Ricardian equivalence, it might be worthwhile to research why households in certain countries act more Ricardian than their counterparts in other (neighboring) countries and see which factors explain this difference.

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