RESEARCH MASTERS IN ECONOMICS

"CAN THE NATIONAL BUDGET INFLUENCE INVESTMENT AND GROWTH? – A RICARDIAN PERSPECTIVE"

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DECLARATION

The dissertation was undertaken in the Department Economics, University of Natal Pietermaritzburg under the supervision of Doctor Richard Simson. This is an original work by the author and has not been submitted in any form for any other degree or diploma to any other university. Where the work of others has been used, it has been duly acknowledged in the text.

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ABSTRACT

Since Ricardo's nineteenth-century suggestion that the means of financing government spending is irrelevant, theoretical debate concerning the burden of government debt has been vigorous (Leachman 1996: 695). The effect of national debt on real economic activity has been a recurring topic in economic literature, with the problem usually stated as follows: *"for a given level of government spending, is the economy sensitive to the financing mix between tax and debt?"* (Carmichael 1982: 202). *"Ricardian equivalence"*, as the revived theory has come to be called, attributes no effects at all; in other words, the debt/tax mix is irrelevant (Seater 1993: 142). Taxation and debt finance (issuing bonds) may therefore be an equivalent means of financing government expenditure (Hoover 1988: 139).

The following dissertation is concerned with the analysis of Ricardian equivalence theory. The analysis engages both macroeconomic and microeconomic theory and concludes with an empirical analysis of Ricardian equivalence using South African data. We study the effects of changes in taxes on the macro economy. The major finding is that the Dalamagas result supporting Ricardian equivalence is not reproduced. In the final econometric analysis we find that government expenditure and private expenditure are hardly close substitutes and individuals do not fully incorporate future tax liabilities into current decisions. Based on these results, the ability of government to influence output using fiscal policy adjustment is limited only to the extent that their actions cause adverse interest rate changes.

CHAPTER ONE
INTRODUCTION

1.1 Introduction

David Ricardo (1772–1832) made important contributions to explaining a host of economic problems and issues, ranging from the value of money to the theory of value, exchange, and international trade, and laid the foundations of modern public finance theory (Parkin 1990: 904). Theoretical as it is, much of Ricardo's work has practical implications. His contribution that has most relevance for us today, however, is that concerning the public debt and on what has come to be called Ricardian equivalence.

Since the appearance of large government budget deficits in the late 1970's, there has been continued concern that these deficits cause higher real interest rates, low saving and low rates of economic growth. Standard Keynesian and Neo-classical models provide theoretical justification for this belief if deficits are funded by the private sector and not monetised. More recently, however, the Ricardian equivalence hypothesis has received increasing attention.

Ricardian equivalence offers a unique perspective on budget deficits, which takes the position that neither deficits nor the way they are financed are crucial to economic policy and future economic prosperity. The basic theory indicates that for a given path of government spending, a deficit-financed cut in current taxes leads to higher future taxes that have the same present value as the initial cut (Barro 1989: 39). Therefore the substitution of a budget deficit for current taxes (or any other rearrangement of the timing of taxes) has no impact on the aggregate demand for goods. In

this sense, budget deficits and taxation have equivalent effects on the economy – hence the term *"Ricardian Equivalence Theorem"*.

1.2 Research Objective

The objective of this economic study is to offer both a theoretical and an empirical analysis of Ricardian equivalence. The research objective is firstly, to locate Ricardian equivalence within the macroeconomic debate concerning budget deficits and to develop an understanding of the origins of this theory. The second objective is to develop an understanding of the behaviour of Ricardian individuals within the microeconomic context of intertemporal choice. The final objective of this study is to provide empirical testing for Ricardian equivalence using South African data. In testing for Ricardian equivalence one either gets support for the theory or not, depending on minor changes in model specification, and this thesis will attempt to see if this is the case. Different tests and different time periods (e.g. annual as opposed to quarterly) are utilised in this study for testing for Ricardian equivalence, which may lead to different conclusions with respect to the existence of Ricardian equivalence behaviour amongst South African consumers.

1.3 Research Method

The research method in this study is of both a secondary and primary nature. Secondary material is obtained primarily from books and journals. The primary research is undertaken using quantitative methods. The quantitative methods involved an econometric study using South African macroeconomic data (1946 – 1998). The data in Empirical Analysis A was processed using the *SHAZAM 8.0 Version* econometrics computer package. We add to Dalamagas's (1994)

econometric test by conducting joint tests of implied theoretical restrictions, using expanded sets of economic variables for calculating expected outcomes.

1.4 Study Outline

Following on from this introductory chapter, Chapter 2 covers the macroeconomic debate concerning Ricardian equivalence and budget deficits. Chapter 3 presents a micro-economic perspective of the Ricardian equivalence problem so as to develop an understanding of the behavioural characteristics of the Ricardian consumer. Chapter 4 considers certain key assumptions regarding Ricardian equivalence and the current criticism of Ricardian theory.

Having established the theoretical basis for Ricardian equivalence theory, an empirical study is undertaken in Chapter 5 to test for evidence in support of the Ricardian equivalence theory discussed in the previous chapters. The standard econometric model is initially considered and then an examination of previous econometric research is undertaken with respect to Ricardian Equivalence to place the empirical analysis component of this thesis in context.

The specific framework of analysis is detailed and the Dalamagas (1994) model, as the basis of the empirical testing, is examined. Dalamagas's econometric approach is applied to two differing empirical analyses using extended data ranges for South Africa. From the theoretical analysis and the observations made in the empirical section the thesis is concluded with a summary and conclusions chapter which alludes to the relevance of Ricardian Equivalence in the South African situation and the irregularities that may result from empirical testing.

CHAPTER TWO

BUDGET DEFICITS AND RICARDIAN EQUIVALENCE – A MACROECONOMIC DEBATE

2.1 Introduction

Historically, attention has focused on the question of whether or not individuals perceive government bonds as net wealth, with the link between wealth and real activity being taken as given. This question has dominated contemporary macroeconomic thought and has generated a considerable amount of research as investigators seek to explain the private sector's response to governmental behaviour (Darius 2001: 49). The models that are commonly tested are associated with the Keynesian, the Neo-classical and the Ricardian equivalence paradigms with respect to the influence of budget deficits.

Before analysing the nature of Ricardian equivalence behaviour, the economic effects of deficits and government debt are discussed in this chapter. The macroeconomic debate concerning budget deficits is discussed in relation to the three main paradigms concerning budget deficits. Finally, the *IS-LM* framework is used to demonstrate Ricardian equivalence showing the relationship between budget deficits, money demand and interest rates.

2.2 Budget Deficits

The budget and especially the budget deficit is a major preoccupation of economic policy, and thus is often the main feature of fiscal policy debates (Dornbusch and Fischer 1996: 120; Miller 1982: 266). Such so-called fiscal policy consists of deliberate changes in government spending and tax collections to achieve full employment, control inflation, and encourage economic growth (Brue and McConnel 2002: 224). Governments use budgets to control and record their fiscal affairs. A budget shows, for a given year, the planned expenditures and expected receipts that government spending and tax programs would yield. The budget typically will contain a list of specific programs (education, welfare, defence, etc.), as well as tax sources (individual income tax, social-insurance taxes, etc.) (Samuelson and Nordhaus 1989: 385). In a given year, governments run either budgetary surpluses or budgetary deficits.

What exactly is the budget deficit? The government's budget surplus or deficit is simply the difference between the taxes it receives and its total expenditure in a given period of time, which we refer to as the budget balance (Parkin 1990: 892). The government's budget balance can be defined specifically as its total tax revenue (T) minus its total expenditures, i.e. $T - (G + Q)$, where the government's total expenditure ($G + Q$) is divided between expenditure on final goods and services, G, and expenditure on transfer payments, Q (Lipsey et al 1987: 570; Lipsey 1989: 498). When this equation takes on a zero value, the budget is said to be balanced, and tax revenues just balance total expenditures. When the value is positive, the government's budget is in surplus, and there is an excess of tax revenue over expenditures. Finally, when the value is a negative, the government's budget is in deficit and there is an excess expenditure over tax revenue (Lipsey 1989: 498).

Rising budget deficits in both developed and developing countries have received considerable attention over more recent decades and therefore have been considered a key economic issue, often second only to employment (Gupta 1992: 19, Bernheim 1989: 55). Many economists and other observers refer to deficits as being harmful to world economies by causing high real interest rates, low saving, low rates of economic growth and large current-account deficits. Harvard economist Benjamin Friedman (1988) summarizes the concern when he writes, *"We are living well by running up our debt and selling off our assets. America has thrown itself a party and billed the tab to the future. The costs, which are only beginning to come due, will include a lower standard of living for individual Americans and reduced American influence and importance in world affairs"* (Friedman edited in Yellen 1989: 17).

The crisis scenario described by Friedman (1988) above has, however, been difficult to maintain in the face of robust performance of the economy of the United States in the 1980s and 1990s. Despite its considerable deficit, the economy featured high average growth rates of real GNP, declining unemployment, much lower inflation, a sharp decrease in nominal interest rates, some decline in expected real interest rates and high values of real investment expenditures (Barro 1989: 37). Thus, while fiscal adjustment is commonly regarded as the cornerstone of macroeconomic stabilisation, the actual impact of lower public deficits on national saving and the current account balance remains both theoretically and empirically controversial (Lopez et al 2000: 226).

In his speech on the budget and entitlements at Bryn Mawr College in December 1993, then President Bill Clinton declared that *"high deficits keep interest rates high, and they crowd out private demands for capital,"* and with the passage of this budget, *"the markets had it figured out. That's why interest rates are down and investment is up."* President Clinton was correct, but only

to the extent that he chose to analyse and describe the effects of the standard Keynesian macroeconomic model (Savage 1994: 98). It is clear, however, that not all economists agree with the Keynesian model or with Clinton's interpretation of the deficit's effect on interest rates. There are three main schools of thought concerning the economic effects of budget deficits: Keynesian, Neo-classical and Ricardian. The basic structure and implications of each model will be considered below.

2.3 The Keynesian Model

A traditional theory of budget deficits, which appears in most textbooks, holds that an increase in government debt leads to an increase in private sector wealth. Adherents of this view argue that the increase in wealth, in turn, leads to an increase in the price level, output and interest rates (Wheeler 1999: 274). The starting point in explaining the traditional perspective can be the assumption that the substitution of a budget deficit for current taxation leads to an expansion of aggregate consumer demand (Bernheim 1989: 61; Vamvoukas 1999: 66). In other words, because desired private saving rises by only a fraction of the budget deficit/tax cut, desired national saving- the sum of public and private saving, declines.

In a closed economy it follows that the expected real interest rate would have to rise to establish equality between desired national saving and investment demand. The higher real interest rate crowds out investment, which shows up in the long run as a smaller stock of productive capital, and hence lowers productivity (Barro 1996: 91). This standard theory thus implies a close relationship between a country's deficits, real interest rates, and levels of investment.

In an open economy with perfect markets for goods and credit, each country faces the same real interest rate, which is determined by the world aggregates of investment demand and desired saving. In the standard analysis, the home country's decision to substitute a budget deficit for taxes normally leads to increased international borrowing, rather than to a higher real interest rate. That is, budget deficits lead to current account deficits (Barro 1989: 37).

Expected real interest rates, only rise for the home country if that country is large enough to influence world markets, or if the increased national debt induces foreign lenders to demand higher expected returns on the country's obligations. Therefore for an open economy, it can be said that there is a much weaker tendency for a single country's budget deficit to be associated with higher real interest rates or reduced domestic investment (Barro 1996: 92). However, if the entire world runs budget deficits, then real interest rates rise on international capital markets, and investment is crowded out in each country. Correspondingly, the world's stock of capital is lower in the long run and these effects for the world parallel the standard ones for a single closed economy.

The Keynesian model has been associated with this Neo-classical model and is based on the argument that the approach is relevant in the short run (i.e. temporary deficits), while the Neo-classical approach is concerned with the long run (i.e. permanent deficits) (Darius 2001: 50; Bernheim 1989: 59). The Keynesians assume the existence of unemployed resources and that the economy contains a large population of liquidity-constrained individuals. The second assumption implies sensitivity of consumption to changes in contemporaneous income (Darius 2001: 50).

2.4 The Neo-classical Model

According to Bernheim (1989: 57), the standard Neo-classical model is premised on three main assumptions:

- Firstly, the consumption of each individual is determined as the solution to an intertemporal optimisation problem ruled by the market rate of interest.
- Secondly, individuals' life spans are considered finite.
- Thirdly, market clearing is assumed to take place in all periods.

The basic Neo-classical model, like the Keynesian model discussed above, supports the view that substitution of a budget deficit for current taxation will increase consumption, and personal savings will not increase to offset public sector savings (Darius 2001: 50). Such models thus assume that aggregate consumption is higher, and national saving (private and public) is lower, if a given government spending program is financed through the issuing of bonds rather than through current taxation (Yellen 1989:18).

If resources are fully employed, so that output is fixed, higher current consumption implies an equal and offsetting reduction in other forms of spending. With domestic savings on the decline in a closed economy, the equilibrating rate of interest between investment and savings would have to increase in order to maintain equilibrium in the capital market. The increase in interest rates crowds out domestic investment, leading to a decline in long-term capital accumulation, and thus to an eventual reduction in the long-term steady growth rate (Darius 2001: 50).

Diamond (1965: 1126), who was one of the first to study formally the effects of budget deficits in the context of this model, argued that *"external debt"* (budget deficits) reduces the utility of an individual living in long-run equilibrium. Diamond (1965), who focused on permanent rather than temporary deficit changes, indicated that a permanent increase in the ratio of domestically held debt to national income reduces the steady state capital-labour ratio (Bernheim 1989: 57). Consumers are unwilling to hold the original volume of capital and bonds (including the new bonds) at the original rate of interest. Rising interest rates increase the level of saving, reducing investment, until capital market equilibrium is re-established. Persistent government deficits thus crowd out private capital accumulation.

Yellen (1989: 18) argues that one must consider that there are two distinct mechanisms by which, crowding out occurs. In a closed economy, a change from tax to deficit financing raises real interest rates and crowds out investment. In contrast, in the case of smaller open economies, with internationally mobile capital, net exports rather than domestic investment are crowded out. Deficits place upward pressure on interest rates, inducing an inflow of foreign funds. With flexible exchange rates, an influx of capital causes an appreciation of the country's currency, which diminishes the competitiveness of its products in world markets. In large open economies, both these mechanisms are likely to be in operation.

The mechanism by which crowding out occurs and the implications for future living standards are identical in both cases. Deficits retard domestic capital formation and shift the economy to a growth path with lower per capita output and capital per worker than in a closed economy scenario. In the open economy scenario, current account deficits cause a growing level of foreign

indebtedness, resulting in a burden of future interest payments, which will decrease the disposable income of domestic residents (Yellen 1989: 18).

2.5 The Ricardian Equivalence Model (New view of the deficit)

Over the last 25 years, the two theoretical models discussed above have been cast into doubt through the revival of a theory, first explored by Ricardo, suggesting that debt policy has none of the effects attributed to it by traditional analysis (Seater 1993: 142). Tobin (1952) asked rhetorically: "*How is it possible that society merely by the device of incurring debt to itself can deceive itself into believing that it is wealthier? Do not the additional taxes which are necessary to carry out the interest charges reduce the value of other components of private wealth? There must certainly be effects in this direction.*" (Poterba and Summers 1987: 369). The central Ricardian observation is therefore that deficits merely postpone taxes and that a rational individual should be able to see through the intertemporal veil and realise that the present discounted value of taxes depends only upon real government spending – not on the precise mix of debt and taxes by which purchases are financed (Bernheim 1989: 63).

Barro (1996: 93) explains that consumer demand depends on the anticipated present value of additional future taxes. In other words, each person subtracts his or her share of the present value of future taxes from the present value of expected income, to determine a net wealth position, which then determines the desired level of consumption. Since a budget deficit does not affect the present value of taxes, it must therefore have no impact on consumer demand. Another way to express this result is that a decrease in public saving (implied by an increase in the government deficit) induces an equal offsetting increase in private saving, thus government deficits are not

viewed as net wealth by the private sector because the present value of implied future tax liabilities is equal to the value of debt (Feldstein and Elmendorf 1990: 589; Gulley 1994: 239).

The Ricardian modification of the standard analysis begins with the proposition that if the path of government expenditures on goods, services, and transfers is unchanged, then a deficit-financed tax cut or the issuing of bonds leads to an exactly offsetting increase in the present value of future taxes (Barro 1989: 38; Evans 1988: 983). This result follows from the government's budget constraint, which equates total expenditure for each period (including interest payments) to revenues from taxation or other sources and the net issue of interest-bearing public debt. Barro (1996: 93) argues *"There is no free lunch; the government must pay for its expenditures now or later: but not never."*

Economic agents will realise that the rising public debt must be repaid at some point in the future, and, in anticipation, they will save their additional income after taxes so as to meet future tax hikes. Under these circumstances taxation and debt finance (issuing bonds) can be seen as equivalent means of financing government expenditure. If the government levies a tax, it reduces private sector wealth, and if it sells bonds instead to the same value of the tax, to be paid off with interest, wealth remains intact (Hoover 1988: 139). This is so because the government will have to raise taxes later in order to pay off the bonds with interest. Dissaving by the government should therefore be fully compensated by increased private sector savings, and the creation of government debt has none of the effects predicted by either Keynesian or Neo-classical theory, assuming GDP is constant (i.e. changes in the price level, output or interest rate) (Allers et al 1998: 566; Wheeler 1999: 274).

Barro (1996: 93) explains that consumer demand depends on the anticipated present value of taxes. In other words, each person subtracts his or her share of the present value from the present value of income, to determine a net wealth position, which then determines the desired level of consumption. Since a budget deficit does not affect the present value of taxes, it must therefore have no impact on consumer demand. Another way to express this result is that a decrease in public saving (implied by an increase in the government deficit) induces an equally offsetting increase in private saving, thus government deficits are not viewed as net wealth by the private sector because the present value of implied future tax liabilities is equal to the value of debt (Darius 2001: 50; Feldstein and Elmendorf 1990: 589; Gulley 1994: 239).

When considering the closed economy situation, it is noted that the desired national saving must be equated to domestic investment demand. If the Ricardian result is correct (so that the budget deficit has no effect on desired national saving), then the real interest rate does not have to change to maintain the equality between desired national saving and domestic investment demand (Barro 1996: 93). Therefore, in the case of the closed economy, the budget deficit has no effect on the real interest rate or quantity of investment. In an open economy, the current-account balance equals the excess of desired national saving over domestic investment demand. From a Ricardian perspective it has been observed that a budget deficit does not affect desired national saving and therefore does not affect the current-account balance. That is, budget deficits do not cause current-account deficits. There is no need to borrow from abroad because desired private saving from domestic residents increases enough to compensate for the decline in public saving.

2.6 *IS-LM* Framework

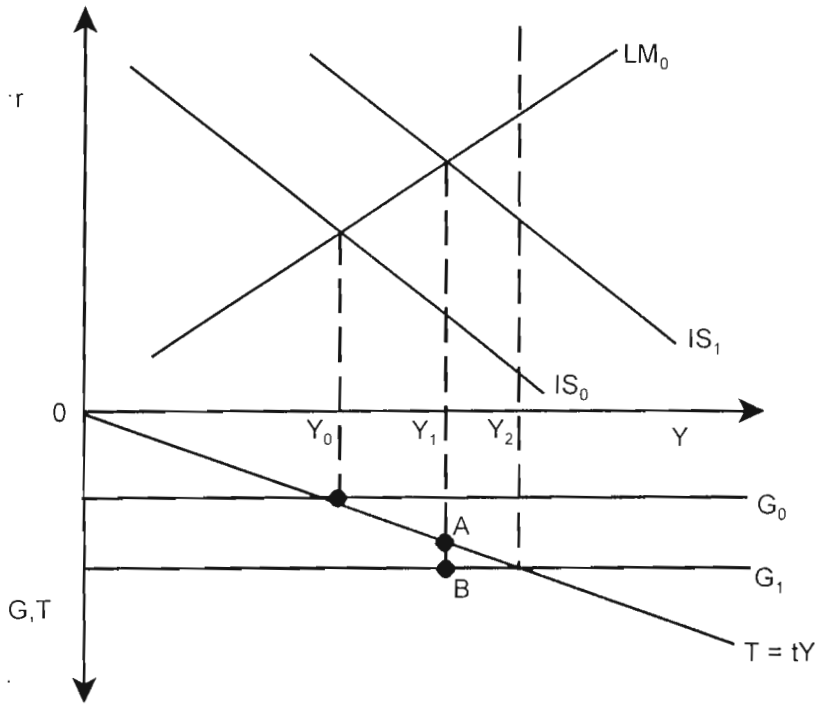
A simple *IS-LM* framework can be used to demonstrate the relationship between budget deficits, money demand and interest rates, in all three models discussed above (Gulley 1994: 239). The *IS-LM* model, invented by the economist John Hicks, is the simplest model that integrates the monetary-asset side of the economy with the real expenditure side (Lipsey 1989: 546). The *LM* relation is derived from the equilibrium condition that the demand for money, L – 'liquidity', should equal the existing quantity of money, M, – hence the name *LM* (Kennedy 1984: 128; Lipsey 1989: 546; Parkin 1990: 782). The curve therefore plots national income against the rate of interest.

The *IS* relation shows all combinations of income, Y, and the rate of interest, r, at which $I = S$, that is, at which planned investment is equal to planned savings (Glahe 1973: 113; Lipsey et al 1987: 768; Lipsey 1989: 556). The *IS* curve, often referred to as the goods market equilibrium schedule, therefore shows the combinations of Y and r that give equilibrium in the goods markets, whereas the *LM* curve shows the combination of Y and r that give equilibrium in asset markets (Dornbusch and Fischer 1996: 129; Lipsey 1989: 556). The only combination where both markets are in equilibrium, that is the unique point of overall equilibrium, occurs where the two curves intersect (Cobham 1987: 7).

This simple framework can be effectively used to demonstrate the relationship between budget deficits, money demand and interest rates in the Keynesian, Neo-classical and Ricardian models (Gulley 1994: 239). The effect of incorporating a government budget constraint into the standard *IS-LM* model was first examined by Ott and Ott (1965) and Christ (1968) (Vane and Thompson

1992: 114). The argument considers that if we assume the extreme case of a self-contained economy that is not growing over time, long-run equilibrium is not possible if there is a continuing budget deficit. This is because in order to finance the deficit the authorities would have to issue either bonds or money, in which case the supply of financial assets would change, disturbing stock equilibrium. Long-run equilibrium requires a government budget that is balanced (Vane and Thompson 1992: 114).

Figure A: *Ricardian equivalence and the IS-LM Model*



(Source: Vane and Thompson 1992: 115)

Consider Figure A. The top panel depicts the normal *IS-LM* model, whereas the lower panel represents the government budget position determined by the relationship between government expenditure and tax revenue.

To simplify the analysis, government expenditure (G) is assumed to be independent of income (Y) (hence the horizontal line) while tax revenues (T) increase as income increases. The slope of the tax function represents the marginal rate of tax (t) and is thus assumed to be constant. In Figure A, positive values occur on either side of the horizontal axis, i.e. positive rates of interest upwards, and positive values of government expenditure and tax revenue downwards from 0.

We begin from a position of long-run full stock equilibrium at an income level Y_0 (the intersection of IS_0 and LM_0), with a balanced government budget, i.e. $G_0 = T_0$, at income level Y_0. An increase in government expenditure shifts the IS curve outwards to the right from IS_0 to IS_1 and the government expenditure function downwards from G_0 to G_1. At an income level of Y_1 (the intersection of IS_1 and LM_0), there is a budget deficit equal to AB. The restoration of full stock equilibrium requires income rising to Y_2 such that government tax revenue equals the increased government expenditure, thereby closing the budget deficit and restoring budgetary balance (Vane and Thompson 1992: 115).

By contrast if we consider a tax-cut induced increase in the deficit, *ceteris paribus*, the IS curve will shift outwards to the right from IS_0 to IS_1 and the government expenditure function downwards from G_0 to G_1 (it must be noted that the slope of the tax function represents the marginal rate of tax (t) and it is assumed constant in Figure A). Standard analysis (i.e. Keynesian and Neo-classical) argues that money demand increases via an increase in consumption (for transaction purposes) and an increase in saving (for store-of-wealth purposes). Further, if money demand is also a function of wealth, the increased holdings of government bonds will raise money demand as well. These increases in money demand will occur as long as the private sector does not fully discount future tax liabilities resulting from the new debt. The short-run adjustment process will tend to increase

real interest rates (Gulley 1994: 240). The long-run adjustment process in the Neo-classical model will leave output unchanged, while in the Keynesian model output will rise.

The re-establishment of full stock equilibrium requires that income rises to Y_2 such that government tax revenue equals the increased government expenditure, thereby closing the budget deficit and restoring budgetary balance (Vane and Thompson 1992: 115). The establishment of equilibrium at Y_2 can be related to the wealth effects on consumption and the demand for money. Where an increase in government expenditure is financed through the sale of bonds, private sector holdings of bonds will increase as long as the budget deficit persists. If the assumption is that the wealth effect on consumption (which shifts the *IS* curve further outwards to the right) is stronger than that on the demand for money (which shifts the *LM* curve upwards to the left) the level of income rises and long-run equilibrium will be re-established when the budget is balanced at an income level of Y_2. However, if the wealth effect on demand for money outweighs that on consumption, then, although the immediate impact of increased government expenditure will be expansionary (i.e. income will initially rise from Y_0 to Y_1), in the long run the equilibrium will continually decrease and the budget deficit will increase, because as the income falls tax revenues also fall. Vane and Thompson (1992: 116) argue that in this case income will be continually driven further away from its long-run equilibrium income level (Y_2) and there will be instability in the model.

An objection to the predictions concerning the power of fiscal policy can be made on the grounds of rationality – 'Ricardian equivalence'. The basis of this view, as previously discussed, is that the private sector will realise that increased bond issues will necessitate future increases in taxes to meet interest payments on the bonds (Vane and Thompson 1992: 117). In the Ricardian model, the

value of new debt is seen simply as the present value of future tax liabilities. Thus, when 'debt' is issued, the private sector will hold the debt and private saving will increase by an equal amount (Gulley 1994: 240). Ricardian equivalence states that as demand shifts out, the supply of loanable funds will also shift to the point where interest rate has remained unchanged (Winner 1993: 81). The shifts in demand and supply therefore counterbalance each other. This shows that the interest rate holds constant and we remain at Y_0 in the diagram under Ricardian Equivalence.

Thus, in the *IS-LM* model, the Ricardian equivalence hypothesis denotes that the rise of the budget deficit does not influence the equilibrium of the *IS* and *LM* curves. In this way, the government deficit does not affect the equilibrium level of the national income, interest rate, money demand, consumption, savings or investment (Vamvoukas 1999: 67). The impact of an increase in government expenditure would thus also be the same, whether financed by an increase in taxes or bond sales, in the Ricardian case.

2.7 Conclusion

Since the appearance of large government budget deficits in the late 1970s, there has been continued concern that these deficits cause higher real interest rates, low saving and low rates of economic growth. Standard Keynesian and Neo-classical models provide theoretical justification for this belief. More recently, however, the Ricardian equivalence hypothesis has received increasing attention.

After introducing Ricardian equivalence in Chapter 1, Ricardian equivalence is placed in the theoretical context of budget deficits in this chapter – the aim being to locate Ricardian theory

within the macroeconomic debate concerning the economic effects of budget deficits and the way they are financed.

CHAPTER THREE

RICARDIAN EQUIVALENCE – A MICROECONOMIC PERSPECTIVE

3.1 Introduction

"Barro's (1974) argument is a modern restatement of David Ricardo's equivalence theorem. As formulated by Ricardo, equivalence was a matter of present value arithmetic. Barro converted an arithmetical proposition into one with behavioural content by assuming that present taxpayers will treat their heirs as extensions of themselves" (Vaughn and Wagner 1992: 42).

In this chapter an attempt is made to explain Ricardian equivalence by trying to understand certain behavioural characteristics of individual consumers over time. In this respect Barro's modelling of Ricardian equivalence is analysed within the microeconomic context of intertemporal choice. Critical but often controversial assumptions required for the operation of the Ricardian equivalence model will also be identified in this chapter. Finally, relevant criticisms facing Ricardian equivalence theory will be discussed before the empirical analysis of this theory in Chapter 4.

3.2 Intertemporal Choice

Ricardian equivalence is essentially about consumption decisions over time, and in order to model these decisions we utilise intertemporal choice theory. Thus, although Ricardian equivalence is basically a macroeconomic phenomenon, it does have a microeconomic basis. Intertemporal choice, simply stated, refers to consumption of choices over time (Varian 1993: 179). In order to

model Ricardian equivalence with respect to intertemporal choice, for this purpose, we need to make a few simplistic assumptions:

1. The consumer chooses how much of a good to consume in each period (c_1, c_2)
2. The price of a consumption good in each period is constant
3. The amount of money income the consumer has in each period is (m_1, m_2)
4. The only way to transfer money from period 1 to period 2 is by saving without earning interest
5. There is no possibility of borrowing money, so the most the consumer can spend in period 1 is m_1

3.2.1 The Budget Constraint

An economic problem facing the 'intertemporal' consumer is to find out how to maximise consumer satisfaction. In order to do so, we consult not only our preferences – given by indifference curves – but also our opportunities – given by our available income, called our budget constraint (Miller 1982: 434). The consumer would like to consume large quantities of almost all desirable commodities, but, unfortunately, the individual's income limits how much he/she can spend and he/she therefore has to make choices or trade-offs among possible goods (Glahe and Lee 1989: 126; Miller 1982: 434). Each individual thus has a budget constraint, which limits his/her ability to consume in light of the prices he/she must pay for various goods and services (Pindyk and Rubinfeld 1998: 72).

The budget constraint can be assumed to be found when the rate of interest is at zero and no borrowing is allowed, and thus the less the individual consumes in period 1 the more the consumer

can consume in period 2. Relaxing the fourth assumption above, the consumer can now borrow and lend money at the same interest rate r, and keeping prices of consumption in each period constant at 1, we can thus derive the budget constraint. One can suppose that the consumer decides to be a saver so his first period consumption c_1, is less than his first period income, m_1. In this case, interest will be earned on the amount saved, $m_1 - c_1$, at the interest rate r. The amount that can be consumed in the next period is thus given by:

$$c_2 = m_2 + (m_1 - c_1) + r(m_1 - c_1) \quad (1)$$

$$= m_2 + (1 + r)(m_1 - c_1) \quad (2)$$

This says that the amount the consumer can consume in period 2 is his income added to the amount he/she saved from period 1, added to the interest that he/she saved on savings (Varian 1993: 180).

We can arrange the budget constraint for the consumer into two alternative forms:

$$(1 + r)\, c_1 + c_2 = (1 + r)\, m_1 + m_2 \quad (3)$$

Or

$$c_1 + (c_2 / 1 + r) = m_1 + (m_2 / 1 + r). \quad (4)$$

Equation 3 expresses the budget constraint in terms of future values and equation 4 expresses the budget constraint in terms of present values. The first budget constraint makes the price of future consumption equal to 1, whereas the second budget constraint makes the price of present consumption equal to 1. The first budget constraint thus measures the period-1 price relative to the period-2 price, while the second equation does the opposite (Varian 1993: 181).

3.2.2 The Indifference Curve (Preferences for Consumption)

Indifference curves enable us to represent an individual's preferences graphically as long as each bundle only contains two goods (Glahe and Lee 1989: 110). An indifference curve is the locus of points – particular combinations or bundles of goods – which yield the same utility (level of satisfaction) to the consumer, so that he/she is indifferent as to the particular combination he/she consumes (Blair and Kenny 1987: 17; Koutsoyiannis 1985: 18; Parkin 1990: 180; Pindyck and Rubinfeld 1998: 64). In other words, the individual has an equal preference for all bundles of goods that lie on the indifference curve, and the shape of indifference curves indicates the consumer's tastes for consumption at different times (Glahe and Lee 1989: 110; Lipsey et al 1987: 146; Samuelson and Nordhaus 1989: 462).

If indifference curves $C_1 + C_2$ were drawn for perfect substitutes, the consumer would be entirely indifferent whether he/she consumed today or tomorrow (Pindyck and Rubinfeld 1998: 64; Varian 1993: 182). The marginal rate of substitution between consuming today and tomorrow is thus constant at -1 and the indifference curve takes the shape of a straight line (Koutsoyiannis 1985: 20; Pindyck and Rubinfeld 1998: 64). In contrast, if indifference curves $C_1 + C_2$ were drawn for perfect complements, this would indicate that the consumer wanted to consume equal amounts of a good today and tomorrow (Koutsoyiannis 1985: 20; Pindyck and Rubinfeld 1998: 64; Varian 1993: 183).

According to intertemporal economic theory, one can say that the intermediate case of well-behaved preferences is the more reasonable situation. The consumer is willing to substitute some

amount of consumption today for consumption tomorrow, and how much he/she is willing to substitute depends on the particular pattern of consumption that he/she has (Varian 1993: 183).

After discussing the basic components of the intertemporal choice model, we relate this literature to Ricardian equivalence theory. As discussed above, this theory is modelled on the principle that whether government spending is financed by taxes or bonds is inconsequential, as government debt does not represent net private wealth.

3.3 Infinite Lives and the Two-Period Model

Robert Barro (1974), who resurrected Ricardo's theoretical argument, used two distinct models to model Ricardian equivalence theory. In the first, individuals are assumed to have infinitely long lives. The point of this is to ensure that the same individuals who buy bonds will be taxed later to pay them off. The key assumption here is that perpetual bond finance is ruled out and that debt has to be paid off at some point in time. Barro's point, however, can be made in a much simpler model where both the individual and the economy are assumed to exist for just two periods and that any debt incurred in the first period must be paid off with interest in the second (Hoover 1988: 140). In this model we can consider each period as corresponding to roughly thirty years. The policy intervention may then entail a tax cut during a person's youth coupled with a tax increase during his/her old age. Under this view, the relevant measure of uncertainty is that of a young person regarding his/her income during the second half of his/her life (Barsky et al 1986: 680).

The intertemporal choice problems for a representative individual are shown in Figure B. Here each individual is endowed with Y_1 units of a homogenous consumption good in their youth and Y_2

units in their old age. We thus assume that all consumers are identical, except for their age, and that the output is non-produced and non-storable (Wiel 1987: 379). In this model each individual is subject to taxes of T_1 and T_2 in each period, which are assumed to be non-distortionary (lump-sum). Capital markets are also assumed to be perfect and again relaxing the fourth assumption, income is saved at a fixed real rate of interest to allow for appropriate intertemporal portfolio adjustments (Yotsuzuka 1987: 411, Hoover 1988: 143).

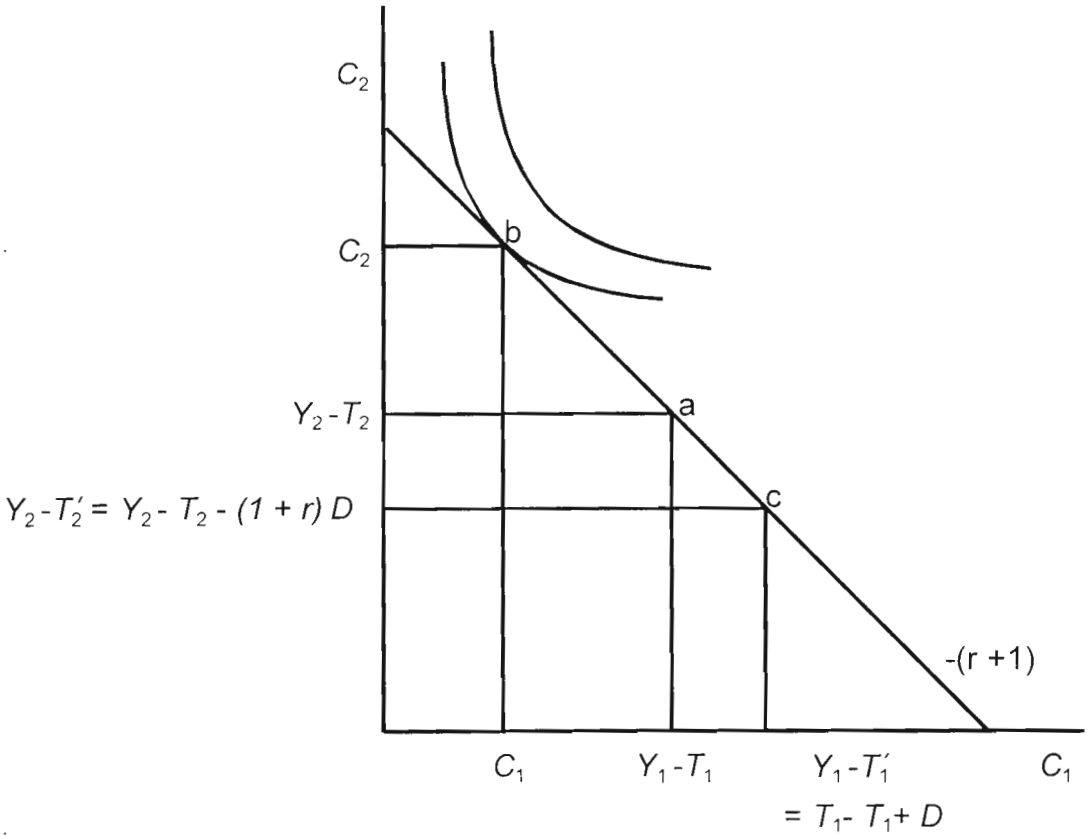
The initial disposable income is shown at point *a*. The individual can borrow or lend at a constant real rate of interest r, and so can consume at any point along the budget constraint *a*. The consumer's optimum point is at point *b* where he/she plans to consume C_1 in period 1 and C_2 in period 2. Here the consumer maximises his/her utility constraint where the indifference curve is tangent to the budget constraint at *b*. This point of consumption is represented (without the introduction of taxes) in future value by:

$$(1 + r)\, C_1 + C_2 = (1 + r)\, Y_1 + Y_2 \qquad (5)$$

and present value by:

$$C_1 + (C_2 / 1 + r) = Y_1 + (Y_2 / 1 + r). \qquad (6)$$

***Figure B**: Ricardian Equivalence and the Two-Period Model*



(Source: adapted from Hoover 1988: 140)

Now let us assume an economy with taxes and the government decides to cut them (the tax cut is financed by the sale of government bonds). We then consider a decrease D in taxes and equal increase in sale of bonds. Total government expenditure is therefore not affected (Hoover 1988: 141).

The individual's first-period disposable income:

$$Y_1 - T_1 \qquad (7)$$

is increased to:

$$Y_1 - T_1' = Y_1 - T_1 + D. \tag{8}$$

According to the Keynesians, the tax reduction is considered net wealth in period 1. However, if government purchases remain unchanged, taxes in period 2 must be raised so that the second-period disposable income falls from:

$$Y_2 - T_2 \tag{9}$$

to:

$$Y_2 - T_2' = Y_2 - T_2 - (1 + r)D. \tag{10}$$

The implication here is that the present value of income of the individual remains unchanged as prior to the issue of debt, and that the budget constraint (discussed previously) also remains unchanged. Since the ratio of the changes of disposable income is:

$$-(1 + r)D/D = -(1 + r), \tag{11}$$

the new point of disposable income in Figure B is c, which must lie on the same budget constraint as point a. The individual's optimum point of disposable income, however, remains at point b. In conclusion, tax and bond finance are equivalent as far as the economic agent's consumption

decisions are concerned. In other words, the discounted value of the increased taxes in period 2 just offsets the reduced taxes in period 1, as follows:

$$\Delta T_2 / (1 + r) = (T_2' - T_2) / (1 + r) = [(1 + r)D] / (1 + r) = D = -(T_1 - T_1') = -\Delta T_1, \quad (12)$$

leaving the individual's opportunity set unaffected.

3.4 Overlapping Generations

Barro's first model assumes that people live for an infinitely long time in order that no one might use *"a convenient death"* to avoid taxes (Hoover 1988: 141). However, the fact that economic agents (people) do not live forever appears to undermine Ricardian equivalence. In other words: *"A tax cut today augments the wealth of those alive today"* (Hoover 1988: 141). If bonds, which are issued to replace tax revenues, are not repaid until far into the future, then the current generation will be deceased and thus not have to be taxed to pay them off; thus their wealth will be higher.

The modern analysis of the Ricardian equivalence paradigm, however, imagines families as *"dynastic"* units, in the sense that each family is thought of as a single, infinite-lived agent that is linked through operative intergenerational transfers (Barro 1974: 1097; Bernheim 1989: 63; Drazen 1987: 506; Graham and Himarios 1996: 527). Intergenerational transfers in the process of wealth accumulation, has been a recent subject of substantial empirical and theoretical analysis (Kotlikoff 1988: 41). However, the notion of intergenerational transfers was initially brought to our attention through the works of David Ricardo, when referring to rational individuals: *"The*

great objective of their lives is to save a fortune, both because it is their duty to make provision for their families, and because they cannot spend an income with so much comfort to themselves..." (David Ricardo in Dobb and Sraffa 1966: 423).

An implication of this saving by individuals is that when death does occur, the rational individual is generally holding some wealth, which is then passed on to his/her heirs in the form of a bequest (Abel 1985: 777). Bequests, which are gifts from one generation to the next, are either accidental or are motivated by the parents' concern for their children's welfare (Drazen 1987: 507; Parkin 1990: 484). According to theory, the wealthier the family, the more the family tends to save and bequeath to later generations. By making a bequest, "*a family can spread good and bad luck across the generations*" (Parkin 1990: 484).

Following from the issue of bequests, Barro (1974), to demonstrate that taxes would not be escaped through death, recast the argument into an "*overlapping-generations model*", first introduced by Allais (1947) and Samuelson (1958) (Obstfeld and Rogoff 1996: 129). Here successive generations of rational consumers are linked through operative intergenerational transfers, so that consumption decisions can be modelled as being made by a consumer with 'infinite horizons' (Yotsuzuka 1987: 411). People can therefore be described as living for two periods, but overlapping one period with their children. In other words, 'young' economic agents (consumers) plan how much to consume in each period of their lives and then how much to leave their children as a bequest (endowment). Since it is assumed that they have rational expectations (perfect foresight in this context), these plans turn out to coincide with their (and their children's) actual choices (Hoover 1987: 142). The same result holds in models in which individuals live more

than two periods, as long as some of the future taxes implied by debt are borne by future generations (Seater 1993: 147).

In this setting, households capitalise the entire array of expected future taxes, and thereby plan effectively with an infinite horizon. In other words, the Ricardian result, which seemed dependent on infinite horizons (as in the model above), can remain valid with finite lifetimes (Barro 1989: 40). The critical assumption in Barro's second model, however, is therefore not the fact that a household's generations overlap, but it is rather that the utility of the children is of some concern to the parents. In this model we assume that each generation lives for only a single period, passing away just as the next generation is born. We also assume that each generation, nevertheless, cares for the welfare of its children or as described by Seater (1993: 147): "*...people regard children as extensions of themselves.*"

The economic agent's utility function can be described as:

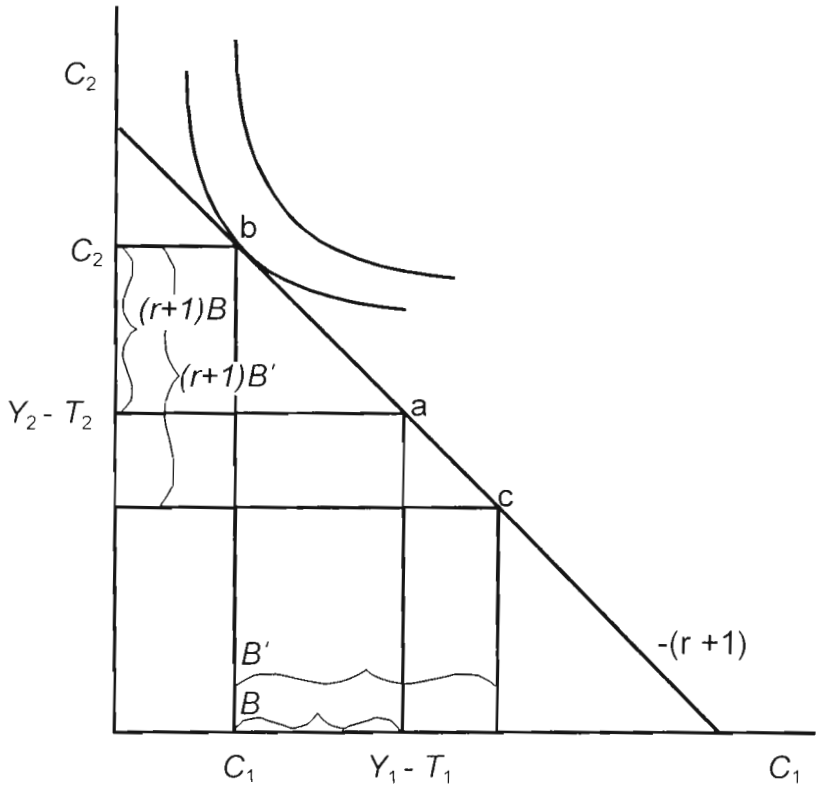
$$U = U(C_1, U^*), \qquad (13)$$

where C_1 is the consumer's own consumption and U^* is the level of utility, which naturally depends on the children's utility. This utility function thus implies that, although parents care directly only about their own children's utility and not that of any future generation, they must care indirectly about every future generation, for anything that affects the consumption of their grandchildren affects the utility of their children and therefore affects their own utility (Hoover 1988:142; Seater 1993: 147).

Barro (1974) thus argues that once we include bequests in this way we return to a zero net wealth effect. The argument is simply that if an individual's utility depends not only on his/her own consumption but also on either his/her children's consumption or utility (whose utility depends on his children's utility etc.), he/she will choose consumption and bequests to maximise utility over an infinite horizon. (Though it is important to note, of course, he/she cannot choose his/her children's consumption bundle directly.) Therefore, by including bequests based on a nested utility function, Barro (1974) converts *"infinitely long lives"* into a 'more realistic' finite horizon problem (Hoover 1988: 141). Drazen (1987: 506), however, argues that the intergenerational transfer mechanism must be *"operative"* in the sense that individuals plan to leave positive bequests to their children.

This chain-linked nature of the utility function means that without loss of generality we can refer to the case in which the children are taxed in order to pay off debt issued in place of taxes to the parents (Hoover 1988: 142). Figure B is reinterpreted in Figure C, so as to refer to two generations instead of one.

Figure C: *Ricardian Equivalence and Overlapping Generations*



(Source: adapted from Hoover 1988: 140)

The parents' initial after-tax income is:

$$Y_1 - T_1 \qquad (14)$$

The economic agents (i.e. the parents) then perfectly foresee (rationally expect), the children's initial after-tax income to be:

$$Y_2 - T_2 \qquad (15)$$

The budget constraint through point a represents the possible trade-offs between the parents' and the children's consumption, given the real rate of interest r. The indifference curves represent the parents' utility function and takes account of the children's and future generations' utility functions and budget constraints. Initially the parents choose to consume C_1 and to leave a bequest of B to their children, whom they correctly expect to consume C_2.

Just as in the case of the single generation with two-period lives (Figure B), substitution of debt for taxes increases the after-tax income of the parents but is exactly offset by increased taxes on the children, leaving the budget constraint and consumption plans unaltered. The parents therefore increase their bequest from B to B' to offset the increased taxes on the children. Therefore Ricardian equivalence holds in the 'more realistic' situation, where lives are finite and generations overlap. It should also be noted, as in Figure B, that if an individual changes his/her endowment from a to c, that does not change his/her optimal choice at b.

3.5 Conclusion

In this chapter Ricardian equivalence is modelled within intertemporal microeconomic theory. A substantial part of the argument presented in this chapter relates to intergenerational economic linkages and whether transfer motives give consumers effectively infinite horizons. Barro (1974) implied by his celebrated model that provided agents loved their descendants and actually left them positive bequests, and that finite horizons were no impediment to the operation of debt neutrality, a theorem such as Ricardian equivalence should be a reality. However if the real rate of time preference is positive, one reason may be that the public care much less about the future and the problems of their descendents than they do about the present and themselves.

CHAPTER FOUR:

CRITQUE OF RICARDIAN EQUIVALENCE

4.1 Introduction

It is clear from the discussion so far that Ricardian equivalence depends on a number of assumptions about individual behaviour and/or the economic environment (Bernheim 1989: 63; Darius 2001: 50; Gupta 1992: 19; Seater 1993: 143; Yotsuzuka 1987: 411).

Key Ricardian assumptions are commonly identified as:

1) Successive generations of rational consumers linked by altruistically motivated transfers, so that consumption decisions can be modelled as being made by a representative consumer with infinite horizons;
2) Capital markets are either perfect or fail in specific ways;
3) Taxes are non-distortionary (lump-sum) and there is full certainty about their future path; and
4) Equal planning horizons of the private and public sector.

The literature of recent years has thus shown that complete Ricardian equivalence would be expected to prevail only under special conditions/assumptions (Feldstein and Elmendorf 1990: 589). Virtually all well-articulated arguments against the Ricardian doctrine are based on theoretical and empirical criticisms of the assumptions, as violations of one or more of the assumptions could lead to deviations from the equivalency proposition (Gupta 1992: 19;

Yotsuzuka 1987: 411). Criticisms thus generally relate to problems associated with the relaxation of the various assumptions made in the Ricardian models.

4.2 Rational Expectations

Firstly, rational expectations are hard to justify in this particular context. The rational expectations hypothesis advocates that people do not make systematic mistakes, not because they have knowledge of the true model of the economy but because they adjust their behaviour to obvious errors until they act as if they knew the true model. It is, however, not likely that ordinary people implicitly develop an analysis that has only recently accurately been formulated by professional economists, and it is not plausible to suppose that they acquire this skill through a process of trial and error since the necessary experiments generally extend beyond their deaths.

The rule for bequests (or for that matter saving between youth and old age) that originates out of the analysis of Ricardian equivalence, is simple: save all the gains from tax cuts, and then never treat government bonds as net wealth (Hoover 1988: 144). Although this rule itself appears to be simple, adequate justification for it requires a degree of economic sophistication that tends to be beyond the commonplace. According to Hoover (1988: 144), it is too much to assume that most people perform a complicated economic analysis in order to adjust their bequests consistently, and thus it seems unlikely that they attempt to integrate future generations' utility with their own. Barro's argument may seem plausible because generally parents care about the needs of their children and wish to leave them bequests. However, while this may be true, they probably do not compare their *children's* consumption or utility with their own; they rather compare the actual size of the bequest to their *own* consumption.

Poterba and Summers (1987: 144) support these arguments and suggest that consumers are myopic (short-sighted) and may thus fail to project their income, fail to systematically incorporate future (possibly unlegislated) tax liabilities that can be inferred from the government budget constraint, or even fail to allocate resources taking full account of consumption needs. It can be argued in this respect that consumers may rather employ 'rules of thumb', which in turn lead them to consume a higher fraction of their disposable income than the models suggest.

4.3 Liquidity Constraints

Many consumers may also face liquidity constraints that prevent them from adjusting consumption in response to disposable income (Poterba 1988: 417; Seater 1993: 151). The constraint generally motivating this argument is credit rationing arising from the household's inability to borrow against its future income (Seater 1993: 151). In this case liquidity-constrained individuals may spend part or all of a tax cut, since they wanted a higher level of current consumption but could not borrow this amount at a favourable interest rate because of imperfect loan markets (Mukhopadhyay 1994: 461). Related to liquidity constraints is the possibility of differential borrowing rates for households and the government (Seater 1993: 152).

4.4 Borrowing Constraints

Borrowing constraints may destroy debt neutrality when the majority of households benefit from gains in utility if present taxes are reduced and future taxes are raised (Darius 2001: 52). Economic agents who face borrowing constraints are unable to borrow against uncertain future income, and *"low productivity individuals"* cannot borrow against the future and thus have a marginal

propensity to consume of 1, with respect to a current period cut in taxes (Hubbard and Judd in Darius 2001: 52). Darius (2001: 52) argues that this problem arises because of the differential interest rates of the private and public sectors. The private sector is generally faced with a higher interest rate than the public sector, partially reflecting default potential, administration and transaction costs. Consumers facing higher interest rates view government bonds as net wealth and thus discount future tax liabilities at a higher rate than the market; hence the present value of future taxes falls short of the tax reductions.

4.5 Distortionary Taxes

Another key assumption underlying the derivation of Ricardian equivalence is that taxes are lump-sum and nondistortionary (Leiderman and Blejer 1988:13). However, in most practical situations taxes tend to be distortionary. These taxes may apply to personal income, consumption, corporate income, foreign borrowing, and so forth. Changes in the timing of these distortionary taxes can affect private sector and economy-wide allocations.

Budget deficits in this case change the timing of income taxes, and thereby affect people's incentives to work and produce in different periods (Barro 1989:46). Budget deficits that are associated with changes in the timing of taxation could for instance produce real reactions in the economy via induced wealth, redistribution and intertemporal substitution effects. Changes in labour income taxes and corporate income taxes, for example, will affect labour supply, production, and consumption incentives through substitution, wealth, and distribution effects. In addition to aggregate real effects of distortionary taxes, changes in the type of taxation are likely to have distribution effects that reflect differential incidence across individuals in the economy. These

distribution effects contribute to possible deviations from equivalence that arise in the presence of distortions (Leiderman and Blejer 1988:14).

4.6 Uncertainty about Future Taxes and Income

In deriving the Ricardian-equivalence proposition, it is assumed that a current decrease in taxes indicates a future rise in taxation (Leiderman and Blejer 1988:14). The nature, amount and timing of these future increases in taxes are assumed to be known with certainty by consumers. Uncertainty about future taxes alters the saving behaviour of individuals, as consumers cannot adequately predict the timing, nature and amount of future taxation, as assumed under Ricardian equivalence (Darius 2001: 52; Mukhopadhyay 1994: 460). Some economists argue that this uncertainty about individuals' future taxes – or the complexity in estimating them – implies a high rate of discount in capitalising these future liabilities (Barro 1989:45).

If the reason individuals happen to be uncertain about what their future income is through the indirect effect of changes in their tax rate, they will also be uncertain of the amount of bequest they will want to make (Feldstein 1982:17; Seater 1993:152). Uncertainty about the timing and path of future taxation thus translates to a level of uncertainty regarding the path of future disposable income. Confronted with an uncertain income stream, the rational consumer will increase present savings in an attempt to smooth consumption over his/her lifetime. It is likely that rational consumers may overestimate the average tax burden (especially in countries with a high direct-indirect tax ratio) (Dalamagas 1994: 1204).

Contrary to the standard hypothesis, declines in present taxation will increase the level of domestic savings, interest rates will decrease and investment will increase. Incidentally, the opposite scenario would occur when consumers are reasonably certain about future taxes and uncertain about future income, which tends to be more likely in countries with a high debt/income ratio where consumers are better informed of the fiscal constraints under which the economy functions (Dalamagas 1994: 1204; Darius 2001: 52). It can therefore be determined from such an analysis that deviations from the neutral Ricardian equivalence position depend on the predictability of income relative to taxes.

4.7 Fiscal and Debt Illusion

Darius (2001: 52) argues that in such a situation, although economic agents may intend leaving a bequest, because of their inability to obligate the future labour income of their descendants, consumers will use tax cuts to increase their ability to consume at the expense of future generations. In this respect it was Ricardo himself who noted that taxpayers might suffer from what we now refer to as *"fiscal illusion"*. Rather than taxation and debt issuance being equivalent in their effects, Ricardo found them to be distinctly different (O'Driscoll 1977: 208). Ricardo believed that in this case the existence of the debt issue would deceive the wealth holder-taxpayer into believing that he/she was richer than he/she was. It appears that in many cases consumers may also have little knowledge of the government's indebtedness and suffer from what is commonly referred to as *"debt illusion"* (Allers et al 1998: 568).

4.8 Information Costs

Using survey evidence, Allers et al (1998: 568) indicates that the saving behaviour of individuals may not be influenced by fiscal policy. Dalamagas (1994: 1203) argues that consumers do not exactly perceive important fiscal variables due to the imminent costs involved in obtaining accurate information on each individual's fiscal burden, and thus may be less Ricardian, as they do not know their true tax burden. Three kinds of information costs are usually mentioned:

1. Costs dependent on the degree of visibility of the taxes. (The less visible a tax system, the less aware are people of their tax burden).
2. Costs dependent on the timing of the tax levy. (When taxes are paid at large intervals and in excessive amounts, the individual's perception of the actual tax burden is increased, and vice versa).
3. Costs dependent on the degree of complexity of the tax structure. (The more complicated the tax system, the more difficult it is for an individual to develop an accurate picture of his/her tax burden).

4.9 Finite Horizons and Related Issues

The idea of finite horizons, motivated by the finiteness of life is central to life-cycle models mentioned previously. In these models individuals capitalise on taxes that they expect to face before they die. If one considers a deficit financed tax cut, and assumes that the higher future taxes occur partly during the typical person's expected lifetime and partly thereafter, then the present value of the first portion must fall short of the initial tax cut, since the full balance results only with

the inclusion of the second portion (Barro 1989:40). The net wealth of persons currently alive rises and households react by increasing consumption demand. Therefore desired private saving does not increase to offset fully the decline in government saving.

The argument above fails if the typical person is already giving to his/her children out of altruism. In this case people react to the government's imposed intergenerational transfers, which are implied by budget deficits or social security, with a compensating increase in voluntary transfers. The main idea is that a network of intergenerational transfers makes the typical person a part of an extended family that goes on indefinitely.

A criticism of this however is with regard to the uncertainty surrounding the lifetime of the average consumer, as one can die at any age. Even if the planning horizons of households are effectively infinite, the theory collapses if the probability of each dynasty surviving into the next period is not equal to unity. With no bequest motive, uncertainty could result in net wealth effects. It is argued by Seater (1993: 148) that with such a degree of uncertainty there is a strong probability that consumers die before all taxes implied by current debt are collected, passing on to their children their assets with no altruism intended. Weil (1985) and Balanchard (1985) in Darius (2001), in turn, show that in the absence of operational bequests, an uncertain lifespan together with a positive birth rate would eliminate debt neutrality.

Yellen (1989: 20), in contrast, refers to the fact that the impact of interpersonal linkages may be incomparably stronger than what Barro (1974) asserts. The argument is that all individuals are in a single interconnected network and are ultimately biologically linked, not only to their own children and parents but also to virtually all other persons who have ever lived or will live, through

intermarriage across the generations. When an individual forgoes consumption in order to make a bequest to a child, he/she in essence increases the aggregate wealth of all individuals other than him/herself. This bequest will then in equilibrium be divided equally between all individuals and, if the economy is large, there will be a negligible effect on a child's consumption (Bernheim 1989: 65). Bernheim (1989: 65) shows that no government transfer or tax program should thus have any real effect on people and that prices should therefore play no role whatsoever in resource allocation over generations.

4.10 Childless Families

Another objection to Ricardian equivalence however is that some persons, such as those without children, are not connected to future generations. Even if families with children behave altruistically there are families with no children (Seater 1993:151). Persons in this situation tend to be made wealthier when the government substitutes a budget deficit for taxes (Barro 1989:41). Having little or no concern for taxes levied on future generations, they will tend to alter their economic decisions when the government swaps debt for taxes. As a result Ricardian equivalence will not hold.

4.11 Different Planning Horizons for Private and Public Sectors

For economic agents to behave in a manner that is consistent with the Ricardian hypothesis, the planning horizons and the discount factor of the private and public sector should be similar (Darius 2001: 52). A departure from this condition may arise due to an individual's uncertainty about his/her lifetime. The main result from analysing this departure is that, in the presence of such

uncertainty, and assuming no bequest motive, a tax cut will lead to a rise in perceived wealth and consumption of currently alive individuals (Leiderman and Blejer 1988:17). That is, the tax cut enables a shifting of future tax liabilities to later generations.

4.12 An Alternative Perspective

One could deduce that Barro (1974) may have set up the Ricardian equivalence problem incorrectly. The whole motivation behind Ricardian equivalence is based on the belief that parents are concerned about their children's utility. However, an alternative situation may exist where parents may be liquidity-constrained, and may thus prefer to consume the extra income left after a reduction in taxes. This situation where the bequest motive by parents toward their children is non-operational is described below in relation to Figure D. It must firstly be noted that the vertical axis in Figure D measures the parents' bequest and not the children's second period consumption and income as in Figures B and C. If the parents have an after-tax income of:

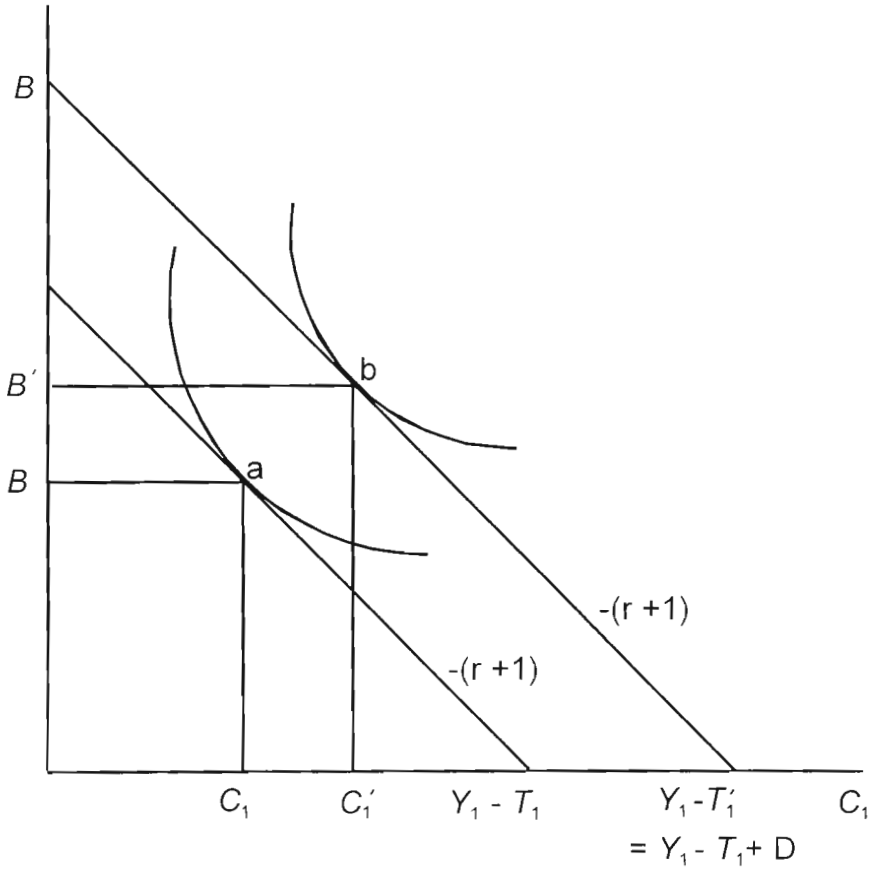
$$Y_1 - T_1, \tag{16}$$

they may either consume it all or trade off consumption for bequests at a rate determined by the real rate of interest. The consumer thus chooses point a, with a bequest B and consumption C_1.

Now we consider a substitution of debt for taxes that increases the consumer's after tax income to:

$$Y_1 - T_1' \tag{17}$$

***Figure D**: Ricardian Equivalence fails when Parents' Bequest Motives are absolute*



(Source: adapted from Hoover 1988: 145)

Since they do not account for their children's income or consumption choices, in this case, the budget constraint is shifted out to the right. The new equilibrium is at *b*. As shown, both current consumption for parents and the level of bequests rise. Now, since the opportunity set has changed, the parents' real choices will change, and any changes in the level of bequests will only accidentally offset the implied future taxes; thus Ricardian equivalence in this case fails.

4.13 Conclusion

When analysing the behavioural characteristics of Ricardian equivalence it becomes clear that Ricardian equivalence is governed by a number of strict assumptions. It was an identification of the assumptions that led to a final discussion on the strong criticism centred round Ricardian equivalence. These criticisms suggest that the evaluation of Ricardian equivalence may ultimately be an empirical matter. This question is investigated in the next chapter.

CHAPTER FIVE

EMPIRICAL ANALYSIS - AN ECONOMETRIC APPROACH

5.1 Introduction

"It is typically the case in economics that theory is needed to unearth the interesting questions, while empirical research is needed to answer them" (Blinder 1976: 87).

It can therefore be argued that the ultimate test of the theory is not necessarily in the plausibility of its assumptions, but whether or not it leads to predictions that are confirmed by the data (Chan 1983: 371; Rosen 1992: 454). From a review of the literature it can be seen that under certain assumptions the effect of a given rate of government expenditure on aggregate demand is independent of whether these expenditures are financed by taxes or by debt issue. Hence the proposition of 'equivalence'. Given the serious policy implications of this proposition, a large body of empirical work on modelling and testing of Ricardian equivalence has accumulated over recent years (Dalamagas 1992: 59).

The aim of this chapter is to consider empirical research that concerns the testing for Ricardian equivalence over the past three decades and to test for Ricardian equivalence using South African data to determine whether consumer evidence from South Africa, a country with a high degree of indebtedness, supports the Ricardian equivalence proposition as inferred by Dalamagas (1994).

5.2 Econometrics

The branch of economics that deals with the quantitative analysis of people's behaviour using economic data is econometrics (Atkinson 1982: 15; Begg et al 1987: 34). Since Ricardian equivalence, as already discussed, concerns the behavioural decisions of economic agents (individual consumers), the empirical analysis of Ricardian equivalence, in this study, will utilise an econometric approach.

Literally interpreted, econometrics means *"economic measurement"* (Gujarati 1988: 1; 1999: 1). Econometric analysis is utilised because for most economic decisions or choice problems it is not enough to know that certain economic variables are interrelated, or even the direction of the relationship (Griffiths et al 2001: 3). In addition it is important to understand magnitudes involved. That is, it must be possible to say how much a change in one variable affects another.

5.3 The Standard Econometric Model

Economic models are a simplification of reality that offer predictions of future economic activity (Dernburg and McDougall 1980: 15; Miller 1982: 351). More specifically, an econometric model is a set of functions and identities, which have been fitted to historical data. Each function or equation represents the quantitative relationship(s) between the relevant economic variables, expressed in mathematical terms (Botha et al 1995: 27). Therefore one can describe an econometric model as a quantitative version of a particular economic model.

5.4 Previous Empirical Work

Empirical literature over the last decade has devoted considerable attention to the effects of fiscal policy on private consumption or saving (Lopez et al 2000). The Ricardian equivalence proposition has generated a large number of empirical studies most on the United States, some on industrial countries, and a related cottage industry that surveys them (Lopez et al 2000: 4). Among the latter surveys, Bernheim (1987), Leiderman and Blejer (1998), and Elmendorf and Mankiw (1998) indicated that the empirical evidence rejects Ricardian equivalence.

Leiderman and Blejer (1998) considered the impact of government policies on the current level of consumption under a variety of fiscal signals and reviewed some of the evidence on the type of signals that could have been observed in practice. It was argued that although the Ricardian equivalence proposition is valid there are likely to be deviations from it in practice. These deviations are not necessarily as a result of irrationality or lack of full discounting of future tax liabilities by the public. Agents may be fully rational; yet owing to the presence of borrowing constraints and distortionary taxes, which represent deviations from Ricardian assumptions, their optimal behaviour will result in non-equivalence of taxes and debt insofar as aggregate demand is concerned. Leiderman and Blejer (1998) concluded that the fact that deviations exist from Ricardian equivalence, implies that deficit finance policies can have an impact on private consumption and aggregate demand that would be nonexistent otherwise.

However a small but prominent minority of economists, including Robert Barro, have argued that Ricardian equivalence does in fact describe the world, at least as a first approximation (Elmendorf and Mankiw 1998: 43), which is a view reflected in Seater's (1993) survey. Seater (1993) argues

that theoretically we can be almost certain that Ricardian equivalence is not literally true, as it requires a considerable number of stringent conditions. Seater (1993) however argues further that equivalence does appear to be a good approximation and that although some of the early empirical literature sent conflicting signals, recent work tends to support Ricardian equivalence. Most of this empirical work has concentrated on the United States and very little on the developing countries, which is surprising given the fact that these countries have also been experiencing considerable budget deficits (Gupta 1992: 19).

Empirical studies of the Ricardian equivalence hypothesis have taken many forms, however most are from either one of two types. The first type is based on general reduced-form equations for private consumption or saving. The second group of studies are based on the empirical implementation of private consumption functions derived from first principles (and therefore including a limited set of regressors) that are used to test for specific departures from Ricardian equivalence. A measure of government debt or the deficit is often included as a regressor in these studies (Wheeler 1999). The empirical studies developed in this thesis are based on the latter of the two groups. Estimations used in Ricardian studies (as in the studies in this thesis) are typically based on time-series macroeconomic data for one or several industrial and developing countries (Lopez 2000).

The Ricardian studies undertaken in this thesis are based on a linear consumption function. Of previous consumption function studies Kochin (1974), Tanner (1979), Kormendi (1983), Seater and Mariano (1985) and Aschauer (1985) find empirical support for Ricardian equivalence, while Yawitz and Meyer (1976) and Feldstein (1982) do not. Kochin (1974) tested the hypothesis that consumers anticipate the future taxes implied by present deficits and that consumption

expenditures, given disposable income, vary in such a way as to offset the effect of government deficits. Since Keynes placed the consumption function at the centre of his theory of national income determination, there has been considerable effort expended upon finding empirical counterparts to the theoretical concepts *"income"* and *"consumption."* The goals of these efforts have been to test the Keynesian theory, which predicts that a dependable relationship will be found between consumption and income, and to use this relationship to predict changes. The equation used to estimate the following function was:

$$C = a + bY, \tag{18}$$

where C is consumption and Y is income.

In order to estimate the parameters of this equation, empirical counterparts were selected for consumption and income. Initial studies identified *"income"* with what was later termed *"measured income,"* which referred to the actual income accruing to all individuals. Consumption was identified with consumption expenditures, described as the total expenditures of individuals except for purchases of financial assets, business property, and residential real estate. Kochin (1974) indicated that debt is financed by a rise in the future rate of excise taxation on bank balances and that the burden of this tax may fall on the owners of specialised resources used by banks as well as on the owners of bank balances. The savings to income ratio for 1961-71 revealed that the movements of the deficit are highly correlated with movements in the saving ratio suggesting consumers may discount implicit tax liabilities involved in deficit finance. However if debt is funded by households then this is an identity; causality has nothing to do with it.

In order to answer the question of whether deficits reduce the level of consumption, Kochin (1974) estimated the effect of including the federal government deficit in several consumption functions using American data. The deficits consistently had the theoretically predicted effect of lowering the level of consumption. The basic theoretical formulation used, the permanent income hypothesis, suggested that consumption is a constant proportion of permanent income. Kochin (1974) concluded that consumers seem, on the basis of the evidence, to have taken some account of the future taxes implied by the deficit spending. People in the United States appeared to spend less and save more, all other things being equal, whenever the Federal Government was in deficit. The Government tends to run deficits when things are 'bad' and spirits are low.

In order to determine if consumers view government debt as net wealth, Yawitz and Meyer estimate the following equation using aggregate data from the United States for the period 1953 – 69 (Tanner 1979):

$$C_t = a_0 + \alpha_1 YD_t + \alpha_2 W_{t-1} + \alpha_3 GDEB_{t-1} + u_t \qquad (19)$$

Where C is real consumption expenditures, YD is real disposable income, W is household real net worth exclusive of the private sector's holdings of government debt, $GDEB$ is the real market value of the private sector's holdings of government debt, and u_t is a random error term. The argument is that, under the assumption that future expected income is identical with the current level, the above equation is an appropriate version of the life-cycle model for testing the proposition about government debt being net wealth. In the life-cycle approach, consumers' expenditures depend on the *total* amount of resources available over their lifetime. Later versions of this approach account for these resources by not only incorporating current disposable income

and the stock of wealth at the beginning of the period but also by adjusting disposable income by the current unemployment rate to more closely approximate future disposable income by taking into account other forms of accrued income such as corporate savings and by including the stock of durables.

Tanner's (1979) time series evidence from tests using United States data for the 1947-74 period indicated that government debt is not perceived by consumers as being net wealth and that rather, the aggregate United States data supports the view that consumers take account of all the future tax liabilities implicit in the government deficits and in the stock of accumulated government debt. Therefore Tanner's estimates using a respecified life-cycle consumption function find that government debt is not net wealth.

Seater and Mariano (1985) test a version of the permanent income consumption function suggested by Barro (1983). Barro postulated the following consumption function:

$$C = C\,(\,Q^{P}_{+}\,,\,G^{P}_{-}\,,\,G_{-}\,,\,r_{-}\,,\,\ldots),\qquad (20)$$

Where C is real consumption, Q^{P} is permanent real gross income, G^{P} is permanent real government expenditure on goods and services, r is the after-tax real rate of interest, and the sign to the right of a variable is the sign of consumption function's derivative with respect to that variable. According to the permanent income hypothesis, consumption depends on permanent disposable income. Seater and Mariano (1985) expanded the specification of the permanent income consumption function proposed by Barro (1983). The consumption function fitted the data for the period 1929 – 1975 well and suggested that several variables previously ignored in the literature have important

effects on consumption expenditure. Barro's specification yielded results that were very consistent with complete tax discounting and Seater and Mariano (1985) indicated more traditional specifications that also yielded results consistent with tax discounting.

Aschauer (1985) advanced in his paper that probable misspecification bias in previous Ricardian studies renders the results suspect and may account for the fact that minor changes in empirical models lead to radically different conclusions regarding the effectiveness of fiscal policy. The theory in Aschauer's paper applies to a representative individual who has time-separable preferences over private consumption and the goods and services flowing from the government sector. The representative individual is assumed to be *"forward looking"* in regard to the fiscal affairs of the government. In a study of intertemporal consumption behaviour Aschauer (1985) indicated that in order to obtain an adequate measure of consumption, one needed to add to the current consumer expenditure a flow of services from previously acquired consumer durables, and to subtract the current expenditures on durable goods. When consumption is described in this manner consumer consumption is defined. The empirical analysis thus involved per capita consumer expenditure on nondurables and services measured in constant (1972) dollars and quarterly data was used throughout the study. The empirical results of the study suggested that the view of the effects of fiscal policy action on the economy is definitely credible.

Yawitz and Meyer (1976) indicate that their approach differs from Tanner and Kochin's that supports Ricardian equivalence (discussed above), in that they obtain an estimate of tax discounting by employing a properly specified aggregate consumption function and generate a time series for the market value of the debt which takes proper account of capital gains and losses from interest rate changes. The model originally developed posits the individual to maximise

his/her intertemporal consumption function subject to the resources at his/her disposal. These resources are the sum of current income, discounted future income, and current (other) net worth. The basic formulation of the life-cycle hypothesis, under the assumption that future expected income is identical with the current level, is given by:

$$C = C(Y, A), \tag{21}$$

where C denotes consumption expenditure and Y and A are the appropriate income and wealth variables, respectively. Both C_y and C_a are hypothesised to be positive and less than one. Since the attempt was to measure tax discounting within an aggregate consumption function, the specific structural equation estimated contained three independent variables: income, wealth minus the market value of the debt, and the market value series:

$$C_t = \alpha_1 Y_t + \alpha_2 A'hh_{t-1} + \alpha_3 Bg_{t-1}. \tag{22}$$

C = total consumption expenditures

Y = disposable income

Bg = market value of private sector holdings of government securities

$A'hh$ = household net worth minus Bg.

The paper thus developed a methodology which allowed for the measurement of the contribution of the debt to perceived private sector wealth. No evidence was found of even a partial discounting of the future tax liability accompanying debt creation.

Feldstein (1982) argues in his paper that changes in government spending, transfers and taxes could have considerable effects on aggregate demand. He indicates that the change in expectations and spending that results from any given fiscal action will differ from one time to another in a way that depends on the whole history of previous fiscal actions and on the recent and past legislative debates. He further argues that it is impossible to predict with accuracy how consumers' spending will respond to fiscal change in a particular year. This uncertainty and variability in response is therefore found to have important implications for macroeconomic policy and for the econometric testing of the traditional debt view. Feldstein (1982) suggests that the variable response of consumption to fiscal signals implies that econometric analysis cannot estimate 'the' consumption function, but rather the average effects on consumer spending of changes in government spending, in taxes and in transfers. The effectiveness of fiscal policy is seen in this paper as depending crucially on the way in which the consumer links a current fiscal change to his future tax liabilities and how these anticipated liabilities affect his/her current behaviour. The evidence presented in Feldstein's paper indicates that changes in government spending or taxes can have substantial effects on aggregate demand.

A number of studies test for Ricardian equivalence using single-equation reduced-form models. The majority of these studies seem to test Ricardian equivalence by estimating reduced-form equations where the interest rate is the dependent variable, and the deficit or a measure of government debt is included among the list of regressors. Exceptions to these studies however are, for example, Eisner and Pieper (1984) who reject Ricardian equivalence on the basis of regressions of real Gross National Product (GNP), or the unemployment rate, or on various measures of the deficit. Eisner and Pieper (1984) note that official measures of federal debt in the United States are misleading for reasons such as gross public debt figures ignoring financial asset accumulation as

well as the real assets which contribute to a growing net worth. Budget flows have also failed to distinguish between current and capital accounts, and measures of surplus and deficit have been inconsistent with changes in the real value of net debt.

De Leeuw and Holloway (1985) argue that a recurring criticism of potential GNP has been that it is an exceptionally difficult concept to define and measure and that an alternative would be to base a reference trend on movements of actual GNP after filtering out cyclical fluctuations. The reason for the choice of a trend based on movements of actual GNP is that it leads to a more effective measure of cyclically adjusted debt. De Leeuw and Holloway (1985) regressed nominal GNP on a vector of explanatory variables, including the changes in government debt and the level of government debt, and conclude that their data does not support Ricardian equivalence (Wheeler 1999).

The remaining single-equation studies use an interest rate as the dependent variable and generally these studies support the Ricardian equivalence hypothesis (Wheeler 1999). Makin (1983) is an exception to this and unlike other studies, he uses a transfer function model. The study that focussed on short-term interest rates where behaviour in the United States has been particularly unusual rejected Ricardian equivalence. McMillin (1986) however finds empirical support for Ricardian equivalence based on Granger-causality tests using the short-term interest rate.

Evans (1985) finds that there is no link between the deficit and short- and long-term rates. Several researchers have attempted to find an association between nominal interest rates and the United States deficit using post-war data. Although a few have found a weak positive, statistically significant association, many others have found none. Therefore in this case the economic

paradigm that implies that large deficits produce high interest rates is not supported by the facts. In over a century of United States history, large deficits have never been associated with high interest rates and even the post-war periods separately offer no support for a positive association between deficits and interest rates. The explanation most consistent with these observations is Barro's who argues that it may be optimal for households to react to an increased deficit by increasing their saving by an equal amount. An increase in the deficit will therefore entail an equal increase in saving, which will be sufficient to pay extra future taxes levied on current households and the future generations. Evans (1995) argues further that concern should not focus on what deficits do to interest rates, capital accumulation, or economic growth, for there is little evidence that indicates that deficits affect these variables. Evans (1987) therefore supports Ricardian equivalence as he finds that both the actual and the anticipated deficit have no impact on both short- and long-term interest rates.

Hoelscher's (1983) results support Ricardian equivalence using a short-term interest rate, but rejects Ricardian equivalence using a long-term interest rate. The regression tests in this paper employ quarterly United States data for the period 1952 to 1976. The regression results indicate that there is no significant correlation between Federal borrowings, whether measured in absolute terms or as a percentage of GNP, and high short-term interest rates. A Chow test that was performed indicates that results of the regression model were stable. Government borrowing was tested for correlation with an interest rate series, and no correlation was discovered. The empirical results supported Ricardian equivalence to the extent that private expenditures are sensitive only to short interest rates and Federal borrowing does not have financial crowding effects.

Hoelscher's (1986) work shows a positive relationship between a long-term interest rate, the 10-year Treasury rate, and several different measures of deficit spending. These results contradict those found with a short-term interest rate, the three month Treasury rate, in Hoelscher's 1983 results discussed above. The paper examines Hoelscher's two divergent results between deficits and interest rates. The answer to finding the source of the difference in deficit effects on the short term versus long-term rates is determined by the equivalence theorem of Barro. Barro's model states that anticipated deficits would not increase interest rates, given any particular level of government spending. This holds for long and short-term rates. Hoelscher's results thus support the equivalence theorem and it is argued that the Ricardian equivalence theorem should be tested by examining the effects of the anticipated deficit on long-and-short term interest rates.

Swamy et al. (1990) estimated several versions of the relationship between interest rates and deficits with fixed slopes, using different estimation techniques. A random walk model is a relatively good forecasting model for the (3-month) Treasury bill rate. Swamy et al. (1990) concludes that both the magnitude and sign of the coefficient on federal deficits divided by nominal GNP in the 3-month Treasury bill equations might change from one period to the next. From this result the conventional paradigm cannot be rejected because in the presence of measurement errors the positive signs for the coefficient on true deficits are consistent with the negative sign for the coefficient on measured deficits in the 3-month Treasury bill equations. A negative relationship between the deficit and measure of the short-term interest rate is thus found. Authors such as Barro (1974), Fackler and McMillin (1989), Kormendi (1983), and Evans (1987) interpret this result as a rejection of Ricardian equivalence. However, other authors have interpreted a negative relationship between various economic aggregates and deficit or debt measures as support for Ricardian equivalence.

A few previous studies considered testing for Ricardian equivalence using Vector Autoregression (VAR) models. These models involve a truly simultaneous system in that all variables are regarded as endogenous. In VAR modelling the value of the variable is expressed as a linear function of the past or lagged values of the variable, and all other variables included in the model (Gujarati 1995). If each equation contains the same number of lagged variables in the system, it can be estimated by ordinary least squares (OLS) without resorting to any systems method, such as two-staged least squares (2SLS) or seemingly unrelated regressions (SURE).

The VAR studies generally support Ricardian equivalence. Plosser (1982), Fackler and McMillin (1989), and Darrat (1989, 1990) in their papers, all confirm the Ricardian equivalence hypothesis using post-war data. Plosser's (1982) paper concerns an empirical investigation between government financing decisions and asset returns. In particular, the focus is on whether a substitution of debt financing for tax financing of a given level of expenditures is associated with an increase in interest rates. The initial model is developed using the assumption of capital market efficiency or rational expectations. The assumption of market efficiency refers to when capital markets respond to movements in various economic variables. The paper brings a different perspective to empirical investigations of government fiscal policies by examining the response of asset prices in an efficient capital market to such policies rather than focusing on aggregate consumption behaviour. The empirical analyses in this paper provide little evidence that government bonds represent net wealth to the private sector. The results are rather consistent with the idea that asset prices are unrelated to how the government finances its expenditures.

The objective of Fackler and McMillin's (1989) study is to analyse empirically the effects of federal government debt on the macro economy for the period 1963-1984. An important distinction between this and most of the earlier analyses is that the effects of the debt on key variables (output, prices and a long-term interest rate) are analysed within the context of a small empirical macro model. A second distinction is the separation of the market values of privately held federal debt into two components: domestically held debt and foreign held debt. This distinction is important both conceptually and economically. The results are determined by using vector autoregressions (VARs) and in light of the evidence that the results of some types of analyses are sensitive to the particular type of VAR that is estimated, the robustness of the results was checked by employing different variants of the VAR methodology.

The effects of debt were evaluated by computing impulse response functions, variance decompositions, and historical decompositions. The results indicated that the sum of domestically held and foreign-held debt had non-trivial effects on the long-term interest rate and output and the effects on prices were much weaker. Fackler and McMillin (1989) suggest that their results are Ricardian as, due to uncertainty about the individual's share of future taxes and timing of these taxes, individuals may save more than the present value of the income streams associated with bonds issued to finance a government deficit. Wealth is thus reduced, implying the expected negative effects on interest rates, output, and prices.

Darrat's (1989) paper on "*Fiscal Deficits and Long-Term Interest Rates*" focused on the causal relationship between budget deficits and long-term interest rates in the United States in the context of annual data covering the period 1946 through to 1986. As in Hoelscher (1986), long-term (rather than short-term) interest rates are the focus of the paper because of the importance of long-

term interest rates in transmitting the real effects of budget deficits. The paper re-examines empirically the conventional proposition that budget deficits cause changes in interest rates. Initial studies in the area have typically tested this proposition in the context of correlation-based analysis; however, such analysis is incapable of discriminating between four alternative but equally plausible hypotheses, each with different policy implications. These are that deficits cause interest rates (the conventional view), that interest rates cause deficits, that there is bidirectional causality between the two variables, and finally that both variables (although possibly correlated) are causally independent.

The paper employs a multivariate Granger-causality approach to test the validity of the above hypotheses. The Granger-causality test assumes that the information relevant to the prediction of the respective variables used is contained solely in the time series data on these variables and forms the seeds of the VAR model (Gujarati 1988, 1995). The empirical results reject the conventional proposition that budget deficits have caused significant changes in long-term interest rates. Instead support was found for the reverse (reaction-function type) hypothesis that long-term interest rates have caused significant changes in the deficit measures. The results of this paper are thus in support of the Ricardian position and thus cast further doubts on the presence of significant crowding-out effects for budget deficits. The paper *"Structural Federal Deficits and Interest Rates"* of Darrat (1990) found evidence that structural deficits are not co-integrated with the corporate bond rate, implying the lack of any long-run equilibrium relationship between the two variables. If valid, these results cast further doubt on the presence of significant crowding-out effects for budget deficits.

The brief explanation of empirical studies above, indicates the irregular empirical support for Ricardian equivalence. Wheeler (1999) argues that if one compares the consumption function studies it is noted that seemingly trivial changes in specification can dramatically alter the empirical results. Based on the other empirical work discussed in this sections one can argue a stronger line than that of Wheeler. It seems to be the case, based on the many studies we review here, that support for Ricardian equivalence is mixed and sensitive to the data, type of test and other specifications. This provides one with a testable 'viewpoint' namely: How sensitive is a test for Ricardian equivalence (using South African data) to changes in the data, test and other specifications? Thus this thesis conducts empirical work but uses more than one test and time period, not only to replicate the work of others, but also to determine how sensitive the South African results are to changing specifications.

Research conducted a decade ago, that considered South African data, was developed in Damalaga's 1994 paper entitled "*The tax versus debt controversy in a multivariate cointegrated system*". In his paper Dalamagas (1994) considers a sample of countries that he classifies according to their degree of indebtedness, measured by the ratio of government debt to GDP (debt/income ratio) of which South Africa was one. Dalamagas (1994) questions the extent to which relative empirical estimates do not adequately distinguish among countries with varying levels of indebtedness. The paper approaches the problem by using Johanson's cointegration technique and by sorting the sample countries into groups, according to the ratio of debt to GDP.

Dalamagas' (1994: 1198) results indicate that the Ricardian equivalence position relates to countries with a high debt/income ratio, for example the South African national deficit as a

percentage of GDP was 7.5% in 1997/1998 (South African Reserve Bank 2002: 53)[1*]. According to the results, the alternative or traditional view appears to be more prevalent in countries with a low level of indebtedness. The significantly negative coefficient on the deficit using South African data indicates the failure of the traditional views but is insufficient to validate the alternative equivalence proposition indicating rather near Ricardian results for South Africa. This thesis considers the research by Dalamagas (1994) as a platform for testing for the existence of Ricardian equivalence in the South African situation using different empirical techniques. Initially, the basic framework of the empirical analysis utilised is briefly discussed below.

5.5 The Framework of Analysis

The most popular method utilised in determining the relevance of Ricardian equivalence has been to regress private consumption on government budget along with other theoretically determined variables (Darius 2001:53). Consumption functions such as the one used in this study of Ricardian equivalence are commonly depicted as linear functions. Most economic problems involve two or more explanatory variables that influence the dependent variable *Y*. For example, in the consumption function used to identify the existence of Ricardian or the more traditional consumer behaviour, household consumption relates to variables such as household income, government expenditure and the government's budget deficit. When we turn an economic model with more than one explanatory variable into its corresponding econometric model, we refer to it as a multiple regression model (Griffiths et al 2001: 145).

[1] * But 1.15 % in 2003

We may express a multiple regression model as:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + u_t \qquad (23)$$

where Y_t is the dependent variable, X_2 and X_3 are the explanatory variables (or regressors), u the stochastic disturbance or error term, and t is the tth observation. In equation (18) β_1 is the intercept term that gives the mean or average effect on Y of all the variables excluded from the model, although its mechanical interpretation is the average value of Y when X_2 and X_3 are set equal to zero (Gujarati 1995: 192). The β_2 and β_3 are called the partial regression coefficients. The meaning of partial regression coefficient is as follows: β_2 measures the change in the mean value of Y per unit change in X_2, holding X_3 constant.

The disturbance, or error term, is a random (stochastic) variable that captures any approximation error that arises, because the linear functional form we have assumed may be only an approximation to reality (Griffiths et al 2001: 145).

As far as regression analysis is concerned, the method that is used most extensively, and that is used in this study, is the method of ordinary least squares (OLS). This analysis is based on the least squares principle, which asserts that to fit a line to the data values we should fit the line so that the sum of the squares of the vertical distances from each point to the line is as small as possible (Griffiths et al 2001: 51).

5.6 Empirical Testing for Ricardian Equivalence

Empirical analysis in this thesis attempts to consider the assumptions concerning Ricardian equivalence and its relevance to South Africa through empirical evidence. The single equation, multiple regression models used in this study utilise time series data, which implies data collected over discrete intervals of time. The models are based on the model used by Basil Dalamagas in his paper *"The Tax versus Debt Controversy in a Multivariate Cointegrating System"* (1994). The results of the Dalamagas study are based on quarterly data (83 observations) starting in 1971 and ending in 1992. It was decided to test both quarterly and annual data sets. The data used in the research is national statistical macroeconomic data of South Africa, obtained from *Supplement to the South African Reserve Bank Quarterly Bulletin June 1999* (See Appendix).

5.6.1 The Dalamagas Model

Dalamagas (1994: 1205) set up a model to establish whether the choice between financing government expenditure from taxes or from government bonds affected consumption that related to the ratio of public debt to GDP (discussed above). Dalamagas (1994) was thus intent on determining the relationship between private consumption expenditure and deficit financing through the sale of government bonds, as opposed to taxation in sample countries with low and high levels of indebtedness.

Empirical studies of the Ricardian equivalence hypothesis take many forms. Several economists tested for Ricardian equivalence using consumption functions, such as Dalamgas (1994), in which a measure of government debt or the deficit has been included as a regressor (Wheeler 1999: 274).

Dalamagas (1994) indicated that the ability of deficit financing to affect economic activity could be assessed by estimating a consumption function in which the household income, government spending and the government deficit are included as fiscal explanatory variables. The simple equation is shown below:

$$C_t = a_0 + a_1 Y_t + a_2 G_t + a_3 D_t + u_t \qquad (24)$$

where Y_t represents the before-tax gross domestic product, G_t the total government spending and D_t the budget deficit (the subscript t refers to time period).

Dalamagas estimates this equation in two separate stages. In the first stage, expected values $E_{t-1} Y_t$, $E_{t-1} G_t$ and $E_{t-1} D_t$ are generated by running an ordinary least squares (OLS) regression of Y_t, G_t and D_t on itself lagged by one or more periods and on the price level, the monetary base and the government bond yield with various lags. In the second stage, the values of $E_{t-1} Y_t$, $E_{t-1} G_t$ and $E_{t-1} D$ generated are then used to estimate equation (19). Therefore, the final form of the consumption function to be estimated is the following:

$$C_t = a_0 + a_1 E_{t-1} Y_t + a_2 E_{t-1} G_t + a_3 E_{t-1} D_t + u_t \qquad (25)$$

The parameters that are attached to equation (20) are an important addition as the estimates can be used to determine the impact of fiscal policy on private sector behaviour and, thus, test the validity of the Ricardian theorem.

According to Dalamagas (1994: 1199), *government expenditure* should have a negative effect on consumption under Ricardian equivalence, i.e. $-1 \leq a_2 < 0$, (given that the government output, which is composed of a number of consumption-type goods, is assumed to be fully valued by the private sector). From theory, it is expected that this situation would arise, as an increase in government expenditure means the government is spending on goods that essentially household consumers would have to pay for. Consumers are relatively wealthier and should therefore be able to consume more. However, according to Ricardian equivalence theory, believing that an increase in government spending now will mean higher taxes in the future, the household consumer prefers not to consume at the expense of 'his/her children' but rather to increase his/her savings so as to leave the same bequests (i.e. there is concern for the heir's welfare). It is expected that as a precaution risk-adverse rational consumers tend to save more and the present savings of the household consumer does not perfectly offset his/her future taxes. Thus according to Dalamagas (1994: 1199) government spending should have a negative effect on consumption under Ricardian equivalence.

The coefficient on *budget deficit* a_3 measures the extent to which the future tax liabilities, implied by deficits, are discounted by the private sector. It is thus expected that perfect discounting of future taxes means in essence that taxpayers will not consume at the expense of their heirs, but will rather increase their savings so as to leave the same bequests (as discussed in theory above). In this case, a_3 should be zero if the Ricardian hypothesis is to hold. In contrast to this, supporters of the traditional Keynesian view argue that a higher level of deficit, and thus lower taxes, induces individuals to increase their consumption level so that a_3 is greater than zero ($a_3 > 0$).

5.6.2 Empirical Analysis A

In the initial empirical analysis A, using South African data the study is made more current than the Dalamagas study by extending the data range to 1998. Expected values with different variables[2*] to those used in the original study were also chosen. It is important to note that one would have more confidence in the original Dalamagas (1994) results if it could be shown that they were not sensitive to the calculation of the expected values of income, government expenditure and the fiscal deficit.

The consumption function estimated in this study utilises data on household income, government spending and the government deficit (outstanding government debt) as explanatory variables, as in the Dalamagas (1994) model described above. The consumption function used in the empirical analysis, using South African macroeconomic data, is therefore:

$$C_t = a_0 + a_1 E_{t-1} Y_t + a_2 E_{t-1} G_t + a_3 E_{t-1} D_t + u_t \qquad (26)$$

Where: C is actual final household consumption, Y_t is adjusted disposable household income, G_t is current expenditure of general government and D_t is saving of general government (all at current prices). Government savings D_t is used as proxy for Dalamagas' deficit coefficient, as 'negative' saving implies a deficit.

[2*] With the quarterly data, we followed the original study and used the variables as suggested in Dalamagas (1994)

The variables above (see Appendix: Table 1 for full data sets) are all at current prices, which is not an appropriate measure of the economic variables over time, as the data also reflects price increases (inflation). Therefore the real value of the data is calculated using an implicit price deflator (Botha et al 1995: 36). In other words, all the above variables are converted using a price deflator to constant 1995 prices (See Appendix: Tables 2 and 3).

The final specified equation used in this econometric analysis utilised expected values or forecasts, which can be defined as theoretical values occurring in an idealised situation so that, in reality, slight variations from these expected values are normal (Bless and Kathuria 1993: 88). Estimated values $E_{t-1}\ Y_t$, $E_{t-1}\ G_t$ and $E_{t-1}\ D_t$ were generated by running an ordinary least squares (OLS) regression of (Y_t, G_t, D_t) on itself lagged by one period, and on other variables. It is important to note that unlike Dalamagas (1994) this model used many more variables to predict each expected value. Amongst others, foreign investment, exports and transfers were included (See Appendix: Tables 4.1 and 4.2). Once the equations were estimated, they were used to forecast values at Y_t, G_t and D_t and these become the expected values.

Econometric Data Analysis Technique

In this econometric study, the DOS-operated *SHAZAM 8.0 Version* computer package is used. Assumptions on the validity of the Ricardian theorem with regard to the a_2 and a_3 coefficients were tested in this analysis by using a Bayesian (Geweke) Inequality Constrained Estimation. A Monte Carlo simulation exercise is then run in order to calculate the proportion of restrictions satisfied and the final estimated regression values.

Monte Carlo Study

The econometric technique used in assessing the above econometric model is the Monte Carlo study, which is essentially a computer simulation or sampling experiment (Gujarati 1995: 84). A Monte Carlo study can be further described as a simulation exercise designed to highlight the small sample distribution properties of competing estimators for a specific estimating problem. These studies are called upon whenever, for that particular problem, there exist potentially attractive estimators whose small-sample properties cannot be derived theoretically. Estimators with unknown small-sample properties are regularly being proposed in economic literature, so Monte Carlo studies are common, now that computer technology has become more affordable.

The process behind a Monte Carlo study can be outlined in four phases:

1. Modelling the data-generating process

This phase involves the simulation of the process thought to be generating the real-world data for the problem at hand. This essentially involves building a model for the computer to mimic the data-generating process, including its stochastic components.

2. Creating sets of data

This phase involves the generation of several sets of artificial data. With a model of the data-generating process built into the computer, artificial data can be created. This artificially generated

set of sample data can be viewed as an example of real-world data that a researcher would use when faced with the kind of estimation problem this model represents. By creating data from a model, we know we can evaluate how alternative estimation procedures work under a variety of conditions (Griffiths et al 2001: 287).

3. Calculation of several estimates

The artificial data is employed to create several estimates. The process is repeated a number of times (e.g. 5 000 times) to obtain the same amount of estimators. For example, each of the 5 000 repeated samples is used as data for the a_i estimators, creating, say, 5 000 estimated a_i, (i = 1, 2... 5 000) of each a_i parameter. The 5 000 estimates can therefore be viewed as random 'drawings' from the sampling distribution of each a_i parameter.

4. The estimation of sampling distribution properties

The random drawings from the sampling distribution of the parameters (i.e. a_i) can be finally used as data to estimate the properties of the sampling distribution.

Bayesian (Geweke) Inequality Constrained Estimation

The validity of Ricardian assumptions was determined by testing for the traditional case regarding the coefficients a_2 and a_3 using inequality restrictions (explained later). The *Bayes* command used in *SHAZAM 8.0 Version* provides a procedure for estimation with an inequality restriction. The Bayesian Inequality Constrained Estimation method, introduced by John Geweke (1986), uses a

Monte Carlo numerical integration procedure that is implemented by generating replications from a multivariate *t* distribution (White 1997: 115).

The inequality constrained estimates and standard errors are reported as the mean and standard deviation of the values that satisfy the inequality restrictions. If one assumes that *R* is the number of replications and *s* is the number that satisfies the restrictions, the *"proportion"* (See Appendix No.2) is computed as $P = s / R$ and this gives the probability that the restrictions are true (White 1997: 115). The *"numerical standard error of proportion"* (a standard error for numerical accuracy) is computed as the square root of $P(1-P) / R$. The data set with the label *"numerical se"* is the standard deviation of the mean computed as the standard deviation divided by the square root of *s*.

Process and Results (See Appendix)

The initial step in the empirical testing for Ricardian equivalence using equation (26) is to model the data-generating process. The model-generating process involves the creation of three models. These models include adjusted disposable household income (b), adjusted government expenditure (c) and adjusted saving (or deficit) of general government (d). Individual models were generated by lagging each variable b, c and d on itself. This modeling process is programmed in *SHAZAM 8.0 Version* as:

```
genr lb=lag(b)
genr lc=lag(c)
genr ld=lag(d)
```

Predicted values for adjusted disposable household income (b), adjusted government expenditure (c) and adjusted saving (or deficit) of general government (d) are then regressed using ordinary least squares (OLS) on the variables used to forecast income Y_t (See Appendix: Tables 4.1 and 4.2.) This process is also programmed in *SHAZAM 8.0 Version* as:

```
?ols b lb e f g h / predict=ey
?ols c lc  i j k  / predict=eg
?ols d ld  l m n / predict=ed
```

where:

b - is regressed on itself lagged by one period and on variables e, f, g and h

c - is regressed on itself lagged by one period and on variables i, j and k

d - is regressed on itself lagged by one period and on variables l, m, and n

Two constraints/restrictions are then tested on the data obtained in the manner above. Here, Dalamagas' assumptions are tested on the validity of the Ricardian theorem, with regard to the coefficients a_2 and a_3. Instead of testing the validity of the interval $-1 \leq a_2 < 0$ for Ricardian equivalence, we rather test the simpler a_2 hypothesis $a_2 \geq 0$ that is expected to exist under traditional theory. Dalamagas (1994: 1199), when referring to the a_3 coefficient, indicated that a higher level of deficit induces individuals to increase their consumption, in the traditional case, where $a_3 > 0$. When testing for the traditional case in our model, however, government savings is

used as a proxy for Dalamagas' deficit coefficient, and our inequality ($a_3 < 0$) is therefore expressed as the opposite of Dalamagas' (1994), as 'negative' saving implies a deficit in this case.

Inequality restrictions are programmed in *SHAZAM 8.0 Version* as:

```
restrict eg.ge.0
restrict ed.lt.0
```

(See Appendix No.1 for the entire *SHAZAM 8.0 Version* command file.)

The results indicate that at 10 000 replications of a Monte Carlo simulation, only 4 percent of the restrictions are satisfied. (See Appendix: No. 2, for all results/output.) The results of the Monte Carlo simulation run on the Bayesian restrictions indicate that South African consumers may be Ricardian in their behaviour. Restriction inequalities in support of the traditional case are thus rejected. Of the 10 000 replications only 407 satisfy the traditional case's inequalities. We set up the test in such a way so as to compare the traditional model with the Ricardian one. The inequalities which we test and reject are those of the traditional model. We therefore find, in an indirect manner, some support for the Ricardian view on the basis of the test here.

Lawrence Boland's 1996 paper on realism in economic modeling suggests that there are concerns around the reliance on the so-called axiom of the excluded middle. This axiom says that to be admissible into a logical argument, a statement cannot be both true and false. That is, there is no third status such as a probability value. Boland (1996) argues that most econometricians directly contradict the axiom. Any argument or proof that involves an assumption that is considered neither absolutely true nor absolutely false cannot be used to provide an indirect proof. The so-called

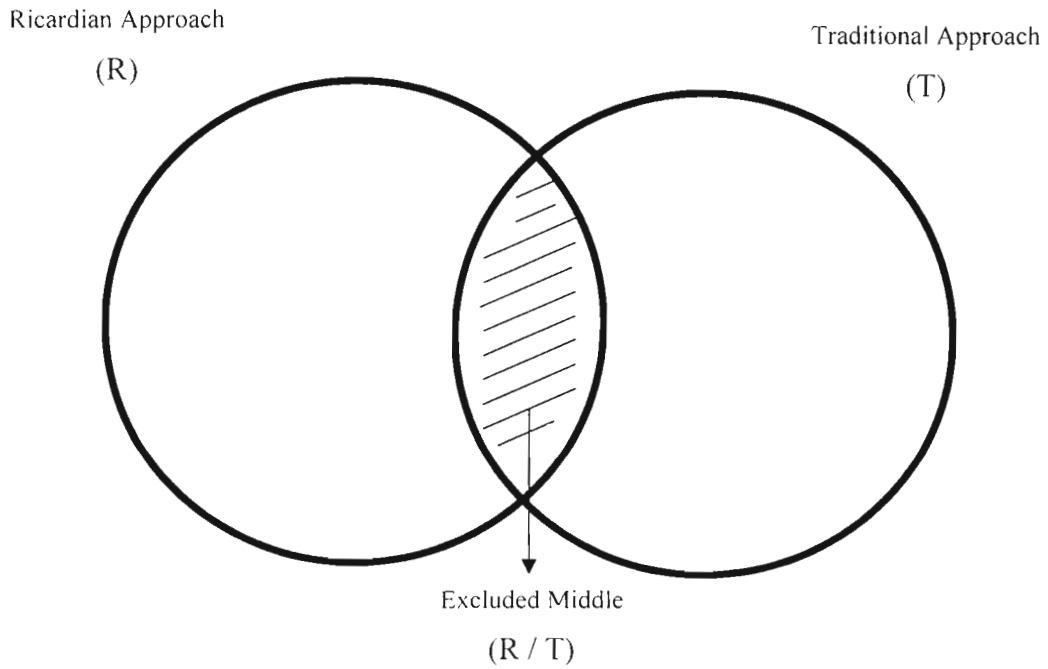
subjectivist approach to economics such as in Bayesian econometrics falls into this category. This is not to say that Bayesian economics needs to be rejected but rather Bayesian econometrics should not be used in a model that provides an indirect proof of some important economic proposition. Despite this objection we examine the two estimated coefficients.

In this Bayesian environment, we have two competing hypotheses. In this thesis consumers are either considered to be Ricardian in their behavior or they are considered to behave in a manner consistent with the traditional model. But given the Bayesian nature of the technique there is the possibility that there is no 'excluded middle' and it would not be possible to say that either competing hypothesis is true or it is possible to say either is true following the Boland critique. In Figure E below, the 'excluded middle' is shown as the shaded area. Therefore to say that the data in this thesis fails the tests for the traditional model does not imply acceptance of the Ricardian model due to the problem of the 'excluded middle'. This is one objection to the tests as we have constructed them in this section. Therefore we try to do additional testing in Section 5.6.3.

The coefficient on the budget deficit (a_3), which is a fraction less than zero, supports the restriction results by indicating that for a higher level of deficit (or in our case a lower level of government saving), there is no significant impact on consumption. The a_3 coefficient in our model indicated a slight decrease in consumption. The reason for this decrease may be that rational consumers may decrease consumption only slightly after a tax cut and save more as a precautionary measure, in anticipation of future taxes (i.e. taxpayers in this case over capitalise their future obligations that public debt issue embodies). The stated view is that $C \neq f(Y)$ supports Ricardian Equivalence.

Government spending should have a negative effect on private sector behaviour (i.e. private consumption, $-1 \leq a_2 < 0$), rather than a positive effect in the traditional case. From the regression results, the government spending coefficient is close to 1, which, in contrast to the restriction results, seems to support traditional theory, as the coefficient shows that for a 1 unit increase in government spending private consumption will increase by 1 unit *ceteris paribus*. The main reason why the Bayesian test does not support the traditional case is because of the coefficient on the budget deficit (a_3) is negative, which is the opposite of the traditional Keynesian view that argues that a higher level of deficit, and thus lower taxes, induces individuals to increase their consumption level so that a_3 is greater than zero ($a_3 > 0$). So it appears that the budget deficit effect outweighs the government expenditure effect.

Figure E: *The Ricardian and Traditional Approach versus the "Excluded Middle"*



An additive relationship can be developed: C = f (Y, G + D) if I is stable Y = C + G + I + D. When observing the OLS regression results, we notice that there is a high R^2 value of 0.9948. The R^2 in

the case of this model measures the proportion or percentage of the total value of household consumption explained by the regression model (Gurajati 1999: 172). An R^2 of 1 means a 'perfect fit' for the entire variation of dependent variable explained by the regression. Therefore at 0.9948 the model that is specified in this case has a 'good fit'. To analyse the relationship between the household consumption variable and the independent variables of the regression, individual t tests were conducted. When dividing the coefficients by the numerical standard error term, attained after running the Monte Carlo simulation and Bayesian Inequality Constrained Estimation, we obtain calculated t values. As the calculated t values are greater than the critical t values, in each case the null hypothesis is rejected (with 95% confidence). This means, for this data, a higher deficit is associated with lower consumption, and thus supportive of the Ricardian case.

Regression models involving time series data, however, sometimes produce results that are 'spurious', or of dubious value, in a sense that superficially the results may look good (i.e. extremely high R^2 and significant t ratios), but on further investigation they may look suspect (e.g. with respect to a low Durbin Watson d value) (Gujarati 1999: 455). To understand why the regression results of this study may be spurious, it is necessary to briefly introduce the concept of stationary time series. Broadly speaking, 'a stochastic process' is said to be stationary if its mean and variance are constant over time and the value of the covariance (expected value of how two variables vary or move together) between two time periods, depends only on the distance or lag between the two time periods and not on the actual time at which covariance is computed. The 'stochastic or random process' refers to the economic model generating the time series variable Y_t (Griffiths et al 2001: 335). If a time series is not stationary in the sense just defined, it is called a nonstationary time series. 'Nonstationarity' can have severe econometric consequences resulting in

unreliable least squares estimators, test statistics and predictors, and thus the regression results may 'spuriously' indicate a significant relationship when there is none.

As a problem relating to time series data, the problem of possible 'spurious results' and stationarity is synonymous with the issue of autocorrelation. The term autocorrelation in the modeling of time series data may be defined as the correlation between members of a series of observations ordered in time (Gujarati 1988: 353). When we have time series data, where the observations follow a natural ordering through time, as in the case of this econometric study, there is always a possibility that successive errors will be correlated with each other (Griffiths 2001 : 258). To test for autocorrelation in our model the Durbin-Watson test, named after its inventors Durbin and Watson (1950), was utilised. This test, which remains one of the most important tests for testing for autocorrelation, was programmed into *SHAZAM 8.0 Version* as `Rstat`. (See Appendix: No. 1.) The Durbin-Watson *d* value at 2.349 (See Appendix: No.2) means that under the null hypothesis of no autocorrelation, there is no evidence of positive first-order serial correlation. No autocorrelation was implied, because given the sample size of 53 and the number of explanatory variables- (excluding the constant term), the Durbin-Watson *d* value falls outside the upper limit, at a 0.05 level of significance.

The high Durbin-Watson *d* value may therefore indicate that the 'stochastic process' is stationary and that there is zero autocorrelation so that the regression results are 'non-spurious'. This indicates that the regression model may thus hold true in its support of Ricardian equivalence.

Test Analysis Conclusion

The results of empirical analysis A that uses a Bayesian Inequality Constrained Estimation rejects the traditional proposition, indicating that there is a possibility that South African consumers (1946–1998) may not consume at the expense of their heirs, but rather may increase their savings, so as to leave bequests in a Ricardian or near Ricardian manner. This result is a replication of Dalamagas' (1994) results.

5.6.3 Empirical Analysis B

In the empirical analysis of the previous section, we found some support for Ricardian equivalence as increasing the deficit reduces consumption. This surprising result needs greater scrutiny. Thus we decide to 'replicate' the Dalamagas result showing support for Ricardian equivalence in South Africa.

Annual statistical macroeconomic data of South Africa (53 observations) from 1946 to 1998 are considered in the first empirical analysis (See Appendix). However, this second analysis, like Dalamagas' (1994) study, uses quarterly data, but unlike Dalamagas's study where the time series started in 1971 and ends in 1992, the replication is done for the period 1974 to 2002. To add an additional element of confirmation we also performed the second empirical study with a time series of annual data for the years 1946-1998.

Developing the Model: A Short Primer on Ricardian Equivalence

The following assumptions are made in this analysis:

1. The money stock is not changing and the price level is within a target range.
2. The government has in mind a level of real government expenditures to be made each year. Let us call these expenditures cg_t.
3. Initially the government has no debt. Calling debt dg, in effect we are saying dg_1 is equal to zero.

The government's budget constraint in real terms is:

$$cg_t + rdg_{t-1} = t + dg_t - dg_{t-1}. \quad (27)$$

which, allowing for no debt in the previous period, is:

$$cg_t = t + dg_t. \quad (28)$$

So if cg_t is fixed then increasing dg_t will mean that t or real taxes can fall by an equal amount. This means for every increase in dg_t disposable income rises. One option for the government is to reduce dg back to zero in each and every subsequent period from now on but still having to pay back dg_t with interest in the subsequent year. So the overall real macroeconomic impact after discounting is:

$-dg + \{dg(1+r)\}/(1+r)$ or $-t + \{dg(1+r)\}/(1+r)$ (29)

which is zero. In other words consumers know that the lower taxes today mean higher taxes in the future and they save just enough to pay these higher taxes with interest. It is the government bond that provides the vehicle for saving just the right amount. This is a tidy and simple statement of the Ricardian equivalence proposition.

If the bond is never repaid and government persists in maintaining the debt dg_i for all future time periods, consumers know they are indebted for the interest payments. So the overall real macroeconomic impact is:

$-dt + dg(r)\{1/(1+r) + 1/(1+r)^2 + 1/(1+r)^3 ...\}$ or (30)

$dg = dg(r)\{1/(1+r)\}\ \{1 + 1/(1+r)^1 + 1/(1+r)^2 ...\}$ (31)

and the last term in brackets above reduces to $1/r\{(1+r)/1\}$ giving only dg. Again giving the Ricardian result that there are no real effects ($-dt + dg$) from shifting to a deficit from taxes, as the impact is zero. What does not always receive emphasis is that under Ricardian equivalence changes in government spending do not alter the rate of interest so that investment is not 'crowded out' as is the case under the traditional view. Thus if policymakers are concerned about investment and growth, they should be supportive of the Ricardian view as then there are fewer impediments to these processes if this view is correct. A lack of Ricardian behaviour imposes a cost on the macro economy as the interest rate changes makes for confusion in investment decisions with an adverse effect on economic growth.

Replicating a Previous Result -The Dalamagas Model

It was felt necessary to replicate the Dalamagas (1994) results given the implication for fiscal policy. The original study specifies the consumption function as:

$$C_t = a_0 + a_1 E_{t-1} Y_t + a_2 E_{t-1} G_t + a_3 E_{t-1} D_t + u_t \quad (32)$$

$$C_t = \alpha + \beta Y_t^{et-1} + \gamma G_t^{et-1} + \delta D_t^{et-1} + \epsilon \quad (33)$$

where the independent variables are the expected values at time t-1 of income, government spending and the fiscal deficit. With Ricardian equivalence, the coefficient on $E_{t-1}G_t$ should fall into the range $-1 \leq a_2 < 0$ as individuals reduce consumption in the face of higher government consumption. If individuals discount future taxation changes then changes to $E_{t-1}D_t$ should be accompanied by offsetting changes in consumption. This implies under Ricardian equivalence that a_3 is expected to be less than zero.

We reproduce Dalamagas' results below.

Coefficients on:	a_1	0.59
	a_2	-0.36
	a_3	-0.28.

and the size and signs of the estimated coefficients conform to those expected under Ricardian equivalence.

In the Empirical Analysis B a number of decisions were undertaken in an attempt to replicate the above results:

1. As discussed above the data sets used are annual data taken from 1946, and quarterly data from 1974.
2. The study is made more current than the one undertaken by Dalamagas (1994) with the annual data taken to 1998, and quarterly data to 2002.
3. The expected values with different variables to those used by Dalamagas (1994) were calculated with respect to the annual data. With the quarterly data the original study was followed and the variables, as suggested in Dalamagas (1994), were used. One would have more confidence in the original results if it could be shown that they were not sensitive to the calculation of the expected values of income, government expenditure and fiscal deficit.

Before estimating the consumption function in Empirical Analysis B each of the four variables were examined for nonstationarity.

Variable	t-statistic for unit root (95%)
$E_{t-1}Y_t$	-3.6753 (-3.41)[3*]
$E_{t-1}G_t$	-1.1990 (-3.41)
$E_{t-1}D_t$	-1.7888 (-3.41)

[3*] Only $E_{t-1}Y_t$ is stationary

As not all variables are stationary, one cannot use the usual methods to estimate the consumption function as the usual t and DW (Durbin-Watson) statistics do not keep their usual features when the data is nonstationary as are two of the variables. Running a regression with such data can mislead one to thinking there is a relationship between these variables when in fact no such relationship exists. Thus we need to look for the number of cointegrating vectors (called r) in the data in Dalamagas. These results are shown below:

Null	Alternative	Statistic
r = 0	r = 1	50.9297
r <= 1	r = 2	4.9911

95% Critical Value	Decision
31.00	Reject r = 0
24.35	Accept r = 1

Thus there is evidence of cointegration and like Dalamagas we find that there is 'at most' one cointegrating relationship for South Africa. Recent studies have used the full information maximum likelihood (FIML) procedure developed in Johansen (1988) and Johansen and Juselius (1990) both to test for cointegration and to estimate long-run equilibrium relationships. The Johansen technique is used in Empirical Analysis B to find the single cointegrating relationship from which one can obtain the implied coefficients for a_1, a_2 and a_3. Our results are reported below:

Estimated	Coefficient
a_1	0.0052
a_2	0.976
a_3	-0.066.

Our results are not 'close' to Dalamagas as the two Ricardian coefficients (a_2 and a_3) are not consistent with the prior results as we regard the small negative estimate of a_3 to be hardly overwhelming support for the Ricardian view of the deficit.[4*] Of the three estimated coefficients only a_2 is statistically significant. Therefore as a_3 is not different from zero and with a_2 falling in the range suggested by the standard model rather than Ricardian equivalence, we have had difficulty reproducing the Dalamagas result. Government 'output' is to a large extent not fully valued by private agents, and lower taxes do change lifetime expenditures by those same agents but not to a degree that would make them Ricardian.

5.7 Conclusion

The initial econometric study (Empirical Analysis A) tends to partially support the findings of Dalamagas (1994) that countries with a high debt to income ratio, like South Africa (1946–1998) have consumers that are Ricardian in behaviour. However, the results of the econometric analysis using the Johansen technique (Empirical Analysis B), in contrast to the initial study, finds little support for the Ricardian equivalence proposition, indicating that South African consumers (1946-

[4*] Using our quarterly data we found two cointegrating vectors. One did not seem to be economically meaningful. However, another gave support to our conclusion which we present here, namely, that we find support for the traditional model. One possible reason for the change in the South African data is that the deficit as a percentage of output began to fall after 1992.

1998) may not fully value government expenditures but may save to the benefit of their heirs, when considering tax cuts.

As this Ricardian effect is not strong we are of the opinion that in this case the empirical analysis is more in support of the theoretical analysis of the traditional model including the adverse consequences of 'crowding out' private investment, and the resultant deleterious effect on growth. In section 5.4 we however argue that it is possible to test a 'view point' that tests for Ricardian Equivalence and is also sensitive to various specifications. We thus find that the strong support for Ricardian equivalence in the Dalamagas case changes to support for the traditional model when considering a longer time period in Empirical Analysis B.

Table 1: *Table showing Estimated Coefficients for the Empirical Tests considered in this Study*

	Method/Approach		
	Dalamagas	Bayesian Averages	Replication
	Year of Last Observation		
Estimated Coefficient	1994	1998 (Empirical Analysis A)	2002 (Empirical Analysis B)
a_1	0.59	-0.00957	0.0052
a_2	-0.36	1.0106	0.976
a_3	-0.28	-0.0384	-0.066

The two tests (Empirical Analysis A and B) can be considered to be in broad agreement. It is interesting that these two tests use different variables to calculate expected values but come up with similar results. It seems to be the case though, that by changing the time period by four years

changes the measured results, and in particular the biggest change is the coefficient a_2. Thus for the longer sample the consumers are no longer Ricardian in their behaviour.

From empirical analysis A we observed that Government spending in the Ricardian case should have a negative effect on private sector behaviour (i.e. private consumption, $-1 \leq a_2 < 0$), rather than a positive effect in the traditional case. From the regression results, the government spending coefficient is close to 1, which, in contrast to the restriction results, seems to support traditional theory. However this test supports the Ricardian case because the coefficient on the budget deficit, although close to zero, (a_3) is negative, which is in contrast to the traditional Keynesian view that supports a consumption level where a_3 is greater than zero. The results of Analysis A can be described as pointing towards near-Ricardian behaviour by individuals as the results were not as 'strongly' Ricardian as in the case of Dalamagas' test in his 1994 paper.

A further attempt was therefore made to determine whether the South African population tended toward Ricardian behaviour as shown in the Dalamagas (1994) article. It was thus decided that more data (i.e. the quarterly data) would be utlised in Empirical Analysis B as opposed to annual data that was thus used in the previous analysis. Empirical analysis B shows that the results are not 'close' to Dalamagas as the two Ricardian coefficients (a_2 and a_3) are not consistent with the prior results as we regard the small negative estimate of a_3 to be hardly overwhelming support for the Ricardian view of the deficit. Of the three estimated coefficients only a_2 is statistically significant. Therefore as a_3 is not different from zero and with a_2 falling in the range suggested by the standard model rather than Ricardian equivalence, we have had difficulty reproducing the Dalamagas result. Government 'output' is to a large extent not fully valued by private agents, and

lower taxes do change lifetime expenditures by those same agents but not to a degree that would make them Ricardian.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

The analysis of Ricardian equivalence initially identified the Ricardian equivalence proposition as being associated with the budget deficit, which is the main feature of fiscal policy debates, as governments use budgets to control their fiscal affairs. The literature shows that the traditional (Keynesian or Neo-classical) theory of budget deficits holds that an increase in government debt leads to an increase in private wealth so that personal savings do not increase, to offset public sector savings. The fiscal implications of this theory relate to aggregate consumption being higher and national savings lower if a government spending program is financed through the issuing of bonds rather than through current taxation.

However, traditional theory concerning budget deficits has recently been cast into doubt through the revival of Ricardian equivalence theory. The Ricardian modification of the traditional analysis begins with the proposition that if the path of government expenditures on goods, services and transfers is unchanged, then a deficit-financed tax cut or the issuing of bonds leads to an exactly offsetting increase in the present value of future taxes. It was determined from the literature that economic agents realise that rising public debt must be repaid at some point in the future and that in anticipation of future taxes they will save their additional income after tax cuts. It is under these circumstances that the assumption is made that taxation and the issuing of bonds are an equivalent means of financing government expenditure.

To further understand the above assumption, and the Ricardian theory behind the assumption, the behavioural characteristics of consumers were analysed. Ricardian equivalence was modelled

within the framework of a two-period model where both the individual and the economy are assumed to exist for just two periods and that any debt incurred in the first period must be paid off with interest in the second. The modern analysis of Ricardian equivalence, however, refers to each family as a single, infinite-lived agent that is linked with all others through operative intergenerational transfers. Thus to demonstrate that taxes would not be escaped through death, Ricardian equivalence was analysed with respect to the *overlapping-generations model*, where consumers can be described as living for two periods, but overlapping one period with their children.

The analysis of Ricardian equivalence theory has shown that complete Ricardian equivalence would be expected to prevail only under special conditions/assumptions. Virtually all arguments against the equivalency proposition are developed around the theoretical and empirical criticisms of the assumptions, as violations of one or more of the assumptions could lead to deviations from the Ricardian equivalence doctrine. When analysing Ricardian equivalence, however, it is argued that the ultimate test of Ricardian equivalence theory may not necessarily be in the plausibility of all its assumptions but rather in whether or not it leads to predictions confirmed by the data. Defenders of Ricardian equivalence argue that the theory is an approximation and they may claim that, although all the strict conditions required for complete Ricardian equivalence may not hold, the economy's behaviour in practice is close to the predictions of Ricardian equivalence.

The empirical analysis of Ricardian equivalence for South African consumers (1946–1998) is based on work done by Dalamagas (1994) concerning the tax versus debt controversy, the level of indebtedness of countries and Ricardian equivalence. Econometric analyses were conducted with consumption functions estimated, using predicted values. The analyses aimed to determine

whether budget deficits/government debt either affect (traditional view) or do not appreciably affect (Ricardian equivalence) private consumption.

The results of this initial econometric analysis (Empirical Analysis A) that uses a Bayesian Inequality Constrained Estimation rejects the traditional proposition, indicating that there is a possibility that South African consumers (1946–1998) may be Ricardian. On closer inspection of the results it is clear they are not a replication of Dalamagas's 1994 results. One can rather describe the test results as indicating near-Ricardian behaviour by individuals as the results were not as 'strongly' Ricardian as in Dalamagas' case.

Table 2: *Table showing Estimated Coefficients for the Empirical Tests Conducted*

Estimated Coefficient	1994 (Dalamagas)	1998 (Empirical Analysis A)	2002 (Empirical Analysis B)
a_1	0.59	-0.00957	0.0052
a_2	-0.36	1.0106	0.976
a_3	-0.28	-0.0384	-0.066

A further attempt was therefore made to determine whether the South African population tended toward Ricardian behaviour as shown in the Dalamagas (1994) article. It was decided that more data (i.e. the quarterly data) would need to be utlised in Empirical Analysis B as opposed to annual data that was used in the previous analysis. Empirical analysis B shows that the results are not 'close' to Dalamagas as the two Ricardian coefficients (a_2 and a_3) are not consistent with the prior results as we regard the small negative estimate of a_3 to be hardly overwhelming support for

the Ricardian view of the deficit. Thus Dalamagas' results are sensitive to the number of observations in the sample.

The results of Empirical Analysis B using the Johansen technique thus found little support for the Ricardian equivalence proposition, indicating that South African consumers (1946-1998) do not fully value government expenditures, but may save to the benefit of their heirs when considering tax cuts. As this latter effect is not strong we are of the opinion that the empirical analysis here supports the theoretical analysis of the traditional model including the adverse consequences of 'crowding out' private investment, and the resultant deleterious effect on growth.

Empirical research is essential in providing answers to the theoretical questions concerning Ricardian equivalence. However, although the ultimate test of the economic theory is whether or not it leads to predictions that are confirmed by the econometric results, the brief explanation of empirical research and analysis above, reveals irregular proof of Ricardian equivalence. According to the review of literature, complete Ricardian equivalence seems to however, be expected to prevail only under special conditions or assumptions.

.It has also been argued that if one compares consumption function studies it is noted that seemingly minor changes in specification (such as sample size) can dramatically alter the empirical results. This thesis, considering the relevance of Ricardian equivalence to the South African situation, also reveals irregular Ricardian results from the two empirical analyses conducted using the same South African data sets.

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APPENDIX

(Refers to Empirical Analysis A as an illustration of SHAZAM testing methods and data sets used)

1. ***SHAZAM 8.0 Version*** (Command File for Empirical Analysis A)

```
file 11 a:\data.txt
read(11) a b c d e f g h i j k l m n
sample 1 53
genr lb=lag(b)
genr lc=lag(c)
genr ld=lag(d)
?ols b lb e f g h / predict=ey
?ols c lc  i j k  / predict=eg
?ols d ld  l m n / predict=ed
ols c ey eg ed / Rstat
bayes / nsamp=5000
restrict eg.ge.0
restrict ed.lt.0
end
stop
```

2. *SHAZAM 8.0 Version* (Output File Empirical Analysis A)

```
OLS ESTIMATION
53 OBSERVATIONS     DEPENDENT VARIABLE = C
SAMPLE RANGE SET TO:       1,      53

R-SQUARE =    0.9948     R-SQUARE ADJUSTED =    0.9945
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.18310E+08
STANDARD ERROR OF THE ESTIMATE-SIGMA =    4279.0
SUM OF SQUARED ERRORS-SSE=  0.89719E+09
MEAN OF DEPENDENT VARIABLE =    78733.
LOG OF THE LIKELIHOOD FUNCTION = -516.283

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
NAME      COEFFICIENT   ERROR      49 DF  P-VALUE  CORR. COEFFICIENT  AT MEANS
EY       -0.40564E-01 0.2897E-01  -1.400    0.168 -0.196    -0.0749    -0.1221
EG        1.1027      0.6269E-01   17.59    0.000  0.929     1.0996     1.1027
ED        0.16395     0.9159E-01   1.790    0.080  0.248     0.0361    -0.0044
CONSTANT   1876.0       2629.      0.7136   0.479  0.101     0.0000     0.0238

DURBIN-WATSON = 2.3490    VON NEUMANN RATIO = 2.3942    RHO = -0.29456
RESIDUAL SUM =  0.56616E-09  RESIDUAL VARIANCE =  0.18310E+08
SUM OF ABSOLUTE ERRORS=  0.14704E+06
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9948
RUNS TEST:   28 RUNS,   24 POS,    0 ZERO,   29 NEG  NORMAL STATISTIC =  0.2060

BAYESIAN (GEWEKE) INEQUALITY CONSTRAINED ESTIMATION
NUMBER OF INEQUALITY RESTRICTIONS =    2
NUMBER OF COEFFICIENTS=  4
NUMBER OF REPLICATIONS=       5000
ANTITHETIC REPLICATIONS ALSO INCLUDED
DEGREES OF FREEDOM FOR T DISTRIBUTION =       49
ORIGINAL COEFFICIENT ESTIMATES
-0.40564E-01    1.1027       0.16395        1876.0
10000 REPLICATIONS       407 SATISFIED
PROPORTION= 0.04070 NUMERICAL STANDARD ERROR OF PROPORTION= 0.00198
ASYMPTOTIC STANDARD ERROR OF PROPORTION= 0.00198
VARIABLE  AVERAGE       STDEV       VARIANCE     NUMERICAL SE
EY       -0.95700E-02  0.26963E-01  0.72699E-03  0.13365E-02
EG        1.0106       0.50746E-01  0.25752E-02  0.25154E-02
ED       -0.38402E-01  0.33141E-01  0.10983E-02  0.16427E-02
CONSTANT   1375.6       2718.5      0.73900E+07   134.75
```

3. Macroeconomic Data

***Table 2**: Actual final household consumption, Adjusted disposable household income, Current expenditure and saving of general government – Data for South Africa at current prices in R millions*

Date	HouC(cp)	HouY(cp)	GovtE(cp)	GovtS(cp)
1946	1456	1423	296	50
1947	1601	1598	310	1
1948	1783	1781	309	46
1949	1876	1870	322	31
1950	1981	1980	367	30
1951	2223	2220	395	79
1952	2470	2467	463	54
1953	2671	2824	500	99
1954	2817	3012	518	138
1955	3018	3242	545	148
1956	3152	3391	588	143
1957	3347	3613	609	180
1958	3502	3698	648	148
1959	3624	3890	677	187
1960	3802	4056	707	203
1961	3941	4419	762	146
1962	4136	4742	886	56
1963	4472	5013	973	276
1964	4933	5325	1094	276
1965	5301	5737	1232	239
1966	5749	6335	1377	184
1967	6240	6899	1503	416
1968	6895	7707	1658	401
1969	7719	8352	1954	446
1970	8667	9255	2264	386
1971	9724	10932	2684	184
1972	10877	12262	2916	285
1973	12660	13497	3340	887
1974	14795	16063	4231	1115
1975	17075	18576	5460	638
1976	19265	20386	6684	149
1977	21231	23886	7628	106
1978	23599	25608	8586	359
1979	27241	30566	10526	125
1980	34065	38165	12841	1558
1981	42253	43671	15373	989
1982	49625	50984	20009	-890
1983	57978	59073	23459	-1196
1984	67040	70974	29334	-2841
1985	74025	82509	35463	-2945
1986	87607	92697	42266	-4307
1987	104483	111579	50146	-6714
1988	126010	134504	58086	-5179
1989	149337	159675	72284	-6173
1990	206087	211052	84167	-6776
1991	238226	243948	97332	-10162

1992	271299	284525	118644	-27249
1993	304297	316733	134223	-28593
1994	342625	351104	152031	-28330
1995	388460	394672	162555	-23128
1996	435987	443101	191447	-30300
1997	494325	501340	211258	-33230
1998	533857	540408	229489	-28837

Source: South Africa's National Accounts 1946 – 1998, Supplement to the South African Reserve Bank Quarterly Bulletin June 1999.

***Table 3**: Real gross national income (1995 prices), Gross national income (market prices) and the calculated Price deflator – Data for South Africa in R millions*

Date	Real GNY ('95)	GNY (mp)	Price deflator
1946	97382	1648	59.09102
1947	96950	1826	53.09419
1948	104699	2014	51.9856
1949	109133	2157	50.59481
1950	120427	2478	48.59847
1951	122511	2687	45.59397
1952	126464	2884	43.85021
1953	129291	3295	39.23854
1954	136010	3545	38.36671
1955	142992	3732	38.31511
1956	150781	4014	37.56378
1957	157072	4269	36.79363
1958	158724	4409	36
1959	169845	4669	36.37717
1960	171771	5006	34.31302
1961	170515	5253	32.4605
1962	180416	5646	31.95466
1963	189668	6293	30.13952
1964	205142	6912	29.67911
1965	212769	7537	28.22993
1966	224710	8223	27.32701
1967	244630	9201	26.58733
1968	259227	9930	26.10544
1969	271988	11180	24.32809
1970	279498	12268	22.78269
1971	298219	13612	21.90854
1972	315603	15348	20.56314
1973	356674	19016	18.75652
1974	392705	23339	16.82613
1975	384258	26074	14.73721
1976	380276	29405	12.93236
1977	384569	32602	11.79587
1978	399881	37539	10.65241
1979	423734	44956	9.425527
1980	468488	59991	7.809305
1981	472098	69340	6.808451
1982	454896	78869	5.767741
1983	446513	90392	4.93974
1984	476701	105929	4.500194
1985	473018	121612	3.889567
1986	476628	142385	3.347459
1987	493960	167954	2.941043
1988	514022	202041	2.544147
1989	519702	242366	2.144286
1990	511825	278287	1.839198
1991	509596	323121	1.577106
1992	497588	363826	1.367654
1993	504507	417433	1.208594
1994	522336	473520	1.103092

1995	537675	537673	1.000004
1996	558622	601593	0.928571
1997	572398	665417	0.860209
1998	575304	721133	0.797778

Source: South Africa's National Accounts 1946 – 1998, Supplement to the South African Reserve Bank Quarterly Bulletin June 1999.

Price deflator calculation:

$$\textit{Price deflator} = \frac{\textit{real gross national income (1995 prices)}}{\textit{gross national income (market prices)}}$$

***Table 4**: Adjusted final household consumption, Adjusted disposable household income, Adjusted expenditure of general government, Adjusted saving of general government – Data for South Africa at 1995 prices in R millions*

Date	HouC(adj)	HouY(adj)	GovtE(adj)	GovtS(adj)
1946	86036.52	84086.52	17490.94	2954.551
1947	85003.81	84844.52	16459.2	53.09419
1948	92690.33	92586.36	16063.55	2391.338
1949	94915.86	94612.29	16291.53	1568.439
1950	96273.56	96224.96	17835.64	1457.954
1951	101355.4	101218.6	18009.62	3601.924
1952	108310	108178.5	20302.65	2367.911
1953	104806.1	110809.6	19619.27	3884.616
1954	108079	115560.5	19873.96	5294.606
1955	115635	124217.6	20881.74	5670.637
1956	118401	127378.8	22087.5	5371.62
1957	123148.3	132935.4	22407.32	6622.853
1958	126072	133128	23328	5328
1959	131830.9	141507.2	24627.34	6802.531
1960	130458.1	139173.6	24259.31	6965.544
1961	127926.8	143442.9	24734.9	4739.233
1962	132164.5	151529	28311.83	1789.461
1963	134783.9	151089.4	29325.75	8318.508
1964	146407	158041.3	32468.95	8191.434
1965	149646.9	161955.1	34779.28	6746.954
1966	157103	173116.6	37629.29	5028.17
1967	165904.9	183426	39960.75	11060.33
1968	179997	201194.6	43282.82	10468.28
1969	187788.5	203188.2	47537.08	10850.33
1970	197457.5	210853.8	51580	8794.117
1971	213038.6	239504.1	58802.51	4031.171
1972	223665.2	252145.2	59962.1	5860.494
1973	237457.6	253156.8	62646.78	16637.03
1974	248942.6	270278.1	71191.35	18761.13
1975	251637.9	273758.4	80465.16	9402.34
1976	249141.9	263639.1	86439.88	1926.921
1977	250438.1	281756.2	89978.91	1250.362
1978	251386.3	272787	91461.63	3824.217
1979	256760.8	288100.7	99213.1	1178.191
1980	266024	298042.1	100279.3	12166.9
1981	287677.5	297331.9	104666.3	6733.558
1982	286224.2	294062.5	115406.7	-5133.29
1983	286396.3	291805.3	115881.4	-5907.93
1984	301693	319396.7	132008.7	-12785
1985	287925.2	320924.3	137935.7	-11454.8
1986	293260.9	310299.4	141483.7	-14417.5
1987	307289	328158.7	147481.6	-19746.2
1988	320588	342197.9	147779.3	-13176.1
1989	320221.2	342388.9	154997.6	-13236.7
1990	379034.9	388166.5	154799.8	-12462.4
1991	375707.6	384731.8	153502.9	-16026.5
1992	371043.1	389131.7	162263.9	-37267.2

1993	367771.5	382901.6	162221.1	-34557.3
1994	377946.8	387299.9	167704.1	-31250.6
1995	388461.4	394673.5	162555.6	-23128.1
1996	404845	411450.9	17772.2	-28135.7
1997	425223	431257.4	181726.1	-28584.8
1998	425899.3	431125.6	183081.3	-23005.5

Source: South Africa's National Accounts 1946 – 1998, Supplement to the South African Reserve Bank Quarterly Bulletin June 1999.

***Table 5.1**: Variables used in forecasting Y_t. Foreign investment, Exports of goods, Exports of services, Primary income from the rest of the world - Data for South Africa at current prices in R millions*

Date	F.Inves(cp)	Expgds(cp)	Expservs(cp)	PriY(cp)	Impgds(cp)
1946	185	277	157	6	438
1947	378	316	175	7	607
1948	343	332	245	9	716
1949	253	357	254	9	638
1950	58	359	463	11	621
1951	287	356	622	19	953
1952	191	398	591	23	850
1953	185	496	518	24	867
1954	137	534	578	28	900
1955	134	557	674	31	988
1956	60	596	757	34	1015
1957	60	625	851	35	1127
1958	179	643	728	38	1147
1959	-132	654	893	43	1016
1960	-34	1416	188	46	1141
1961	-196	1495	196	48	1031
1962	-308	1583	208	55	1057
1963	-149	1705	220	55	1305
1964	102	1786	247	73	1605
1965	366	1811	260	74	1830
1966	102	1932	288	79	1679
1967	266	2047	350	104	1977
1968	11	2250	402	108	1925
1969	342	2295	423	125	2188
1970	919	2262	485	129	2621
1971	1061	2486	568	150	2960
1972	143	3349	638	171	2891
1973	169	4196	757	264	3611
1974	979	5747	969	210	5806
1975	1766	6231	1249	231	6778
1976	1654	7237	1267	322	7475
1977	-209	8892	1447	237	6927
1978	-949	10970	1711	344	8105
1979	-2504	14483	1987	480	9852
1980	-2554	19715	2300	447	14288
1981	4176	18124	2564	477	18253
1982	3557	18782	3081	513	18042
1983	428	20030	2955	734	15894
1984	2517	24468	3547	1058	21481
1985	-5208	35204	4494	2215	23228
1986	-6328	40641	4867	2715	25826
1987	-6708	43430	5197	2759	28606
1988	-3383	51826	6064	2820	39408
1989	-3467	57524	8497	3045	44266
1990	-5322	60912	9802	1545	43408
1991	-6244	65734	8803	2414	47466
1992	-5551	69837	9562	2649	51976

1993	367771.5	382401.6	162221.1	-34557.3
1994	377946.8	387299.9	167704.1	-31250.6
1995	388461.4	394673.5	162555.6	-23128.1
1996	404845	411450.9	17772.2	-28135.7
1997	425223	431257.4	181726.1	-28584.8
1998	425899.3	431125.6	183081.3	-23005.5

Source: South Africa's National Accounts 1946 – 1998, Supplement to the South African Reserve Bank Quarterly Bulletin June 1999.

***Table 5.2**: Variables used in forecasting Y_t. Imports of services, Primary income to the rest of the world, Transfers (net receipts), Net capital inflow from the rest of the world, Change in gold and other foreign reserves – Data for South Africa at current prices in R millions*

Date	Mservs(cp)	PriY(cp)	Trans(cp)	NcapInf(cp)	G+F.Res(cp)
1946	78	93	-16	98	87
1947	103	94	-72	376	2
1948	119	108	14	171	172
1949	112	122	-1	116	137
1950	113	159	2	201	-143
1951	151	186	6	215	72
1952	164	200	11	176	15
1953	161	206	11	131	54
1954	162	226	11	225	-88
1955	179	246	17	92	42
1956	178	274	20	84	-24
1957	196	265	17	-3	63
1958	193	267	19	171	8
1959	173	285	16	-25	-107
1960	171	298	-6	-203	169
1961	167	330	-15	-112	-84
1962	181	307	7	-85	-223
1963	234	301	9	-87	-62
1964	260	358	15	-29	131
1965	306	396	21	247	119
1966	328	424	30	158	-56
1967	368	462	40	195	71
1968	399	518	71	545	-534
1969	456	599	51	277	65
1970	568	652	28	584	335
1971	669	674	16	791	270
1972	677	776	17	454	-311
1973	795	988	-28	58	111
1974	1032	1148	33	798	181
1975	1350	1480	81	1741	25
1976	1320	1765	31	1132	522
1977	5806	1896	-65	-558	349
1978	1826	2221	-37	-913	-36
1979	2117	2624	-4	-2488	-16
1980	2720	3186	113	-1968	-586
1981	3628	3791	70	3169	1007
1982	3911	4106	-202	4474	-917
1983	3700	4692	-226	1504	-1076
1984	4450	5713	-353	1628	889
1985	5318	8201	-388	-6444	1236
1986	6413	9725	-426	-7481	1153
1987	6581	9452	-576	-4823	-1885
1988	7619	10392	-523	-5063	1680
1989	9183	12355	-512	-2078	-1389
1990	10638	13074	-799	-4445	-877
1991	10552	11273	-1416	-3174	-3070
1992	12428	11050	-1043	-4179	-1372
1993	15405	10986	-2093	-6355	1487

1994	18072	12054	-2159	2137	-2475
1995	21666	14555	-2341	11270	-3278
1996	24681	18042	-3204	3017	5109
1997	27758	20808	-3329	29378	-18951
1998	30208	23936	-4078	12142	-512

Source: South Africa's National Accounts 1946 – 1998, Supplement to the South African Reserve Bank Quarterly Bulletin June 1999.