

Ricardian Equivalence and Lucas Critique: An Alternative Test of Ricardian Equivalence Using Super Exogeneity Tests in Simulated Series

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Abstract

This article considers an alternative methodology nested on super exogeneity tests to verify the occurrence of Ricardian equivalence. The advantage of this new procedure is based on the intuitive appeal and the statistical procedure, more appropriated than the econometric techniques previously adopted in this literature.

Keywords: : Ricardian Equivalence, Lucas Critic, Public Debt, Super Exogeneity Tests

JEL Classification: H30, E62, C63

Resumo

Este artigo propõe uma metodologia alternativa, baseada em testes de exogeneidade, para verificar a ocorrência da Equivalência Ricardiana. A vantagem desse novo procedimento reside no forte apelo intuitivo e na sofisticação do instrumental estatístico, superior as técnicas anteriormente adotadas. Além disso, este artigo possui duas outras contribuições: a) sugere uma explicação para a falha dos testes de Equivalência Ricardiana baseados na função consumo, como propostos por Kormendi (1983); e b) salienta a inadequação dos testes de Equivalência Ricardiana baseados no valor do parâmetro de correlação.

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1. Introduction

One of the economic subjects that bring about the curiosity of both the academics and the policy makers is related to the effect of governmental interventions on the economy. Issues such as the possibility of the public policy to affect the welfare of the population are frequently formulated. However, the answers are not conclusive. They are also sensible to the inherent hypotheses by which the different models are formulated and to the respective areas of public policy.

If one understands public policy constraint to fiscal policy – that is, change in taxation, the public debt and the government expenditures – the problem can be posed in the following way. Are the changes in the public deficit (or the public debt) able to affect the real variables of the economy?

Barro (1974) in a seminal article demonstrated the conditions by which the government debt is not understood as liquid wealth by the agents. Thus, when there is an increase of the public debt, the reduction of the government saving is accurately compensated by the increase of the private saving. Thus, the domestic saving is not changed and the change in public debt does not have effect on the real economic variables. This result was known in literature as Ricardian Equivalence (RE) and establishes that the choice between lump-sum taxation or the increase of public debt to finance the government expenditures neither affect the consumption of the households nor the stock of capital.

The goal of this article is to suggest an alternative method to test the theory of Ricardian Equivalence. That is, the main contribution of this work is to consider a new methodology that try to related Ricardian Equivalence with Lucas critique. The RE theory implies that a change in fiscal policy does not modify the behavior of the agents while Lucas critique (1976) states exactly the contrary. Lucas Jr (1976) argued that, under a rational expectation hypothesis, econometric models could not be used to formulate economic policy because, when the policy maker changes the policy, the agents change their behavior. Consequently, the parameter found before the political change would not be the same after the change. Based on this fact, it seems that we have an intuitive way to test the RE hypothesis. Then we formulate the following rule: if we accept Lucas critique, we reject the RE hypothesis and vice versa.

The advantage of this methodology is that, differently from the previous econometric procedures used to test RE, Lucas criticism can be test in a more consistent and accepted way. In general, the use of super exogeneity test is the most accepted approach to test Lucas criticism.¹

This paper is outlined in the following way. In Section 2, we present a brief description about the concept of Ricardian Equivalence. In Section 3, we described the procedure used by Cardia (1997) to test RE hypothesis. This

¹ Favero e Hendry (1992) and Linde (2001) are papers that use super exogeneity tests to verify the Lucas Critic.

author constructed and calibrated models based on Blanchard (1985) e Yaari (1965) that reproduce the stylized facts of the economy. We consider in Section 4 an alternative approach based on Lucas criticism to verify the occurrence of Ricardian Equivalence. This alternative procedure is applied on the simulated data and the performance of this methodology is analyzed in Section 5. Herein we use the same procedure defined by Córdia to simulate the economic series. Finally, we present the concluding remarks in Section 6.

2. Brief Comments on Ricardian Equivalence

The idea that the private agents are indifferent the way the government finances its spending, it does not matter whether a government finances with debt or a tax increase, is not new in economy. It was first proposed by the British economist David Ricardo (Ricardo 1820). Ironically, Ricardo himself was skeptical about the empirical validity of this idea. Despite of the incredulity of this great economist, this theory deserved attention of some important economists, such as Patinkin (1965), Diamond (1965), Bailey (1971) and Kochin (1974). But it was just from the Barro' seminal article in 1974 this theory started to occupy a remarkable place in the economic debate.

Barro (1974) proposed an overlapped generation model that assumes that families act as infinitely lived dynasties because of intergenerational altruism, capital markets are perfect (meaning that all can borrow and lend at a single rate), and the path of government expenditures is fixed. Under these conditions, if governments finance deficits by issuing bonds, families will grant bequests to children just large enough to offset the higher taxes that will be needed to pay off those bonds. In the conclusions of the paper (page 1116), he states that “in the case where the marginal net-wealth effect of government bonds is close to zero ... fiscal effects involving changes in the relative amounts of tax and debt finance for a given amount of public expenditure would have no effect on aggregate demand, interest rates, and capital formation”. This sentence sounded as the negation of the Keynesian theory where a bond financed spending has a bigger effect than tax financed spending. If consumers are “Ricardian” they will save more now to compensate for the higher taxes they expect to face in the future, as the government has to pay back its debts.

In accordance with the paragraph above, it can be inferred that fiscal effect, involving changes in taxes and emission of public debt would not have impact in the added demand, interest rate and in the formation of capital. Such effect is known in literature for Ricardian Equivalence. Thus, when one argues that a certain economic model presents Ricardian Equivalence, it means that the economic agents does not modify its way of consumption due to the changes in the way the government uses to finance its expenditures.

An interesting commentary concerning Ricardian Equivalence was made by Evans (1989). Initially, Evans manifested his skepticism about the relevance of

the ER. But after that many studies were not able to reject ER hypothesis, he confess that it seems to reasonable to attribute some credit to Barro's proposal. In general, the thought of Evans (1989) seems to reflect the thinking of the majority of academics that work with this issue. At first, the ER hypothesis may be only a theoretical curiosity without any practical application. Notwithstanding, after 30 years the Barro's contribution still alive and keep on to call attention the economists.

The real economies are far from to present the theoretical conditions required by ER theory. However, the relevant question is to know if the deviations from these requirements are sufficient to modify the results suggested for it (Feldstein e Elmendorf 1990).

3. Simulated Series Based on Four Theoretical Models

Cardia (1997), using the model of Blanchard (1985) e Yaari (1965), constructed and calibrated models that reproduced stylized facts of the American economy. The econometric tests were applied on the simulated series generated by these models and the results corroborated the Theorem of Ricardian Equivalence. In this paper we use the same procedure proposed by Cardia (1997) in order to apply our alternative methodology to verify RE hypothesis. Four calibrated models were built. The relevant details are described as follow.

In the first model the labor supply is constant. It means that taxation on work does not distort its allocation. The households are also doted of infinite time horizon. Thus, this model satisfies the ER hypotheses. The temporal horizon of the households is also infinite in the second model, but the labor supply is endogenous. So it does not satisfy the hypotheses required for Ricardian Equivalence. In the third one, the labor supply is constant, but the time horizon of the household is finite. Therefore, this model does not fulfill the conditions for the occurrence of ER. Finally, in the last model, the labor supply is not constant, in a view that taxation on the work distorts its allocation. Moreover, the temporal horizon of the households is finite. Thus, this model does not satisfy the hypotheses of Ricardian equivalence.

Using the simulated data, Cárdua (1997) estimated the following regression:

$$C_t = \alpha + \beta_1 Y_t + \beta_2 Y_{t-1} + \beta_3 G_t + \beta_4 W_t + \beta_5 TR_t + \beta_6 B_t + \mu_t \quad (1)$$

where C_t is the consumption of the households, Y_t is the output, G_t represents the expenses of the government, W_t is the private wealth, TR_t represents the income of the taxes (or transferences), B_t it is the public debt and μ_t is a Gaussian white noise disturbance.

To test the theory of RE, Cardia (1997) adopted the following rule: test null hypothesis $H_0 : \beta_5 = \beta_6 = 0$ against the alternative one $H_1 : \beta_5 \neq 0$ or $\beta_6 \neq 0$.

As one can see the null H_0 is associated to the occurrence of RE, that is, if one accepts H_0 , one also accepts RE.

4. Alternative methodology for the Test of Ricardian Equivalence

The objective of this section is to show that the previous tests presented in last section based on the correlation suffer from serious weakness. Three important criticisms regarding the traditional procedure deserve to be analysed. Firstly, in the majority of the studies the estimated regressions are based on univariate models. It means that there is an implicit hypothesis that the explained variables are exogenous. In other words, the additional information from modeling these variables does not improve the estimation. In statistical terms, the marginal models do not display significant information to modify the conditional (original) model.

In agreement with the previous paragraph, the articles that test the RE hypothesis based on univariate models must to demonstrate that they have a statistical property known as weak exogeneity. If this condition is not satisfied we have what it is denoted as endogeneous bias. In this case, the estimated coefficient is biased hindering the inference on the true value of the parameter. It makes difficult any conclusion regarding the ER on the basis of the value of the estimated regression.

The second critical point is related to the presence of structural break. The certain variables that usually appear in tests to check Ricardian equivalence such as public debt, government expenses, private consumption and domestic saving are susceptible to some forms of shocks that are able to modify the behavior of them. This can imply in the presence of structural break and change of the estimated parameter throughout the series. Consequently, the usual econometric procedure to test RE hypothesis is not appropriated any more. After all, in the presence of structural break the value of the coefficient is not constant throughout the sample data. The analysis of the structural change in studies that search for verify RE does not usually occur in this literature.

Finally, the third critical point regard the interpretation of the parameter of correlation as representative, or not, of the RE. The value of the correlation parameter only indicates a relation between the variables. It can not be taken as indicative if the RR exists or not. This criticism practically makes impracticable the tests of RE based on the value of the parameter. We will now focus in this critical point.

To confirm our point, we return to the basic question: what it is Ricardian Equivalence? To answer this question, we go to adopt the interpretation of RE suggested by Barro (1974) that rescued this controversy such as it has been discussed nowadays. In accordance with him, the RE implies that the consumption of the families is not affected by the way as the government finances its expenses. In other words, it does not matter if the public

expenditures is supported by taxes or by the emission of public bonds. That is, when the government wishes to finance its expenses increasing public debt and reducing taxes, this change can be seen as an equivalent increase of the private saving keeping consumption, the interest rate and the stock of capital unchanged.

It must be noted that, there does not exist anything that relate the value of the estimated parameters with the definition of RE (as proposed by Barro 1974). Barro did not argue that the effect of the public debt on the savings is zero. He inferred that a change in the way by which the government finances its expenses does not modify the aggregate demand, that is, a change in the composition of public financing does not affect the behavior of the agents. In this sense we have that this definition is in opposition to Lucas critique (1976). According to Barro (1974), the RE theory implies that a change in fiscal policy does not modify the behavior of the agents while Lucas critique (1976) states exactly the contrary. Lucas Jr (1976) argued that, under a rational expectation hypothesis, econometric models could not be used to formulate economic policy because, when the policy maker changes the policy, the agents change their behavior. Consequently, the parameter found before the political change would not be the same after the change. Based on this fact, it seems that we have an intuitive way to test the RE hypothesis. Then we formulate the following rule: if we accept Lucas critique, we reject the RE hypothesis and vice versa.

The advantage of this methodology is that, differently from the previous econometric procedures used to test RE, Lucas criticism can be test in a more consistent and accepted way. In general, the use of super exogeneity test is the most accepted approach to test Lucas criticism. The superexogeneity test allows an econometric model to escape from the Lucas criticism. In an article on the consumption function in the United Kingdom, Davidson et alii (1978) presented conditions under which Lucas' criticism does not apply. The variables that satisfied these conditions were labeled super exogenous. Whenever a variable is super exogenous, policy makers can use it to formulate economic policies. In this section, we propose two tests in order to verify superexogeneity.

The consequence of super exogeneity is that the adoption of a new economic policy will not be successful. Intuitively, we have an indirect way to verifying the RE hypothesis. The acceptance of the super exogeneity implies to reject Lucas critique and, consequently, the acceptance of the RE. More directly, accepting super exogeneity implies to accept RE, and vice versa. In a statistical point of view, the idea of super exogeneity implies in to accept weak exogeneity and the structural invariance of the parameters.

In accordance with the theory of Ricardian Equivalence, whether the agents perceive that the public bonds (government debt) are liquid wealth an increase in public debt implies in a reduction of the domestic saving of the economy (Barro 1974). On the other hand, this reduction generates an increase in the interest that decreases and the capital supply (Ball e Mankiw 1995). It suggests a possible way to check the existence of Ricardian Equivalence. It can be verify

noting if an increase of the public debt determines a reduction in capital supply or a reduction in domestic saving.

To carry out the RE test, we can use as the dependent the supply of capital or the domestic saving. Barro (1974) and Ball e Mankiw (1995) suggest the adoption of the public debt as the independent variable. In this case if the government increases public debt neither the stock of capital nor private saving will change. Thus, when the public debt change, the rate of saving change at the value of the parameter β , meaning that breaks in the public debt are not able to alter the private saving.

5. Alternative Test to Verify Ricardian Equivalence.

Cardia (1997) suggests that tests on the consumption function for the study of Ricardian equivalence have low statistical power. Differently, Miller e Roberds (1992) admits the impossibility of verifying the effect of the public deficit on the real interest rate. Herein, we follow Barro (1974) and Ball e Mankiw (1995) that consider tests directly applied on the domestic saving and the stock of capital.

If the economic agents perceive the government debt as a net wealth, an increase of the public headings implies in a reduction of the domestic saving (an increase in the public headings, given the trajectory of public expenses remains unchanged, suggests a reduction in the taxation. A reduction in the taxation would imply then in an increase of the consumption and reduction of the saving). Moreover, according to Ball e Mankiw (1995), this reduction, in turn, results in an increase of the interest rate and in a reduction of the capital supply. Then, an alternative way to test the occurrence Ricardian equivalence consists of verifying if the increase of the public debt reduces the supply of capital or the domestic saving.

5.1. *Tests of superexogeneity for Ricardian equivalence*

The objective of this section is to verify, using simulated series previously mentioned, if the superexogeneity test suggested by Engle e Hendry (1993) (EH) are robust for the characterization of Ricardian Equivalence. We use the method to test superexogeneity. To implement this methodology, a marginal model for saving or the stock of capital must be proposed. The idea of the EH test is to include the squared residuals of the marginal equation its lags in the conditional equation. If the squared residuals of the marginal equation and its lags were not statistically significant in the conditional equation, then this would indicate the acceptance of superexogeneity.

To perform these tests, we follow the same approach used by Cardia (1997) to generate the data sample. We know that the series generated in Case 1, satisfy to the theorem of RE. Using 1,000 simulated responses we will proceed

the exogeneity test at 5% significance level to verify percentage in which the hypothesis of Ricardian Equivalence is rejected in this case. Thus, if the proposed methodology is robust, we expect a small percentage (around 5%) of rejection. Afterwards we will proceed in the same way using the series generated in the remaining cases. In cases 3 and 4 we expected that the RE theory must be rejected. At the same significance level, if the suggested methodology is correct, one expects a high percentage (around 95%) of rejection. We start using two simple conditional models to perform the tests of weak and super exogeneity.

$$K = \alpha_1 + \beta_1 Debt \quad (\text{conditional model - equation I})$$

$$S = \alpha_4 + \beta_4 Debt \quad (\text{conditional model - equation II})$$

where K is the stock of capital and S is the private saving. The following step is to build a marginal model for Debt. The formulation of the marginal model is ad hoc, and herein two models will be considered:

$$\text{a) } Debt_t = f(Debt_{t-k}, G_{t-i}) \quad (\text{marginal model - a})$$

$$\text{b) } Debt_t = f(Debt_{t-k}, Transf_{t-i}) \quad (\text{marginal model - b})$$

The variables are in logarithmic and that t is the time subscript and $t - k$ is the lag order.

Results for Case 1 (RE accept)

The results for Case 1 where RE occurs are reported in the Table 1. This table presents the percentage of results in agreement with RE hypothesis. In other words, the table displays the index of rightness of the alternative methodology. In this specific case the rightness happens when the alternative methodology does not reject the occurrence of Ricardian equivalence.

Table 1
Percentage of results in accordance with ER – Case 1

	Marginal Model (a)	Marginal Model(b)
Condiciona l Model (I)	30.3%	39.8%
Condiciona l Model (II)	31.2%	36.7%

The test appears in Table 1 was performed using 1.000 simulated series. The performance of the alternative methodology suggested by the results of this table is not so confident. The index of rightness of the alternative approach varies between 30.3% and 39.8%. However, one must remember that our marginal and conditional models are very simple. Such specification were appropriately chosen in order to put in evidence the results reported herein would be the inferior limit of rightness regarding the alternative methodology. One possible reason for that is due to the fact we use simple econometric

models here that do not capture the true essence of economic system. It has been done because we want to prevent criticisms regarding that possible good results are only obtained because we are using specific models. One can see that even employing extremely simple econometric models the index of rightness of the alternative methodology is still very reasonable when is compared with the traditional tests of RE. The use of more adjusted models that are able to represent the behavior more appropriately will tends to improve the performance of the alternative methodology.

Results for Case 2 (RE not accept)

In case 2 discretionary taxation invalidates Ricardian Equivalence. Table 2 presents the index of rightness of the alternative methodology. Here the rightness occurs when test rejects the RE hypothesis. Here the index of rightness of the alternative methodology varies between 56.9% and 68.2%. Considering the conditional and marginal models adopted the results seem to be reasonable at first.

Table 2
Percentage in disagreement with RE – Case 2

	Marginal Model (a)	Marginal Model(b)
CondicionaI Model (I)	66.1%	56.9%
CondicionaI Model (II)	68.2%	57.9%

Results for Case 3 (RE not accept)

In Case 3 there is no link between the new and the old generations. It becomes invalid Ricardian Equivalence and the rightness happens when the alternative methodology rejects the occurrence RE hypothesis. As one can see in Table 3 the index of rightness of the alternative methodology varies between 61.9% and 72.6%. These results seem to be very favorable to our method.

Table 3
Percentage in disagreement with RE – Case 3

	Marginal Model (a)	Marginal Model(b)
CondicionaI Model (I)	72.6%	61.9%
CondicionaI Model (II)	68.2%	62.1%

Results for Case 4 (RE not accept)

In case 4, only discretionary taxation does not allow the existence of Ricardian equivalence. Table 4 presents the index of rightness of the alternative methodology. Again, the rightness occurs when the alternative methodology rejects the RE hypothesis. We have that the index of rightness of the alternative methodology varies between 67.4% and 93.6%.

Table 4
Percentage in disagreement with RE – Case 4

	Marginal Model (a)	Marginal Model(b)
CondicionaI Model (I)	74.6%	67.4%
CondicionaI Model (II)	93.6%	90.6%

In Table 5 the results derived from the alternative methodology (based on super exogeneity test) and more traditional approach (based on the consumption function) are compared. This last one is also reported in Cardia (1997). At large, the super-exogeneity test seems to be less susceptible to the specifications. In other words, it takes the advantage in the robustness. Moreover, the index of rightness of the alternative methodology shows better performance than the traditional tests based on the consumption function.

We begin the analysis of the Table 5 checking the results of Case 4. Here the alternative methodology has an index of rightness that varies between 67.4% and 93.6% while the traditional tests based in the function consumption present rightness index that only varies between 6.6% and 80.5%. These results are widely favorable to the adoption of the alternative methodology. In Case 2 the rightness of the alternative methodology varies between 57.9% and 68.2%. The traditional methodology, in turn, shows a bad performance in which the index of rightness varies between 3.8% and 49.9%. It is important to notice that we are adopting very simple structures for the conditional and marginal models. Moreover, when the performance of the traditional methodology seems to be superior, the results are not robust. For instance, in Case 3, the traditional methodology the index of rightness varies between incredible between 4.6% and 100%. That is, practically any result can occur depending on the adopted specification.

Table 5
Performance of alternative and tradicional methodology

(Super exogeneity test)*	Index of rightness			
	Case 1	Case 2	Case 3	Case 4
MCIMMa	30.3%	66.1%	72.6%	74.2%
MCIMMb	39.8%	56.9%	61.9%	67.4%
MCIIMMa	31.2%	68.2%	68.2%	93.6%
MCIIMMb	36.7%	57.9%	62.1%	90.6%
Traditional Methodology **	Case 1	Case 2	Case 3	Case 4
C-O (1)	73.4%	14.7%	95.8%	43.8%
C-O (2)	35%	49.9%	99.6%	78.4%
C-O (3)	46.1%	43.8%	52.1%	49.6%
DELTA (1)	94.4%	3.8%	100%	75.7%
DELTA (2)	60.5%	30.9%	100%	80.5%
DELTA (3)	63.8%	23.9%	4.6%	16.6%

*: MCIMMa = conditional model I and marginal model a; MCIMMb = conditional model I and marginal model b; MCIIMMa = conditional model II and marginal model a; MCIIMMb = conditional model II and model marginal b. **: Tables 4, 5, 6 and 7 (Cárdia, 1997): C-O = Cochrane-Orcutt; and DELTA = first diference.

6. Final Remarks

As one known the traditional approach to test RE hypothesis based on the parameter correlation suffers from serious weakness. In this article an alternative test was considered to verify the theory of Ricardian Equivalence. We proposed to test RE using super exogeneity test that can capture the essence of this issue. In the presence of this property, the conditional model is invariant the public choices. That is, the way by which the government decides to finance its expenditures does not modify the behavior of the economic agents. Our methodology is supported by the following rule if super exogeneity is accepted, we accept RE hypothesis.

We tested the power of our method using simulated series derived theoretical model. The results showed that the competing methodology presents better performance besides to be more robust in face to traditional ones even regarding the simplicity of the conditional and marginal models used to test the alternative proposal.

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