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On the Effects of Fiscal Policies: Ricardian Equivalence or Twin Deficits?

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1 Introduction

The conventional view on the effects of fiscal policies prescribes that if a country decides to run a fiscal deficit, then this ultimately has negative effects on the current account. For this reason, this position has been labelled with the term twin deficit, meaning that fiscal deficit has the consequence of dampening the current account balance. On the other hand, since the 19^{th} century David Ricardo had been reflecting on the very same issue, where his logic led him to opposite conclusions. For several years, colleagues of his have picked up this theory without any major breakthroughs. However, it is only after the seminal paper proposed by Barro [1974] that the theory of Ricardian equivalence finally gets the attention of the macroeconomic community, where the opinions are sharply divided among praisers and criticizers.

In the study hereby proposed, the focus is on the decision of running a fiscal deficit through the issuance of government bonds, albeit both the theoretical argument, and the empirical methodology can be generalized to fiscal policies as a whole. The focal point is the reaction of consumers to fiscal schemes, and more precisely to the additional amount of money that they get after the introduction of government bonds. In fact, depending on the consumption path that households decide to implement, be this total consumption as opposed to total saving, the final effect on the economy is of pure twin-deficit or Ricardian equivalence.

This paper is organized as follows. Section 1 presents the theoretical framework and presents, firstly, the classical theory, and secondly the Ricardian equivalence hypothesis. In this regard, this latter theory is initially presented with a theoretical argument, which is further enhanced through an overlapping-generations model. After this, a number of critiques/replies to the debt neutrality position are presented: namely, bequests, imperfect capital markets, permanent postponement of taxes, distortionary taxes, and myopia. Furthermore, a survey of the empirical literature is displayed: starting off with country-specific studies and ending with panel analyses. Following this, section 3 outlines the empirical exercise: the first step is to describe the dataset and the panel of countries considered; then, a dynamic panel model is presented with its main features; finally this section closes with the description of a dynamic panel threshold model that gives more insights on the effect of fiscal policies and the role of public debt. Section 4 presents the results for both the models, then section 5 concludes.

2 Theoretical Framework

This chapter sets up the theoretical framework for the discussion and presents: firstly, the classical theory; secondly, the Ricardian equivalence position, together with its history and the reasons for its success; thirdly, the critiques raised against the Ricardian position; and lastly, a review of the empirical findings, as well as the estimation approaches of recent studies.

2.1 The Classical Vision

Assume the government decides to implement a budget deficit, for example by holding the tax rate constant while increasing its total expenditure. As a consequence, households will experience a raise in their disposable income and will be likely to spend more. Therefore, this manoeuvre should boost consumption, thus increasing the aggregate demand. A higher demand for goods and services triggers further rounds of spending, since one person's spending is another's income, and this will ultimately raise GDP by more than the initial injection of money (this is the so-called multiplier effect). Table 1 shows the potential effects of a budget deficit; the concept of Ricardian equivalence will be analysed more into depth in the following subsection.

Table 1: Potential impact of budgetary adjustments on economic activity.

Taxonomy	Main Assumptions	Definition	Multiplier
Traditional Keynesian Multiplier	Slack in productive capacity; fixed price;	Raise in income after higher public expenditure	≥ 1.
Weak Keynesian	Potential capacity close to full use	Crowding-out effects reduce the multiplier	$0 < x < 1$.
Ricardian Equivalence	Altruism; no liquidity constraints; ...	Precautionary savings fully offset consumption	$= 0$.

However, in the long run sticky prices, sticky wages, and eventual temporary misconceptions play a big role in the economy as they have an impact on the factors of production. To see this, let Y denote national output, C private consumption, I domestic investment, G government spending and NX be net exports. Then from basic macroeconomics we have:

$$Y = C + I + G + NX. \tag{1}$$

On the other hand, national output must equal national income, which can be written as:

$$Y = C + S + T, \tag{2}$$

where S is private saving, and T is the total tax revenue. Plugging together equation (1) and (2) yields:

$$\begin{aligned} S + T &= I + G + NX, \\ S + (T - G) &= I + NX. \end{aligned} \tag{3}$$

Which means that savings, both private and public, must coincide with investments and net exports. Furthermore, it is also known that the current account must equal net foreign investments (NFI), where the current account is the sum of NX, net investment income (NII) and net unilateral transfers (NUT). Following Elmendorf and Mankiw [1999], NII and NUT will be neglected in the rest of the paper as they are typically small for countries. Hence we have:

$$\begin{aligned} CA &= NFI, \\ CA &= NX + NII + NUT, \\ NX &= NFI. \end{aligned} \tag{4}$$

In other words, whichever the flow of goods an economy may observe, this must be reflected by a flow of funds of equal magnitude. Equation (3) and (4) together yield:

$$S + (T - G) = I + NFI. \tag{5}$$

This last equation shows that the sum of private and public saving must equal the amount of investments both in the domestic economy and abroad. With equation (5) in mind, let us assume that the government undertakes an expansionary fiscal policy. One can easily note from the identity that a decrease in public saving can be compensated by a raise in private saving, or by a decline in domestic and/or foreign investment.
If private saving rises by less than the decline in public saving, which is what is predicted by the classical theory, national saving, $S + (T - G)$, will decrease, the interest rate will raise and since financing will become more expensive, this will crowd out the total amount of investments. The consequence of less investments in the domestic economy is a lower level of

accumulation of capital, and thus a lower output per income ratio.[1] Productivity of labour falls as well, which consequently leads to lower wages and thus lower income. For this reason, Modigliani [1961] describes public debt as an intergenerational burden that in the long run leaves smaller stock of capital to future generations.
In other words, a reduction in the fiscal burden stimulates aggregate demand in the short run, but reduces national saving in the long run. Thus, capital inflows make the domestic currency appreciate, which makes imports of goods and services cheaper and the current account is ultimately deteriorated. The idea that there exists a causal relationship between budget deficit and current account deficit is the so-called twin deficit hypothesis, and implies a positive correlation between the former and the latter accounting figure.

2.2 Ricardian Equivalence

As explained in the previous section, any increase in government debt raises perceived household wealth, consumption, and interest rates; thus capital accumulation falls. However, this is based on the crucial assumption that an expansionary policy indeed increases the perception of wealth, which is what is questioned in this section. In fact, households will spend more and increase consumption if and only if they believe to be richer, which is what is deemed to happen (according to the classical theory) after an expansionary policy.
The baseline for the argumentation are the concepts of government budget constraint, i.e. a deficit today must be matched by future taxes; and the permanent income hypothesis, i.e. consumers adjust their spending based on their whole lifetime income rather than their current income.[2] The focal point is whether or not a given fiscal policy increases permanent income: only in this case households will be richer and will be prone to consume more. In other words, rational consumers will understand that today's government deficit does increase current wealth, but they will also realize that such deficit must be financed through higher taxes in the future and therefore today's wealth will be completely offset by tomorrow's heavier tax burden, which ultimately leads to a zero-sum game. For this reason, the additional

[1] This is well described by Mundell [1963] - Fleming [1962], in the famous model that goes by their names, whereas Feldstein [1976] gets to the same conclusion with his so-called "Feldstein-chain".

[2] See Friedman [1957] for a more detailed analysis.

wealth deriving from the fiscal alleviation will be completely saved to consume more in the future and the fiscal manoeuvre will end up having no effect at all. The first to write about this issue is Ricardo [1824], who reflects on how a 20-million-pounds war should be funded. He comes to the conclusion that levying through taxes 20 million in one payment, 1 million perpetually, or 1.2 million for 45 years are indeed the same thing. In other words, the households considered in the previous scenario are not left better off after a policy that increases deficit since they are just postponing their tax burden to the future. By the same token, Tobin [1971] writes: "How is it possible that society merely by the device of incurring a debt to itself can deceive itself into believing that it is wealthier?". Finally, in his seminal paper Barro [1974] shows that running a deficit through the introduction of bonds does not leave consumers better off, since their utility does not improve. His work has opened a still ongoing diatribe on the effects of fiscal policies and to this date there is no clear-cut solution.

The remaining part of this section shows the set-up proposed by Barro and summarizes his conclusions in order to give a better understanding of why the Ricardian equivalence theory has become so important after his paper. Let us consider an overlapping-generations model with physical capital, similar to Diamond [1965] and Samuelson [1958]. In the following discussion, superscripts y (young) and o (old) refer to the two periods in which each individual lives; whereas subscripts refer to the generation to which an individual belongs (starting with members of generation 1, which are assumed to be old). There are a number N of identical individuals, although we normalize to 1 for simplicity. This means that each generation has one and only one individual, therefore this allows to denote each individual with the generation to which she belongs. Let each individual work only when young, and be paid a wage w. Individuals are assumed to hold assets A, whose rate of return r is paid once for each period. Expectations regarding both w and r are static and equal to the current values. Since individual i lives two periods, she will hold an amount of assets A_i^y and A_i^o when young and old, respectively. Assuming that individuals are altruistic and care about the well-being of their descendants, they will leave their children a bequest amounting to A_i^o. Denoting consumption with c and assuming that both interests and consumption start at the beginning of each period, the old member of generation 1 has the budget constraint:

$$A_1^y + A_0^o = c_1^o + (1 - r)A_1^o, \tag{1}$$

where the left-hand-side can be interpreted as the total resources available (assets plus the bequest obtained) and the right-hand-side represents total expenditure, i.e. consumption plus the bequest for an individual of the second generation, minus interests. With regard to individuals born in generation 2 (and similarly for generation i, $i \in \mathbb{N}$) we have:

$$w = c_2^y + (1-r)A_2^y, \tag{2}$$

$$A_2^y + A_1^o = c_2^o + (1-r)A_2^o. \tag{3}$$

Equations (2) and (3) represent the budget equations for the same individual when young and old, respectively. As for A_1^o and A_2^o, they represent the bequests received from the previous generation and the bequest provision to the future generation, respectively.
Let the utility function of individual i be:

$$U_i = U_i(c_i^y, c_i^o, U_{i+1}^*), \tag{4}$$

that is, utility depends on consumption in the two periods and on U_{i+1}^*, which is the maximum value of utility of individual $i+1$ for a given endowment. From recursive substitutions into the utility function it can be observed that, even though individual i wants to directly maximize the utility of $i+1$, the only way to do so is through the maximization of the utility of $i+2$, $i+3$, ..., and so on. The crucial conclusion is that in this framework individuals will behave as a single infinitely-lived agent, who will certainly be affected by the future tax burden deriving from a given policy implemented today.
Members of generation 1 will maximize their utility subject to (1)-(4), under the constraint that $(c_i^y, c_i^o, A_i^o) \geq 0, \forall i \in \mathbb{N}$. The solution for members of generation 1 will be of the form:

$$\begin{aligned} c_1^o &= c_1^o(A_1^y + A_0^o, w, r), \\ A_1^o &= \frac{1}{1-r}(A_1^y + A_0^o - c_1^o) = A_1^o(A_1^y + A_0^o, w, r), \end{aligned} \tag{5}$$

whereas for members of generation 2, both young and old, it will be respectively:

$$\begin{aligned} c_2^y &= c_2^y(A_1^o, w, r), \\ A_2^y &= \frac{1}{1-r}(w - c_2^y) = A_2^y(A_1^o, w, r), \\ c_2^o &= c_2^o(A_2^y + A_1^o, w, r), \\ A_2^o &= \frac{1}{1-r}(A_2^y + A_1^o - c_2^o) = A_2^o(A_2^y + A_1^o, w, r). \end{aligned} \tag{6}$$

Borrowing from Diamond [1965] a production function with the property of showing constant-returns-to-scale and which depends on capital and labour, we can equate r and w to marginal products of capital and labour to get:

$$K(r, w) = A_1^o + A_2^y, \tag{7}$$

$$y = rK + w. \tag{8}$$

Finally the market clearing condition is given by (2), (3), (7), and (8),

$$c_1^o + c_2^y + \Delta K = y, \tag{9}$$

with ΔK denoting the change of capital stock between two periods.
Let the government introduce one-period bonds for an amount B, paying out interests worth rB at the end of the current period, i, and a principal B at $i+1$. Assuming that the amount of money corresponding to interests and principal are levied through a lump-sum tax on generation $i+1$ when young and old, respectively; then the budget constraint of generation 1 becomes:

$$A_1^y + A_0^o + B = c_1^o + (1-r)A_1^o, \tag{10}$$

with B being the payment that occurs at the beginning of the period. The new budget constraints of young and old individuals of generation 2 become:

$$\begin{aligned} w &= c_2^y + (1-r)A_2^y + rB, \\ A_2^y + A_1^o &= c_2^o + (1-r)A_2^o + B, \end{aligned} \tag{11}$$

with rB representing the incidence of the new lump-sum tax used to pay out interests, with such tax being levied on young consumers of generation 2; as for B, this indicates the money raised to pay the principal attached to the

bonds. Plugging together the two constraints in (11) yields the two-period resource equation:

$$w + (1-r)A_1^o - B = c_2^y + (1-r)c_2^o + (1-r)^2 A_2^o, \tag{12}$$

which allows to write the utility function of an individual of generation 2 in the following way:

$$U_2^* = f_2^*[(1-r)A_1^o - B, w, r]. \tag{13}$$

The first term in the square brackets, $(1-r)A_1^o - B$, represents the gross bequest to generation 2 net of the money levied for the principal payment, in other words, the endowment of a member of the second generation. Finally plugging together equation (4), (10), and (13) yields a final form for the utility function of members of generation 1:

$$U_1 = U_1(c_1^y, c_1^o, U_2^*) = f_1[(1-r)A_1^o - B, c_1^y, A_1^y + A_0^o, w, r]. \tag{14}$$

Since c_1^y, $A_1^y + A_0^o$, w, and r are endogenous variables, hence observable, the problem of members of the first generation reduces to choosing the optimal net bequest, $(1-r)A_1^o - B$, for the future generation. Furthermore, noticing that the only variables of the problem are A_1^o and B, and that there must be a given optimal net bequest, it follows that any change in B must be matched by a change in A_1^o by the same amount. Therefore, future generations see their utility levels unaffected by the imposition of lump-sum taxes levied to repay the interests and the principal attached to the newly issued bonds. Finally, equation (10) can be rearranged in the following manner:

$$c_1^o = A_1^y + A_0^o - [(1-r)A_1^o - B], \tag{15}$$

which clearly shows that, since $A_1^y + A_0^o$ are constants, and so is the net bequest $[(1-r)A_1^o - B]$, the consumption level of individual 1 is left unchanged as well. This means that the concern for future generations induces members of generation 1 to save their wealth deriving from the introduction of government bonds to leave larger bequest to their descendants, so that they will be able to face the incoming taxes without decreasing their utility level. Thus, the effect of the fiscal policy is nil, which is what was predicted by the theory.

2.3 Critiques to the Ricardian equivalence position

Barro's paper has paved the way to the discussion on the effects of fiscal policies. This section puts forward the main arguments against the Ricardian equivalence, namely bequests, imperfect capital markets, permanent

postponement of taxes, distortionary taxes, and myopia.

Bequests: Darby [1979], Kotlikoff and Summers [1981] estimate that U.S. citizens bequeath a large portion of their wealth rather than consuming it during their lifetime. Although this result may be highly affected by unforeseen circumstances such as unexpected deaths, the low incidence of annuity markets suggests that people may wish to leave bequests.[3] However, the Ricardian proposition relies on two assumptions that may not always hold, namely bequests are assumed to be ubiquitous and to be driven by altruism towards future generations. Ubiquitousness has been heavily criticised by Andreoni [1988], Feldstein [1986], and Laitner [1979] who show that under certain specifications on preferences and on consumption functions parents may decide to bequeath nothing to their descendants. Authors such as Buiter [1978] and Carmichael [1982] allow for flows to go from parent to child, and vice versa, in the form of bequests and gifts, but neither presents existence conditions for the equilibria found. Further, Weil [1987] proves that the operative motive for bequests put forward by Barro is not applicable in several specifications of overlapping-generations-models. However, Bernheim [1987] criticizes these approaches as he deems the assumptions made on preferences as too stringent and also underlines how this sub-literature tends to model altruism as strictly related only to a person's immediate successor, whereas the possibility of linking the utility of individual i to that of $i+1$ and $i+2$ (simultaneously), which results in positive bequests in equilibrium, should not be ruled out a priori. Ubiquitous bequests from parents to child are also severely criticized by Bernheim and Bagwell [1988], who display a "reductio ad absurdum" of Barro's model, where they explain that since links between generation imply that any individual belongs to the same family tree, each individual's consumption depends on total wealth and therefore any redistributive policy would have the effect of a lump sum tax. Hence they argue that since this is not observed in the real world, the model cannot be reliable.

For what concerns altruism, the Ricardian conclusion holds whenever the specification of altruism prescribes the utility of an individual as a function of consumption profiles, which means that there is no need to model one's utility as merely depending on the utility of her descendants. Despite this interesting result, altruism may well not be the motive underlying the existence of bequests. Davies [1981] investigates on the uncertainty of life-

[3]This pro Ricardian equivalence conclusion is highly contested by Modigliani [1988] who is himself criticized by Kotlikoff [1988] for focusing on bequests at death without taking into account earnings derived from interests on previous bequests.

times: he wonders whether the retired show mild level of dis-saving because they have no information on their lifespan, that is, old people may tend to accumulate capital instead of consuming because they do not know how long they are going to live. He comes to the conclusion that reasonably small elasticities of inter temporal substitution justify the absence of decumulation observed. Another justification studied concerns intra-family exchanges, the idea that trade can be fostered and transaction costs reduced if investments of resources occur between specific individuals, i.e. family members. For example, Kotlikoff and Spivak [1981] believe that bequests are the result of a contract (either implicit or explicit) between family members, where parents commit to leaving bequests to their children if they die before a given age, whereas children promise to look after their parents in the case of them living more than the threshold age.[4] Lastly, Blinder [1974] believes that the reason to leave bequests depends on the tastes for generosity: according to Andreoni [1990], there are several factors influencing charity donations (or bequests) which differ from pure altruism. In this regard, Olson [2009] maintains that people crave the respect and prestige that these charitable actions bring, while Becker [1974] mentions social acclaim and the repulsion toward social scorn. However, Bernheim [1987] underlines that it is hard, perhaps impossible, to identify the perfect specification of preferences only from a theoretical point of view.

One final remark concerning bequests deals with the critique advanced by Bernheim et al. [1986], who maintain that the harmonious description of family linkages advanced by Barro [1974] is too restrictive since in reality there could be divergence of preferences among family members who can actually have conflicting interests. On the other hand, Becker [1974] with his "Rotten-kid theorem" proves that although interests of distinct family members may not converge it is possible to still get to Barro's conclusion. He depicts a family as driven by a "head", which is defined as a wealthy, altruistic person who transfers purchasing power to all members because concerned about their well being. The main feature of a family is that any redistribution in income is completely offset by transfers from the head so that the utility of each individual does not decrease. As a result, not only the head behaves as if she loved her family members, but so does each individual: even the truly selfish one, whose utility depends on her consumption alone. To see this, take two individuals, i and j, where i is selfish and j is not. Suppose i decides to decrease her income by an amount α to increase

[4]For other studies on intra-family exchanges see Sussman et al. [1970], Adams [1980], Ben-Porath [1980], Tomes [1981] Becker and Becker [2009].

j's one by an amount β. Being i selfish, her utility does not depend on the well being of j and thus she is left worse of by her choice. However, whenever $\alpha = \beta$ the head will transfer purchasing power from j to i so that they are left equally well off, and this is possible because the utility of each individual does not decrease after any intrafamily reallocations of income. In the case of $\alpha < \beta$, the action of the head would be such that i is left better off as a result of her decision. Thus, even the rotten kid would behave as if she loved her family.

Imperfect capital markets: according to Buiter et al. [1978], government borrowing has real effects whenever market inefficiencies reduce household's possibility to obtain loans. For example, Hubbard et al. [1986, 1987] assume that 20 percent of the U.S. population faces liquidity constraints and estimate that a \$1 deficit for taxes swap raises consumption by ¢25, which is clearly larger than the ¢5 rise in consumption due to wealth effect.[5]

The problem is that if households have a high discount rate, or similarly, if they expect their income to increase in the future, their optimal consumption path may be of consuming as much as possible in their youth an less in later years. However, this behaviour can be implemented if and only if one can borrow in financial markets, which may not be possible because of both the risk of default and the risk of bankruptcy. Therefore, the optimal choice would be to consume the current income in its entirety, and to hold no assets at all. In this scenario, Ricardian equivalence is no longer satisfied, since eventual government bonds may represent the money that the household wanted to borrow but that could not obtain: in fact, the would-be received purchasing power would allow to consume more at an early stage in life, despite having to face higher tax liabilities in the future. In this regard, Elmendorf and Mankiw [1999] highlight that in the 90's the U.S. federal government debt amounted to roughly one half of national income. Under the Ricardian prescription, households should have held additional wealth amounting to 50 percent of their income, but this was definitely not the case. However, in this scenario Ricardian equivalence would have been still verified if, in the absence of government debt, most of the households would have had negative net wealth. But this is highly unlikely since very few people can obtain loans without being backed-up by a tangible collateral. Thus, if we rule out this rather implausible justification, the consumption

[5]However, the problem with these studies lies on the treatment of liquidity constraints as an exogenous variable. Jaffee and Russell [1976], Stiglitz and Weiss [1981] go further and show that credit rationing arises as a consequence of asymmetric information; in these frameworks, the equilibria found embody liquidity constraints which are endogenous.

path of households has increased as a consequence of government debt. On the other hand, Hayashi [1985] and Yotsuzuka [1987] depict models where market imperfections and Ricardian equivalence can both exist at the same time, although it should be noticed that the result highly depends on the specification for market imperfections considered.

Permanent postponement of taxes: at first glance it may appear rather straightforward that debt neutrality holds only if today's deficit is offset by tomorrow's tax burden. In fact, the baseline for the Ricardian hypothesis is that households save money because they are expecting higher taxes in the future and if tomorrow's taxes do not rise, then there is no need to save money today. The issue is that a government does not necessarily have to pay off its debt since it can postpone the tax raise indefinitely, which undermines the validity of the theory. On the other hand, debt neutrality does not necessarily need that a government reaches zero indebtedness: assume that the government cuts taxes and increases its debt by an amount D, and leaves it at that level thereafter. If the interest rate on the new debt is, say r, the government would need to raise its tax revenue by rD, yearly. Since the present value of such taxes is $\frac{rD}{D} = D$, this is completely offset by the tax cut. This means that we are still in a zero-sum game where debt neutrality is re-established even though the new debt is never retired.

It is also possible that a government chooses to finance the interests on its debt by issuing new debt. The possibility to implement this Ponzi scheme however depends on the growth rate of the economy g and on the interest rate r:

- for $r > g$ debt raises faster than the economy and the Ponzi scheme is not feasible unless one decides to raise taxes;
- for $r < g$ debt can be rolled over indefinitely since the economy grows faster than debt.[6]

Furthermore, r and g are usually associated to the marginal product of capital and the population growth, respectively. If r is larger than g then the economy can be though to be dynamically efficient because there is less capital than the level prescribed by the so-called golden rule. Conversely, if r is smaller than g the economy is dynamically inefficient due to over-accumulation of capital. In this regard, Tirole [1985] shows that the government could address this situation with a Ponzi scheme based on

[6]For further information on the dynamic efficiency of Ponzi schemes refer to Blanchard and Weil [2001].

asset bubbles to reduce private savings. However, for how Ponzi scheme policies are fascinating from a theoretical point of view, it is widely believed that households do not save too much (not enough to reach the point where $r < g$). In fact, Abel et al. [1989] use as indicator the volume of investments compared the cash flows generated by capital to show evidence of dynamic efficiency.

Distortionary taxes: one big assumption underlying the Ricardian equivalence is that taxes are lump-sum, hence non distortionary. However, if taxes were distortionary, any changes in the tax burden, be it a postponement or other changes, would alter the behaviour of consumers and thus debt neutrality may no longer hold. To see this, it might be useful to keep in mind two main criteria behind the design of a tax scheme. The first criterion is equity, which means that the utility loss due to taxation should be equal for all taxpayers: for example, a very wealthy person does not decrease her utility by the same amount as a very poor one if they both have to pay \$100 in taxes.

The second criterion to keep in mind when designing a tax scheme is efficiency. In an idealized world without taxes, an economy reaches its optimum when the marginal rate of substitution (MRS) of two given goods is equalized to their marginal rate of transformation (MRT): $MRS = MRT$. The problem is that when one introduces taxation, the model becomes less efficient since the above identity becomes:

$$MRS = \frac{(1-t)P_b}{P_a} < \frac{P_b}{P_a} = MRT, \qquad t \in \mathbb{R}_+,$$

where P_a and P_b are the prices of goods a and b, respectively, and t is the corporate tax rate. Figure 1 shows the efficiency loss after the introduction of taxation into the system. The left-hand-side depicts the equilibrium price and quantity, respectively P^* and Q^*, that come from the intersection between the supply and demand curves. On the other hand, the right-hand-side shows that, after the introduction of a tax, t, the supply curve shifts upwards and the new price becomes P_d. However, even though consumers pay P_d, with $P_d > P^*$, suppliers receive only P_s, with $P_s < P^*$. Hence, the tax scheme has left both consumers and suppliers worse off, since the former pay more and the latter gain less. Furthermore, consumer surplus has fallen by $A + C$, whereas producer surplus has decreased by $B + D$. Finally, the efficiency loss brought by the tax, the so-called deadweight-loss, is represented by the gray area $A + B$ which is also known as Harberger's

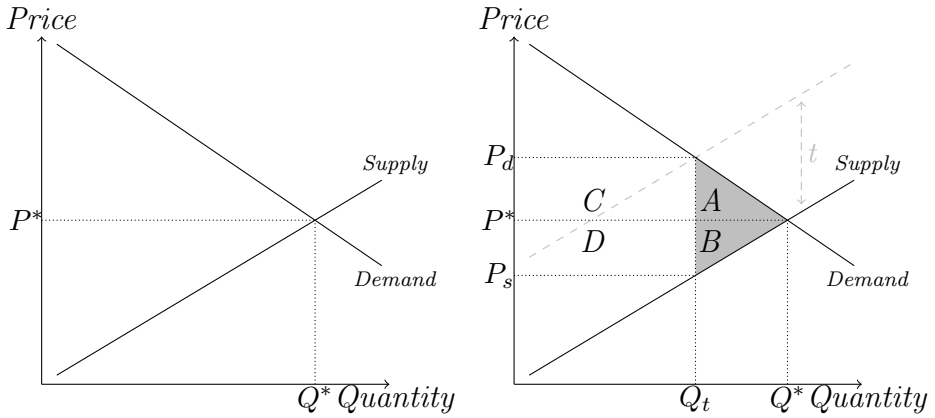

Figure 1: Deadweight-Loss of taxation.

triangle.[7]

Thus, it is clear that if the introduction of taxes, as prescribed by the Ricardian equivalence proposition, has distortionary effects on the economy, then households would experience changes in their utility levels and will have an incentive to alter their behaviour.

Myopia: as already explained, debt neutrality can be reached if and only if forward-looking consumers adjust their consumption path according to their permanent income, which takes into account the future stream of tax-related expenses one has to face. Only after having acknowledged that there will be higher taxes in the future a Ricardian consumer decides to save more for that moment in time. However, in the real world consumers instead of being forward-looking are often affected by myopia. As Elmendorf and Mankiw [1999] suggest, a "rational, optimizing, forward-looking homo hoeconomicus is a creature of the economist's imagination". Additionally, Saito [2016] shows evidence that Japanese people are reducing their optimization horizon.

Strotz [1955] is the first who tries to incorporate myopia into a dynamic utility maximization problem. He considers a model where individuals have to choose a consumption path so as to maximize the present value of their utility. Strotz shows that if individuals are asked to re-evaluate their plan at future times, they will disobey it even if their initial expectations for the future were correct. In other words, the optimal plan for the future chosen

[7]The term comes from Harberger [1964a,b], who proposes to analyse and estimate the deadweight-loss of taxation using "triangles" such as the one shown in figure 1.

today consists in a consumption path from which an individual will deviate *tomorrow*, which means that the individual is time-inconsistent. The focal point is that a rational individual can actually acknowledge that she will not act time-consistently and may thus prevent herself from turning into a spendthrift by pre-committing to the optimal plan.[8] The result is that a binding commitment to increasing saving leaves individuals better off, which means that without commitment individuals would tend not to save money for future contingencies such as those where they have to face higher taxes. However, it must be noted that this result does not explicitly invalidate the proposition of Ricardian equivalence, as it is possible that consumers be Ricardian, but that their myopia alters their behaviour. Put differently, it could be that:

- Consumers are not Ricardian because, due to myopia, they don't save enough;
- Consumers are Ricardian but behave time-inconsistently because of myopia.

With this regard, Smetters [1999] proves that, under the mild condition derived by Weil [1987], the standard Ricardian model is robust to the argument of myopia. However, Sgherri and Bayoumi [2006] start from a Blanchard [1984] - Yaari [1965] model to show the converse.

2.4 Empirical Findings

This section attempts to summarize some of the most recent empirical results on Ricardian equivalence and the twin deficit hypothesis, which are, as explained at the outset of this study, two sides of the same medal. For the sake of clarity, the studies are presented following a geographical approach: starting off with country-specific studies in the American continent, specifically USA, Peru, Costa Rica and Mexico; following with Asia, with India, Pakistan, China, Cambodia, Indonesia, Bangladesh, and Japan; then Europe, namely Italy, Austria, Bulgaria, Greece, Portugal, and Spain; then Africa, with Egypt, Morocco, and South Africa. Finally, this section closes with broader studies of OECD and G7 countries.

[8] This occurs if an individual decides ex-ante to preclude any future strategies that would allow to deviate from the best plan, which is the one chosen at the time of the initial choice. However, it is also possible to modify the initial plan adding a further constraint which rules out the possibility to act time-inconsistently.

America: Blanchard and Perotti [2002] use a VAR approach to study the effect of changes in government spending and taxes in the US between 1947 and 1997. They combine a standard VAR estimation methodology with one akin to an event driven approach. They explain that since the data contain occasionally large and arbitrary jumps in taxation, such as the tax cut of 1975, such changes are too large to be treated as streaming from the underlying stochastic process and need to be studied separately. Thus, they follow the approach of Ramey and Shapiro [1998], Edelberg et al. [1999] and estimate the response of output to a specially designed dummy variable which they include in their specification. Their conclusion is that increases in government spending, as well as in taxes, have a strong negative effect on investment spending, which goes against the classical Keynesian theory. Still in the US, Holmes [2011] investigates upon the relationship between current account and budget balances by means of the threshold cointegration approach in vector error-correction models advocated by Hansen and Seo [2002]. Using a dataset ranging between 1947 and 2009, he finds evidence of a positive cointegrating relationship, which supports the classical twin deficit hypothesis prescribed by Keynes. A third study on the US economy is the one put forward by Tang [2015], who gathers data between 1973 and 2018 to study the equilibrium between income and expenditure, taking into account the behavioural determinants of saving and investment. The cointegration tests suggest that interest rates, real income, current account balance, and fiscal balance are all positively correlated. Furthermore, the Granger causality tests show that budget deficit triggers short run interest rate and real income, which are shown to stream into a deterioration of the current account balance. In other words, he finds evidence in favour of the twin deficit hypothesis since his results describe that a budget deficit indirectly leads to a current account deficit: in fact, he estimates that a 1% increase in budget deficit raises the current account deficit by 0.43%.
With regard to Peru, Sobrino [2013] exploits VAR specifications to analyse the period 1990-2012. He focuses on the causal relationship between current account, fiscal surplus and fiscal spending and finds evidence against the twin deficits hypothesis. Additionally, he estimates the short-run impact of fiscal policy on current account to be nil. This result is however in contrast with the one of Fleegler [2006], who accepts the twin deficit hypothesis for both Peru and Costa Rica, where in the latter he estimates that whenever fiscal deficit increases by 1%, the trade deficit raises by 0.96%. Another study that considers Latin American countries is the one proposed by Kulkarni and Erickson [2001], who use a VAR model and a dataset from

1979 to 1996 to study the twin deficit hypothesis in Mexico. In addition, they also consider the case of India and Pakistan. The result is that, while Mexico shows no signs of twin deficit, India and Pakistan do. However, the robustness of the last two results is undermined by the Granger test, which shows an opposite causality direction for India and Pakistan.

Asia: Basu and Datta [2005] study India and estimate an absence of cointegration between Government budget deficit and external deficit. However, they also find absence of cointegration between Government deficit and private saving, which is also against debt neutrality. Moreover, Banday and Aneja [2016] also reject the Ricardian proposition since their study of the Indian economy between 1990 and 2013 shows a long run association between fiscal deficit and current account deficit. India is studied also by Goyal and Kumar [2018], who use quarterly data between 1996 and 2015 in the framework of a structural vector autoregression model (SVAR). In addition, they also control for oil shocks and output growth but despite this, they still find that current account deficit is raised by fiscal deficit. One last study of the Indian economy is the one conducted by Bhat and Sharma [2018], which is, to the best of my knowledge, the first time the Indian economy is being observed within a non-linear framework: this is done by means of a non-linear autoregressive distributed lag model advocated by Shin et al. [2014]. Their study confirms the long run co-movements of fiscal deficit and current account deficit, thus they refute Ricardian equivalence in favour of twin deficits. In addition, they observe asymmetric linkages between the variables, which means that: in the short run, positive changes are more effective than negative ones; whereas in the long run, the current account balance seems to be affected solely by positive changes.

In Pakistan, Mukhtar et al. [2007] uses quarterly time-series data between 1975 and 2005 and relies on cointegration analysis, ECM strategy and Granger tests. He concludes that there is only partial evidence of the conventional view that budget deficit leads to a deterioration of the current account balance: in fact, he also finds evidence of inverse causality.

With regards to China, Banday and Aneja [2019] use time series data between 1985 to 2016 exploiting autoregressive distributed lag bounds testing and the Zivot and Andrew structural break to test the twin deficit hypothesis. The ARDL test shows that there is a long run relationship between budget deficit and current account deficit and the Granger test gives evidence of bidirectional causality between the variables. The same conclusion is drawn by Lau and Tang [2009] who find evidence of a two-way causality relationship between Government budget deficit and external deficit in

Cambodia. On the other hand, the Error Correction Model with data for the period 1990-2015 used by Saraswati and Wahyudi [2018] to study Indonesia shows that fiscal policy does not affect household consumption, therefore the country does seem to experience Ricardian equivalence. In addition, in Bangladesh the VAR specification proposed by Roy et al. [2013] for the years 1972-2012 does not show any evidence supporting a causal relationship between budget deficit and current account deficit, which goes against the twin deficit hypothesis.

When it comes to Japan, Saito [2016] studies the period 1980-2016 to show that people are becoming less Ricardian: he advocates that since longer lives resulting from health improvements reduce the average remaining life expectancy, people have become more short-sighted, i.e. myopic. This, as explained in section (2.3) is thought to severely undermine Ricardian equivalence, which is what the empirical enquiry yields.

Europe: in Italy Magazzino [2012] analyses the years 1970-2012 using a VAR model and observes that the trade balance Granger causes budget deficit, while in the long run there seems not to be any correlation between the variables. In other words, the estimated causality relationships go completely against what is predicted by the twin deficits hypothesis, according to which a budget deficit should lead to a current account deficit, which is what is found in Greece, Portugal and Spain by Litsios and Pilbeam [2017]. In Austria Kaufmann et al. [2002] use quarterly data for the time frame 1976-1997 in the context of a vector ECM using four lags of the endogenous variables. They compute the variance decomposition of the current account's forecast error to account for its impulse response to one standard deviation innovation shocks. They estimate that 65% of the forecast error's variance is given by movements in terms of trade and domestic productivity; 14% by budget deficit; and 5% by government spending. They conclude that, since the classical theory considers the variable interest rate the linking point between fiscal balance and current account, and since such variable explains little about the error's variance, then they must reject the classical theory in favour of the Ricardian equivalence proposition.

Ganchev [2010] studies Bulgaria for the years between 2000 and 2010 with Granger, VAR and VECM approaches. According to the Granger test, the causality relationship between fiscal deficit and current account deficit prescribed by the classical theory is confirmed; however, in the short-run the VAR analysis proves exactly the converse. Finally, the vector error correction model allows the author to reject strong forms of both twin deficit and Ricardian equivalence.

Africa: Marinheiro [2008] studies Egypt in the period 1974-2002. The exercise rejects the position of full Ricardian equivalence although there is evidence supporting a mild form of this. With regards to the twin deficit hypothesis, there is a weak long-run relationship between fiscal balance and current account balance; however the Granger test shows a causality direction that goes completely against the classical vision, which is thus rejected. Similarly, Nazier and Essam [2012] study Egypt between 1992 and 2010 with a SVAR model that accounts for the business cycle. Once again, the findings do not allow to accept the classical vision, since they estimate a crowding out effect of investments caused by a higher interest rate. Additionally, they notice that private savings partially move according to the Ricardian proposition.

In Morocco, Anas et al. [2013] study the period 1980-2012 with a bivariate VAR model. In addition, they run causality tests between fiscal balance and current account balance, detecting a reverse causality relationship, i.e. from external to fiscal balance. More precisely, the impulse response estimates that for any 1% increase in current account deficit, budget deficit increases by 0.45%.

With regard to South Africa, Ogbonna [2014] uses a dataset ranging from 1962 to 2012. He observes that the classical hypothesis does not hold for South Africa, whereas a mild form of Ricardian equivalence is sustained.

Panel analyses: Giavazzi et al. [1998] study the effect impact of initial debt levels and the composition of a budgetary adjustment to understand the effects a fiscal consolidation. Taking into consideration 18 countries in the period 1970-1996, they find a rather high non-Keynesian effect of changes in taxes and transfers. Interestingly, they detect an asymmetry in macroeconomics effects, which are larger (smaller) when considering contractions (expansions) as opposed to expansions (contractions).

Another study is the one of Reitschuler et al. [2004], who consider a panel of OECD countries in a four-decades time frame. Their result is that in 10 countries out of 26, the proposition of Ricardian equivalence is confirmed. By the same fashion, De Mello et al. [2004] analyses 21 countries to draw the conclusion that there is a partial offsetting movement in private and public savings, which goes in favour of the Ricardian position. A similar result is yield by the study of Bussière et al. [2005], who estimate that the effect of budget balance on current account is less than 10%.[9] On the other hand, Forte and Magazzino [2013] study 33 countries between 1970 and 2010 to

[9]This convalidates the conclusions drawn by Glick and Rogoff [1995].

find that for any 1% increase in budget deficit, the current account deficit plunges by 0.33%.

3 Methodology and Data

3.1 Data

This paper represents an attempt to assess the relevance of Ricardian equivalence using a dynamic panel model. The nineteen countries included in the sample are: Australia, Brazil, Canada, China, Denmark, France, Germany, India, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Russia, Spain, Sweden, United Kingdom, United States. The reason for the choice of a dynamic model is twofold: firstly, from an empirical viewpoint, it is plausible that a country that experiences a fiscal deficit (surplus) in a given year t, runs a deficit (surplus) also in the following year $t + 1$; the second reason comes from the fact that the implementation of given fiscal policies is not immediate, thus, a jump in public deficit requires some time before showing real effects on the economy, and more precisely on the current account balance. The dataset used reflects the timeframe between 2009 and 2018 and was taken from the International Financial Statistics (IFS) and the World Economic Outlook (WEO), both released by the International Monetary Fund (IMF). With regards to the former, it is one of the Fund's principal statistical dataset and has been accessible to public since 1948; whereas the latter is a survey by the IMF usually published twice a year and presents analyses of global economic developments during the near and medium term.

3.2 First Model

The dependent variable of the study is the current account balance of a country, which is labelled by *CA*. It is a metric of a country's foreign trade and enters the study with positive sign whenever there is a surplus, meaning that the value of net foreign assets has increased. Conversely, in the event of a current account deficit, the variable enters the study with negative sign, thus indicating that the value of foreign assets held by a country shrank. The current account of a country is thought to be affected by the fiscal

balance, which is taken into account in the model through the inclusion of the variable DEF, which perhaps reminds more of fiscal deficit. This however, is not a coincidence, since both the theory and the model presented in the previous section focus on the decision of issuing government bonds, or in other words, on government deficit. Further, another control variable is government consumption, which is captured by the variable GC. From a theoretical point of view, the correct variable to use would be government's total expenditure, however, the variable available on the IFS database is "government consumption expenditure", which does not consider transfers, interests, and expenses for public investments. In addition, the database reveals data on investments but does not distinguish between public and private ones. It is therefore necessary to consider the hereby used variable GC as a proxy for public expenditure. For this and other reasons, this paper exploits instrumental variables.

The Gross Domestic Product of each country is labelled as GDP, furthermore, this study includes also the real exchange rate between currencies, which is captured by the variable RER. Ex ante, the effect of real exchange rates on the current account balance is not straightforward. When the economic catching-up process is taking place, the real exchange rate tends to rise. This happens because of gains in overall productivity, coupled by demand-effects such as higher use of capital inflow. As long as the appreciation of a currency is anticipated as a consequence of the catching-up process that a country is experiencing, the effects on savings are identical to jumps in terms of real income: since the currently low price of the currency is expected to raise in the future, this induces higher levels of household's debt because the eventual appreciation of the currency, if any, will deliver them more purchasing power in the future, which thus reduces their current level of debt. Put differently, people incur into more debt to themselves because they anticipate that today's total debt burden will decrease as a consequence of tomorrow's currency appreciation. On the other hand, unanticipated but permanent appreciation of a currency has exactly the opposite effect: in this case, the higher price of a currency increases net wealth as a consequence of higher current as well as future income. However, in this situation the level of saving is drastically reduced. Finally, the consumption smoothing hypothesis advocated by Obstfeld and Rogoff [1994] prescribes that a temporary real appreciation of a currency leads to an improvement in the current account. As for the interest rate, this is captured by the variable INT. The rationale behind the choice of controlling for interest rates has already been explained in the previous section. To summarize, rational individuals may

realize that substituting today's taxes with taxes plus interests tomorrow may not leave them better off, thus the current account may not change. Finally, the level of public debt of each country is denoted by $DEBT$. More insights on the decision to consider this variable in the present study will be discussed below. Table (2) shows a summary of descriptive statistics for the sample.
The estimated equation takes the following form:

$$\begin{aligned} CA_{it} = {} & \beta_0 CA_{it-1} + \beta_1 CA_{it-2} + \beta_2 CA_{t-3} + \beta_3 \Delta DEF_{it} \\ & + \beta_4 \Delta DEF_{it-1} + \beta_5 \Delta DEF_{it-2} + \beta_6 GC_{it} + \beta_7 GC_{it-1} \\ & + \beta_8 GC_{it-2} + \beta_9 RER_{it} + \beta_{10} RER_{it-1} + \beta_{11} RER_{it-2} \\ & + \beta_{12} INT_{it} + \beta_{13} INT_{it-1} + \beta_{14} INT_{it-2} + \epsilon_{it} \end{aligned}$$

Where ϵ_{it} is the error term, which is assumed to be normally distributed with mean 0 and variance σ^2, that is $\epsilon \sim N(0, \sigma^2)$. The subscripts refer to the specific country taken into consideration at a precise moment in time, meaning that, for example, the variable CA_{it} indicates the current account balance of country i, observed in year t.[10]

Table 2: Descriptive statistics.

Variable	Mean	Std. Dev.	Min	Max
CA	0.0150561	0.0449371	-0.0527486	0.1332184
DEF	-2.128537	3.933884	-10.99629	13.76257
GC	0.1986625	0.0391586	0.1029516	0.2656464
GDP	2.50e+12	3.35e+12	1.21e+11	1.74e+13
RER	16.31103	32.8152	0.72584	145.23
INT	3.765214	7.239066	-13.10057	41.98577
DEBT	85.90848	50.42473	8.54382	282.0947

The Ricardian equivalence hypothesis prescribes that the parameter β_3 be nil ($\beta_3 = 0$), as this would mean that a change in the fiscal balance does not alter the current account balance; whereas for the other variables, no

[10] In our case we have: $1 \leq i \leq 19$; $2009 \leq t \leq 2018$.

specific results are expected.
On the other hand, the classical theory dictates that β_3 be positive ($\beta_3 > 0$), since this finding would imply that fiscal policy does have an effect on current account. As for public expenditure, this is believed to have a negative effect on current account, i.e. $\beta_6 < 0$. By the same token, an appreciation of the real exchange rate should boost importations while reducing exportations, thus having negative effects on the current account ($\beta_9 < 0$). Similarly, a higher interest rate makes exportations less competitive, consequently making importations more convenient; for this reason one should expect a negative β_{12}, which is $\beta_{12} < 0$. When introducing the lag of the endogenous variable into the regression, the least squares estimation yields a biased result which arises because such lagged variable is positively correlated with the error term. This bias principally affects the coefficient of the lagged endogenous variable. In order to face this problem, this model exploits the method of instrumental variables advocated by Anderson and Hsiao [1982], where the variables are expressed in their first differences. More precisely, the instruments used for the lags of the independent variables are their first differences. Although this methodology has been conceived for the field of microeconometrics, where the sample contains a large number of individuals, each of which with a low number of observations, scholars such as Judson and Owen [1999] maintain that this approach could be used also in the field of macroeconomics. One final remark concerns the structure of the dataset, which appears unbalanced, thus it was corrected following Greene [2003]. Table 3 displays the correlation matrix of the variables of interest.

Table 3: Correlation Matrix.

	CA_t	CA_{t-1}	CA_{t-2}	CA_{t-3}	DEF_t	DEF_{t-1}	DEF_{t-2}	GC_t	GC_{t-1}	GC_{t-2}	RER_t	RER_{t-1}	RER_{t-2}	INT_t	INT_{t-1}	INT_{t-2}
CA_t	1															
CA_{t-1}	0.967 0.000	1														
CA_{t-2}	0.941 0.000	0.970 0.000	1													
CA_{t-3}	0.920 0.000	0.940 0.000	0.965 0.000	1												
DEF_t	0.672 0.000	0.624 0.000	0.609 0.000	0.579 0.000	1											
DEF_{t-1}	0.679 0.000	0.667 0.000	0.646 0.000	0.645 0.000	0.947 0.000	1										
DEF_{t-2}	0.674 0.000	0.676 0.000	0.685 0.000	0.678 0.000	0.898 0.000	0.968 0.000	1									
GC_t	-0.392 0.000	0.348 0.000	0.339 0.000	0.325 0.001	0.854 0.000	0.808 0.000	-0.773 0.000	1								
GC_{t-1}	-0.405 0.000	0.375 0.000	0.362 0.000	0.357 0.000	0.876 0.000	0.832 0.000	-0.802 0.000	0.993 0.000	1							
GC_{t-2}	-0.412 0.000	0.379 0.000	0.381 0.000	0.371 0.000	0.899 0.000	0.859 0.000	-0.825 0.000	0.986 0.000	0.993 0.000	1						
RER_t	0.187 0.020	0.188 0.020	0.193 0.017	0.152 0.139	0.049 0.542	0.081 0.350	-0.093 0.320	0.061 0.453	0.073 0.400	0.080 0.392	1					
RER_{t-1}	0.194 0.016	0.194 0.016	0.189 0.019	0.146 0.155	-0.049 0.545	-0.074 0.393	-0.094 0.316	0.065 0.426	0.070 0.417	0.083 0.379	0.990 0.000	1				
RER_{t-2}	0.201 0.012	0.204 0.011	0.194 0.016	0.135 0.190	0.056 0.491	0.072 0.406	-0.086 0.363	0.072 0.378	0.072 0.406	0.076 0.418	0.975 0.000	0.988 0.0000	1			
INT_t	-0.069 0.398	0.088 0.276	0.099 0.225	0.122 0.235	0.038 0.634	0.044 0.615	0.072 0.441	-0.101 0.214	0.107 0.219	0.114 0.224	0.072 0.375	0.072 0.374	0.073 0.367	1		
INT_{t-1}	-0.077 0.376	0.095 0.275	0.115 0.184	0.137 0.184	0.003 0.971	0.006 0.944	0.033 0.725	-0.073 0.399	0.065 0.455	0.069 0.460	0.054 0.536	0.057 0.513	0.055 0.527	0.932 0.000	1	
INT_{t-2}	-0.065 0.487	0.085 0.368	0.102 0.277	0.118 0.254	0.020 0.829	0.003 0.971	0.022 0.813	-0.072 0.445	0.068 0.468	0.065 0.487	0.064 0.498	0.064 0.496	0.066 0.484	0.851 0.000	0.933 0.000	1

3.3 Second Model

Having explained the estimation methodology, it is interesting to take some time to discuss the impact that public debt has on Ricardian equivalence. Authors such as Blanchard [1990], Sutherland [1997], Perotti [1999], Berben and Brosens [2007] and Nickel and Vansteenkiste [2008] argue that government debt plays a critical role on consumer's expectations for the future. More precisely, let us consider a scenario where in a country with high public debt the government decides to issue bonds by running a budged deficit. In this situation, the already high public debt that the country is holding raises the likelihood of higher future taxes to finance the scheme. For this reason, in countries with high public debt one should expect, at least from a theoretical point of view, that consumers save more to face the future tax burden. On the other hand, whenever the same fiscal scheme is implemented in a country with low public debt, it is plausible that the flourishing environment induces households to consume more, which ultimately deteriorates the current account, thus validating the twin deficit hypothesis. This is because people would anticipate that their government can afford to increase its level of debt.

As it now appears clear, the impact of a fiscal policy and the acceptance (rejection) of one theory for the other should be studied with attention to the level of debt that a country holds throughout the years hereby analysed. For this reason, the initial fixed-effect dynamic panel model is extended to control for eventual thresholds, which are expressed in terms of debt to GDP. In other words, the relationship between government balance and current account is allowed to change depending on the level of debt that a given country holds. The result should be that below a certain level of debt, the correlation between current account and government deficit is positive, while for higher levels of debt this correlation reduces until reaching a level close to or even below zero.

Following Hansen [1999], and assuming a number n of thresholds, the sample is split in $n+1$ regimes which will take the following form:

$$\begin{aligned} lny_{it} = \alpha_i &+ (\boldsymbol{\beta_1'} \boldsymbol{lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta'} \boldsymbol{lnz_{it}}) I(q_{it} \leq \gamma_1) \\ &+ (\boldsymbol{\beta_2'} \boldsymbol{lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta'} \boldsymbol{lnz_{it}}) I(\gamma_1 < q_{it} \leq \gamma_2) \\ &+ \dots \\ &+ (\boldsymbol{\beta_n'} \boldsymbol{lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta'} \boldsymbol{lnz_{it}}) I(\gamma_n > q_{it}) + \epsilon_{it}, \end{aligned} \tag{1}$$

As common practice in econometrics, the bold text indicates column vectors,

meaning that $\boldsymbol{lnx_{it}}$ and $\boldsymbol{lnz_{it}}$ can be respectively written in the form:

$$\boldsymbol{lnx_{it}} = \begin{bmatrix} lnx_{it1} \\ lnx_{it2} \\ \vdots \\ lnx_{itn} \end{bmatrix} \quad \text{and} \quad \boldsymbol{lnz_{it}} = \begin{bmatrix} lnz_{it1} \\ lnx_{it2} \\ \vdots \\ lnz_{itn} \end{bmatrix}.$$

Furthermore, $I(\cdot)$ is the classic indicator function, i.e. given a generic set X and taken a subset $A \subseteq X$, then for $A := \{x \in \mathbb{R} : x < \gamma_1\}$ we have:

$$I_A : X \to \{0, 1\}, \qquad I_A(x) = \begin{cases} 1 & if\ x \in A, \\ 0 & if\ x \notin A. \end{cases}$$

For ease of notation, the indicator function will take value 1 whenever the condition displayed in the parentheses is true, and 0 otherwise. Equation (1) can be also written as:

$$lny_{it} = \begin{cases} \alpha_i + \boldsymbol{\beta_1'lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta' lnz_{it}} + \epsilon_{it}, & q_{it} \leq \gamma_1, \\ \alpha_i + \boldsymbol{\beta_2'lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta' lnz_{it}} + \epsilon_{it}, & \gamma_1 < q_{it} \leq \gamma_2, \\ \vdots & \vdots \\ \alpha_i + \boldsymbol{\beta_n'lnx_{it}} + \delta lny_{it-1} + \boldsymbol{\theta' lnz_{it}} + \epsilon_{it}, & q_{it} > \gamma_n. \end{cases} \tag{2}$$

The dependent variable lny_{it} represents the natural logarithm of the current account to GDP ratio. As for the threshold variable, this is represented by q_{it}, whereas $\gamma_1, \gamma_2, \ldots, \gamma_n$ are the n thresholds that split the regression model in $n + 1$ regimes. With regard to, $\boldsymbol{lnx_{it}}$ this represents a set of endogenous explanatory variables which depend on the threshold variable, whereas $\boldsymbol{lnz_{it}}$ denotes a sequence of exogenous explanatory variables that do not depend on the threshold variable.[11]

Concerning the observations, these fall in one and only one of the $n + 1$ regimes, depending on the interval to which their threshold variable belongs, or in other words, if q_{it} is smaller, larger or in between $\gamma_1, \gamma_2, \ldots, \gamma_n$. With respect to the regression slopes, each regime is characterized by its own beta, where $\boldsymbol{\beta_1} \neq \boldsymbol{\beta_2} \neq \ldots \neq \boldsymbol{\beta_n}$. For what concerns the identification of the slopes, it is required that the elements of the regressor $\boldsymbol{lnx_{it}}$ be not

[11] Every prime vector i.e. those that show the symbol ', are to be intended as row vectors. With regards to matrices, these are denoted with bold capital letters, however this exercise does not take advantage of such notation.

time invariant. The same characteristic must hold for the threshold variable q_{it}.
As Hansen [1999] explains, in any panel threshold model with non-dynamic nature, that is, for models without the term δlny_{it-1} in (1)-(2), it is possible to estimate the regression slopes by least squares. However, the threshold model proposed in this section does have dynamic nature, since the lag of the dependent variable shows up in the right-hand-side of equation (1)-(2). Thus, the ordinary least squares approach cannot be used for this exercise. Additionally, the assumptions made by Hansen impose that the regressors be strictly exogenous. The first problem, i.e. that it is not possible to apply least squares, can be addressed in two ways: either by means of instrumental variables, or with the generalized method of moments. The approach followed here is the one proposed by Hsiao [2014], who maintains that, in a fixed effect model such as the one here presented, the first-order difference is a good instrumental variable. With regard to the endogeneity problem, Caner and Hansen [2004] suggest a two stage-least squares estimator of q_{it}, the threshold parameter, coupled with an estimator for the slope parameter(s) obtained by means of the generalised method of moments.

4 Results

In this section the results of the two models are presented. The first subsection describes the outcome of the initial specification, whereas the second subsection goes further with the analysis by describing the results obtained after the inclusion of a threshold variable.

4.1 Dynamic Panel Model

The results of the first model are shown in table 4. For the sake of interest, a table including the the estimates of a comparable study proposed by Margani and Ricciuti [2005] is included in the appendix for reference.
The results show that there is a consistent and strongly significant knock-on effect on the current account, whose initial fluctuations are firstly compensated by a second round of adjustments and then, further enhanced in a third period. This can be observed by looking at the sign of the variables CA_{t-1}, CA_{t-2} and CA_{t-3}. The same pattern seems to apply for government consumption, where it appears that, in a second period, there is again a rehearsal in the trend, which in this case is of negative sign instead of positive.

Furthermore, the variable interest rate shows the same behaviour, namely, the positive coefficient of INT_t is offset by the negative coefficient of INT_{t-1} and then reverted to positive sign with INT_{t-2}. With regard to the real interest rate, the variable RER shows that there is only a partial adjustment to the fiscal scheme, which then reverts in subsequent periods, although this result is not significant.

Table 4: Dynamic panel model results.

Variable	Coef.	Std. Error	t-stat	95% Conf. Interval	
				Lower	Upper
CA_{t-1}	0.8557	0.0985	0.000	0.6585	1.0530
CA_{t-2}	-0.3850	0.1317	0.005	-0.6488	-0.1211
CA_{t-3}	0.5623	0.1152	0.000	0.3315	0.7931
ΔDEF_t	0.0008	0.0006	0.156	-0.0003	0.0020
ΔDEF_{t-1}	0.0043	0.0008	0.000	0.0027	0.0060
ΔDEF_{t-2}	-0.0038	0.0008	0.000	-0.0055	-0.0022
GC_t	-0.8102	0.1193	0.000	-1.0491	-0.5712
GC_{t-1}	1.5115	0.3843	0.000	0.7418	2.2812
GC_{t-2}	-0.5984	0.3316	0.077	-1.2621	0.0663
RER_t	-0.8481	0.6117	0.170	-1.0714	3.7455
RER_{t-1}	0.3624	0.8661	1.000	-0.1739	1.7409
RER_{t-2}	0.1080	0.0513	0.040	0.0493	0.2109
INT_t	0.2989	0.9794	0.004	0.1025	0.4949
INT_{t-1}	-0.4675	0.1908	0.017	-0.8471	-0.1688
INT_{t-2}	0.2844	0.1457	0.055	-0.6017	0.5739

Moving further to public deficit, this shows a rather peculiar behaviour, in fact, the variable ΔDEF_t is not significant, whereas the lags, ΔDEF_{t-1} and ΔDEF_{t-2} are strongly significant. This behaviour can be explained by the timing with which macroeconomic movements occur. More precisely, assuming that a government runs for a period a budget deficit, as discussed in the previous sections, it is likely that the effects of such fiscal scheme do not show in the current period but rather in future ones. For this reason, a low significance level for the variable ΔDEF_t does not represent a preposterous result, on the contrary, this finding coupled with the very high significance level of the variables ΔDEF_{t-1} and ΔDEF_{t-2} provide good evidence of this statement. Furthermore, this issue was also considered ex-ante during the

choice of the model to use to test for Ricardian equivalence, hence this is where the decision to opt for a dynamic panel model comes from. Additionally, the coefficients of ΔDEF_t, ΔDEF_{t-1} and ΔDEF_{t-2} are very low, close to zero.[12] This would imply that the change in the level of deficit did not affect the current account balance at all. But this is only possible if consumers do not increase their level of spending after that the government implements a fiscal scheme such as the issuance of government bonds. In other words, these close to zero coefficients imply that consumers are in fact Ricardian.

4.2 Dynamic Panel Threshold Model

This subsection presents the results of the dynamic panel threshold model, where the threshold variable is the debt to GDP ratio.

As a starting point for this type of analysis, it is necessary to determine the number of thresholds beforehand. This analysis allows for sequentially one, two, and three thresholds. When doing this, the arising issue is that the likelihood ratio test which allows to determine the number of thresholds unfortunately suffers from the Davies problem, as described in Davies [1977, 1987]. In few words, given that the threshold parameter is not identified under the null hypothesis, testing is non-standard. Furthermore, this issue has also been studied by Andrews and Ploberger [1994], Hansen [1996]. The model considered in this exercise has the typical form considered by Hansen [1996], who advocates that the best way to simulate the asymptotic distribution of the likelihood ratio test is through bootstrap. Therefore, 1000 bootstrap replicates are used to approximate the likelihood ratio test statistics, which are shown, along with their bootstrap p-values, in table (5). As it can be observed, only one of the three thresholds is strongly significant, therefore there is strong evidence in favour of a single threshold model which is the one implemented.

The further step is to compute the point estimate of the threshold variable. In this regard, table 6 shows the point estimation as well as the 95% confidence interval for each of the three thresholds that were tested, although it has already been explained that this exercise implements a single threshold

[12]The results of a specification that does not consider the changes in the levels of deficit but rather the absolute levels of deficit, DEF_t and DEF_{t-1}, are consistent with the ones proposed here, and are shown in the appendix A for further reference.

Table 5: Test for the number of thresholds.

Single threshold test	
P-value:	0.0000

Double threshold test	
P-value:	0.1162

Triple threshold test	
P-value:	0.3840

Table 6: Thresholds' estimates.

Variable	Std. Error	95% Conf. Interval	
		Lower	Upper
γ_1	39.2808	35.7200	39.9000
γ_2	54.2567	50.2486	59.6421
γ_3	71.2408	65.0045	77.0101

model. The confidence intervals for the first threshold, γ_1 is rather tight, which indicates that the uncertainty linked to the estimate is low. On the contrary, the intervals for the second and third thresholds are quite wide, which suggests more uncertainty in the estimation. A visual representation of γ_1 is given by figure 2, where in this case the point estimate of 39.28% is the point at which the likelihood ratio of γ_1, hits the zero axis. This threshold is consistent with the one proposed by Nickel and Vansteenkiste [2008], whose γ_1 is 36%. The 95% confidence interval is represented by the area of the chart where γ_1 lies beneath the dashed line. Furthermore, table 7 shows the percentage of countries that, throughout the years, were below the γ_1 threshold of 39.28%, as well as those above such value. In this regard, it can be observed that in the past ten years, countries' debt to GDP ratio tended to increase until 2017, and decreased only in 2018. This is probably a consequence of the recent economic crisis and of the fact that macroeconomic fluctuations tend to persist over time. On the whole, the average number of countries with a debt to GDP ratio below 39% was roughly 13% of the panel of countries taken into consideration.

Figure 2: Confidence interval construction in single threshold model.

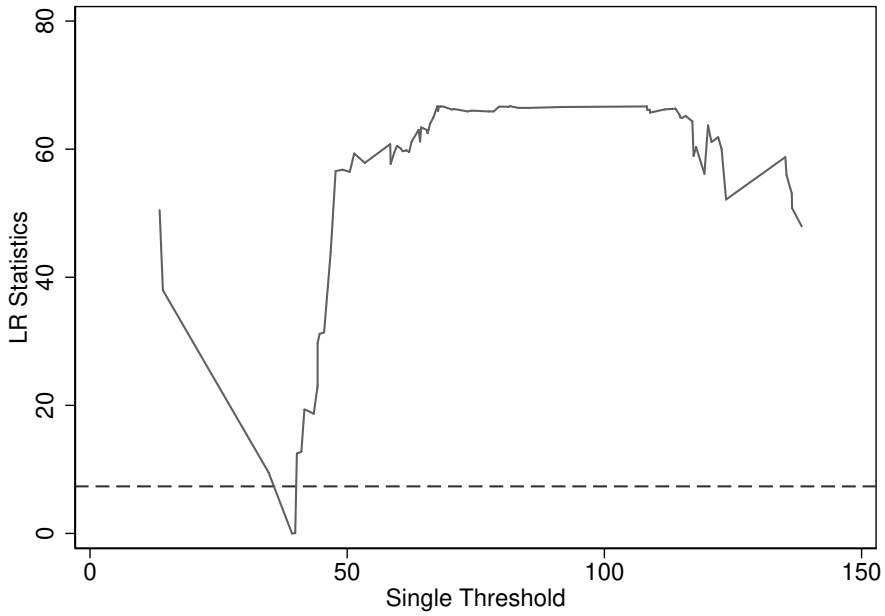

Table 7: Percentage of countries in each regime.

Year	$DEBT \leq 39.28\%$	$DEBT > 39.28\%$
2008	21.05	78.95
2009	21.05	78.95
2010	15.79	84.21
2011	15.79	84.21
2012	15.79	84.21
2013	15.79	84.21
2014	10.53	89.47
2015	5.26	94.74
2016	5.26	94.74
2017	5.26	94.74
2018	10.53	89.47
Average	12.92	87.08

Moving on to the actual results, which are summarized in table 8, these are strongly coherent with the ones found in the previous model. Starting off with the regime-independent variables, there is again evidence of a knock-on effect on the current account balance, since the variable CA_{t-1} displays a coefficient of 0.44; additionally, there is again a rehearsal in the trend in the second lag, which offsets the previous result with its coefficient of -0.46. For the variables real exchange rate and interest rate, neither RER_t, nor INT_t is significant; on the contrary their first lag RER_{t-1} and INT_{t-1} do show strong significance levels albeit the coefficient is close to zero for both of them.

Table 8: Dynamic panel threshold model results.

Variable	Coef.	Std. Error	t-stat	95% Conf. Interval	
				Lower	Upper
CA_{t-1}	0.4436419	0.1083038	0.000	0.2272141	0.6600698
CA_{t-2}	-0.4585785	0.1087657	0.000	-0.6759294	-0.2412276
CA_{t-3}	0.0517706	0.0903321	0.569	-0.1287395	0.2322806
RER_t	-0.0007274	0.0003998	0.074	-0.0015263	0.0000715
RER_{t-1}	-0.0006684	0.0002512	0.010	-0.0011688	-0.0001688
INT_t	0.0000999	0.0004959	0.841	-0.0008911	0.0010909
INT_{t-1}	0.0011096	0.0004602	0.019	0.0001964	0.0020292
DEF_t					
$\leq 39\%$	0.0008944	0.0022303	0.690	-0.0035626	0.0053513
$> 39\%$	0.0016523	0.0006527	0.014	0.0003487	0.0029565
DEF_{t-1}					
$\leq 39\%$	0.0199921	0.0055986	0.001	0.00880424	0.0311801
$> 39\%$	-0.0007592	0.0013335	0.057	-0.003424	0.0019055
DEF_{t-2}					
$\leq 39\%$	-0.0120346	0.0033873	0.001	-0.0188037	-0.0052656
$> 39\%$	0.0004243	0.0010323	0.682	-0.0016387	0.0024873

Note: the dashed lines separate the variables DEF_t, DEF_{t-1}, and DEF_{t-2} because these have a varying coefficient, which changes depending on whether the debt to GDP ratio falls in the regime below or above the 39.28% threshold.

Once again, the most interesting result comes from the regime-dependent variable(s). In this regard, DEF_t is not strongly significant only when analysing the first regime, although in both the intervals the coefficient is quite low. The reason behind the low significance level could be the same as the one explained in the previous subsection, namely, before being able to detect real effects some time has to pass. This is actually confirmed by the stronger significance of DEF_{t-1}, where the coefficients are very close to zero. Furthermore, although the coefficients are very low, their behaviour is strongly in accordance with the theoretical framework, which predicts that, for low levels of debt there should be more reaction on the current account's side, whereas for higher levels of debt the effects should be nil. This is actually what is found, even though in very low magnitude. Finally, DEF_{t-2} displays low significance levels only in the high debt regime, but the coefficients are once again close to zero.
On the whole, there is no evidence of any major effects of the fiscal balance on the current account balance, which suggests that consumers have behaved in a Ricardian manner, which also confirms the findings of the previous model.

5 Conclusion

This paper tries to shed light on the effect of fiscal policies to understand how consumers react to changes in the fiscal balance of a country. After explaining what the main theories dictate, i.e. the classical position as opposed to Ricardian equivalence, this study presents an overlapping-generations model that shows mathematically that it is indeed possible to obtain a Ricardian solution. After that, a number of critiques against such result, as well as its underlying theory, are presented. These arguments try to disclaim the previous conclusion both with discursive arguments and with other mathematical specifications that do lead to classical results. Consequently, the empirical literature is surveyed to give an understanding of firstly, how consumers actually react; secondly, given their reaction, if this is country-specific; and thirdly, how the issue is being addressed by scholars. Overall, it seems like there are varying results and no clear-cut solution, although it should be noted that a slight majority of the empirical literature has found evidence in favour of the classical position.
A further section deals with the whole empirical exercise, starting off with the description of the dataset and of the sample of 19 countries, and then

proceeding with the explanation of the two models with their respective estimation issues.
For what concerns the dynamic panel model, two specifications are here presented: the first one includes the deficit to GDP ratio as proposed by Margani and Ricciuti [2005], whereas the second one considers the changes in the level of deficit and also includes a third lag of the variable current account. In both the cases, the low coefficient of the variable deficit provides evidence in favour of the Ricardian equivalence theory.
Then, this paper exploits a dynamic panel threshold model to understand whether the level of public debt of a country alters the reaction of consumers to a fiscal policy. This model splits the regression into a number of regimes that depends on the estimated number of thresholds, which here amounts to one, whose point estimate is 39.2808%. The variable deficit, together with its first and second lags, are allowed to take different coefficients depending on the regime in which they fall. As for the results, these support the existing literature on the role of public debt. Additionally, the rather low coefficients of the deficit-variables suggest again that consumers behaved in a Ricardian manner.
Given the concordant results of both the models, this paper concludes in favour of the Ricardian equivalence hypothesis, thus, it seems like if consumers were given a so-called "helicopter drop" amount of money today, this would be completely saved to offset the eventual additional tax burden that they may have to face tomorrow.

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A Appendix

List of Tables

Table 9: Results of the dynamic panel model with variable *DEF*.

Variable	Coef.	Std. Error	t-stat	95% Conf. Interval	
				Lower	Upper
CA_{t-1}	0.7170256	0.1046402	0.000	0.5087815	0.9252663
CA_{t-2}	0.1203971	0.1055522	0.257	-0.0896585	0.3304528
DEF	0.0021406	0.0005165	0.000	0.0011128	0.0031685
DEF_{t-1}	0.0023778	0.0008056	0.004	0.0007747	0.0039814
GC_t	-0.0331969	0.0452292	0.465	-0.1232058	0.0568128
GC_{t-1}	0.0847882	0.0631686	0.183	-0.0409214	0.2104979
GC_{t-2}	0.0345303	0.0602032	0.568	-0.0852778	0.1543385
RER_t	-0.1820811	0.5648101	0.748	-0.2301209	0.9417512
RER_{t-1}	-0.5188267	0.3078721	0.513	-1.0870481	1.0591073
RER_{t-2}	0.9334604	0.5812077	0.077	-1.0274101	1.0970946
INT_t	0.0550492	0.1090291	0.614	-0.1619647	0.2719173
INT_{t-1}	0.0655441	0.0730192	0.705	-0.1781701	0.1052449
INT_{t-2}	-0.0448827	0.1271174	0.725	-0.2092017	0.1089411

List of Figures

Figure 3: Percentage of countries below the 39% threshold every year.

Figure 4: Scatter plot of CA (y-axis) and debt (x-axis).

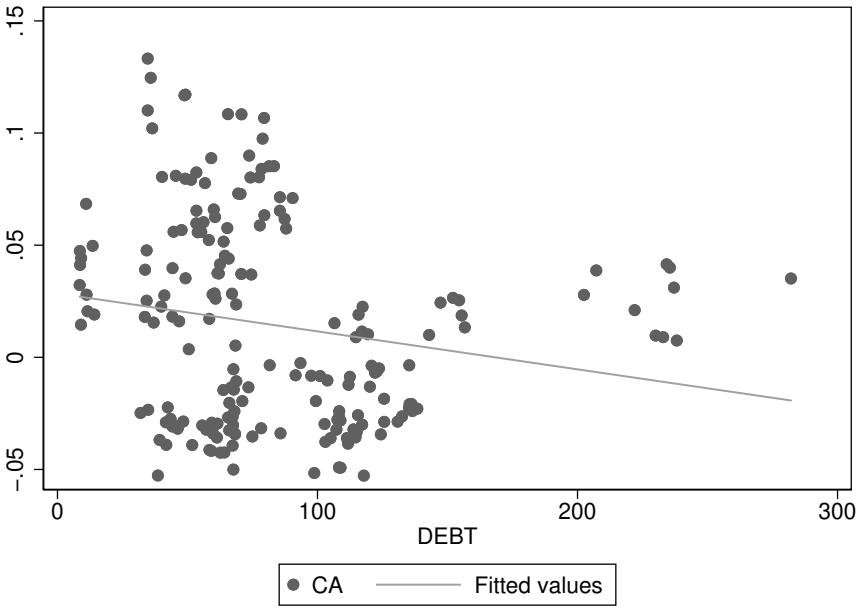
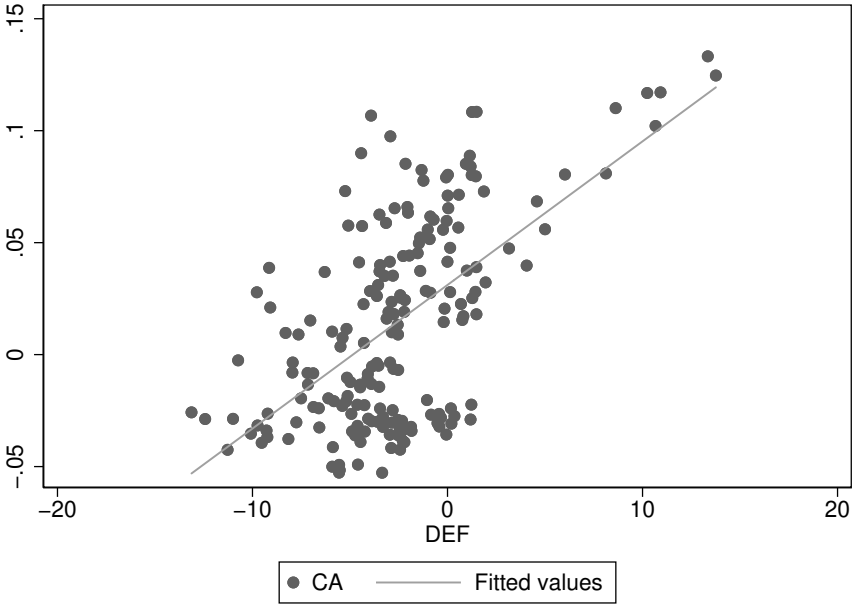


Figure 5: Scatter plot of CA (y-axis) and deficit (x-axis).



Summary of the Thesis

Background Information

The conventional view on the effects of fiscal policies prescribes that if a country decides to run a fiscal deficit, then this ultimately has negative effects on the current account. For this reason, this position has been labelled with the term twin deficit hypothesis, meaning that fiscal deficit has the consequence of dampening the current account balance. On the other hand, since the 19^{th} century David Ricardo had been reflecting on the very same issue, where his logic led him to opposite conclusions. For several years, colleagues of his have picked up this theory without any major breakthroughs. However, it is only after the seminal paper proposed by Barro [1974] that the theory of Ricardian equivalence finally gets the attention of the macroeconomic community, where the opinions are sharply divided among praisers and criticizers.
In this study, the focus is on the decision of running a fiscal deficit through the issuance of government bonds, albeit both the theoretical path, as well as the empirical methodology, can be generalized to fiscal policies as a whole. The focal point is the reaction of consumers to fiscal schemes, i.e. to the additional amount of money that they get after the introduction of government bonds. In fact, depending on the consumption path that households decide to implement, be this total consumption as opposed to total saving, the final effect on the economy is of pure twin deficit or Ricardian equivalence.

Two theories at war

Classical Theory

Assume the government decides to implement a budget deficit, for example by holding the tax rate constant while increasing its total expenditure. As a consequence, households will experience a raise in their disposable income and will be likely to spend more. Therefore, this manoeuvre should boost consumption, thus increasing the aggregate demand. A higher demand for

goods and services triggers further rounds of spending, since one person's spending is another's income, and this will ultimately raise GDP by more than the initial injection of money. On the other hand, the increase in public deficit raises interest rates, which are believed to attract capitals from foreign countries. This, in turn, causes the domestic currency to appreciate, thus, imports become relatively cheaper. In this manner, the tendency toward consuming cheap foreign products rather than expensive domestic ones deteriorates the current account. Given that this whole mechanism was initially triggered by a higher public deficit, and ended with a higher current account deficit, the economic literature has labelled this relationship with the term twin deficit hypothesis.

Ricardian Equivalence

With the same assumption as in the previous subsection, i.e. that the government runs a deficit, another conclusion is possible. In fact, it is plausible that rational consumers will understand that today's government deficit does increase current wealth, but they will also realize that such deficit must be financed through higher taxes in the future and therefore today's wealth will be completely offset by tomorrow's heavier tax burden. This ultimately leads to a zero-sum game. For this reason, the additional wealth deriving from the fiscal alleviation will be completely saved to consume more in the future and the fiscal manoeuvre will end up having no effect at all. This is the so-called Ricardian equivalence hypothesis, and is named after Ricardo [1824], who is the first to posit that the consumption path of an individual should not be affected by eventual redistributions of purchasing power if these do not alter their permanent income.

Empirical Study and Results

The empirical strategy implemented proposes to understand whether, in a panel of 19 countries, there is evidence of twin deficit or Ricardian equivalence. The variables employed in this study are: current account balance (dependent variable); fiscal balance; public consumption; real exchange rate; interest rate; public debt. The variables current account, fiscal balance, public consumption, and public debt are expressed as percentage of GDP. From an empirical point of view, the twin deficit theory is validated whenever the variable deficit displays a positive coefficient. Conversely, with a close to zero coefficient, the twin deficit hypothesis will be rejected in favour of

Ricardian equivalence.
This study exploits two models: firstly a dynamic panel model, where the regressors include both the control variables and their first lags; and secondly, a dynamic panel threshold model, where the influence of the debt to GDP ratio on consumer's reaction is investigated.

Dynamic Panel Model

Since in theory macroeconomic policies take some time before showing real effects on the economy, this study exploits a dynamic model, where the variables are introduced with one lag. As for the variable fiscal balance, a first specification considers the absolute level of deficit, whereas a second one exploits the changes the level of deficit. In both the cases, the variable fiscal balance is not highly significant when considered in the current period, i.e. at time t; on the other hand the first lag is strongly significant. This is highly in line with the theory, according to which macroeconomic movements need time before showing real effects. For both the specifications, the coefficients of the variable fiscal balance are very low, almost zero. Therefore, this model concludes in favour of Ricardian equivalence.

Dynamic Panel Threshold Model

This model takes from where the previous left, adding the effect of public debt. The theory prescribes that the effect of a fiscal policy should change according to the level of debt: if this is low, households should expect that the government can afford to run a budget deficit without having to raise taxes, therefore the reaction would be to increase consumption; on the other hand, if debt is high, rational consumers should anticipate that the fiscal scheme will lead to higher taxes, hence the additional amount of money should be saved. The threshold model here proposed splits the regression into two regimes and allows the variable deficit to take different coefficients, one for the low debt regime and one for the high debt one. In theory, one should detect a higher coefficient in the former regime, and a lower coefficient in the latter one. This is indeed what is found, albeit in very low magnitude. The conclusion is that: firstly, the sub-literature on the effect of public debt is confirmed; secondly, that the very low coefficients allow again to reject twin deficit for Ricardian equivalence.

Conclusion

Having presented the theoretical problem, namely that there are two schools of though that attach to the same economic input a different effect, and having explained the estimation methodology, this paper concludes that, in the two specifications of the first model, as well as in the second model, the very low coefficients of the variable fiscal balance provide good evidence against twin deficit and in favour of Ricardian equivalence.