FINDING THE OPTIMUM TAX RATIO AND TAX MIX TO MAXIMISE GROWTH AND REVENUE FOR SOUTH AFRICA: A BALANCED BUDGET APPROACH

By

Yolandé van Heerden

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Abstract

The optimum level of government intervention in the economy has been researched extensively internationally, but not in South Africa. This research analyses the rates ($\frac{government\ revenue}{gross\ domestic\ product\ (gdp)} = \tau$) *and composition* ($\frac{income\ tax\ (dir)}{total\ tax\ (g)}$ *and* $\frac{expenditure\ tax\ (ind)}{total\ tax\ (g)}$) *of government intervention by means of revenue policies that would optimise economic growth and revenue, using time series data for the period 1960 to 2007. In the analysis a balanced budget is assumed with revenue equal to government expenditure. The results indicate that the actual average tax burden far exceeds its optimum level and that the authorities will have to adjust tax policy accordingly to improve on the level of economic growth. Also, there is a substantial difference between the* $\frac{revenue}{gdp}$ *ratio that maximises growth and the ratio that maximises revenue. However, the tax mix* ($\frac{income\ tax}{expenditure\ tax}$) *over the period under investigation seems to be close to optimal levels determined in this study. The results indicate that more will have to be done to harmonise optimum levels of revenue with growth targets. An international comparison shows that tax rates in South Africa are relatively high, given its growth levels.*

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1. INTRODUCTION

1.1. Background and problem statement

As in many other countries, the growth rates of taxes and government expenditure in South Africa tend to exceed economic growth and relatively high levels of taxation are a feature of this country. However, in a developing country such as South Africa, the merit of this phenomenon should be weighted against the growing needs on the expenditure side (Koch *et al.,* 2005).

In this study an attempt is made to determine the optimum average rate and composition of tax that would optimise economic growth and government revenue in South Africa, by using a balanced budget approach. A Cobb-Douglas type production function is used with two sectors, namely a government sector and a non-government sector. The government sector provides goods produced with capital and labour, thus government expenditure (g) and financed from tax revenue – i.e. $g = \tau(gdp)$, or a balanced budget. The amount spent by the non-government sector is determined by the rate of taxation and that period's national output $(1-\tau)gdp$. Both government and non-government goods contribute to output in time t. Casual analysis shows that, similar to the findings of other studies, a positive (when $\tau \leq$ optimum level) or negative (when $\tau >$ optimum level) relationship exists between the ratio of government expenditure/taxation to gross domestic product (hereinafter referred to as "GDP") (τ) and the economic growth rate (Black *et al.,* 2006).

Government expenditure comprises public goods such as education, social services, security and health and in a balanced budget context sufficient funding is required to provide these services to the public. Clearly, the secret is to find the optimum level of taxes to optimise economic growth without disturbing the morale of the general public (Rosen, 2005).

At this optimum tax level, economic growth is maximised, employment grows and tax evasion is minimised. However, a tax rate beyond this optimum level has a negative effect on economic growth, impacting negatively on the economic behaviour of the tax-paying public. For example, tax rates that are too high result in lower productivity and savings (Black *et al.,* 2006). Such a change in behaviour is often caused by a double tax effect since, firstly, tax payers have to pay their taxes; but, secondly, they also experience a decrease in their standard of living because of the lower growth rates (Scully, 1991).

Disposable income declines and, with that, consumption and investment, causing substitution of leisure for labour. This results in a loss not only in hours worked, but probably also in labour productivity (Feldstein, 2006). The decline in savings (especially household savings) in South Africa over the past decade is often mentioned as the result of tax rates that are too high.

To obtain an optimum average tax rate and composition that optimises economic growth and government revenue, government expenditure should also be optimised by improving its efficiency. For example, appointing more teachers would be a 'quantity' solution to improving education, but spending more on the current teachers' skills would probably contribute more to improving education – and the budget would be spent more effectively (Hood *et al.*, 2002).

1.2. Research objectives

The purpose of this research is to determine a growth maximising tax ratio and tax mix to maximise growth and revenue for South Africa. In the process three different aspects had to be addressed namely:

- The relationship between tax rates; revenue; and economic growth;
- The impact that the size of government expenditure has on economic growth; and
- Tax reform in developed and developing countries over the past number of years.

1.3. Research strategy

The research strategy followed the following pattern:

- A literature review regarding theories of optimum tax rates that maximise economic growth and government revenue;
- Acquiring time series data from the South African Reserve Bank (hereinafter referred to as "SARB");
- Estimating an econometric model that uses the time series data;
- Analysing the econometric model output;
- Calculating the tax ratios that maximise economic growth and government revenue;
- Making conclusions and recommendations on the optimum tax rate.

1.4. Importance and benefits of the study

Tax policy significantly influences economic growth. If the tax ratio is at an inadequate level, it hampers economic growth and deprives the public of their wealth. To maximise economic growth and to ensure the economic prosperity of society, it is essential for the country's tax policy makers to apply the optimum tax ratio.

2. LITERATURE REVIEW

2.1. Taxes and related concepts used in the analysis

The level of revenue collected and government expenditure in an economy seems to be strong determining factor of economic growth. Gwartney (1999) states that government can actually enhance growth by implementing efficient tax policies. Too high taxes and borrowings to finance government expenditures can have a negative effect on economic growth and welfare. Thereagainst, too low levels of government intervention result in reduced levels of rule of law and could destabilise economic growth. This view is supported by others, including Kerr (1997), who states that government interference in economic policies should be limited but sufficient, given its impact on individual behaviour and social needs and the impact of that on economic growth.

Hicks (1961) states that public expenditure – not revenue – should be prioritised as a governing factor in public finance policies. Wagner (Black, 2006) outlines a number of factors responsible for government expenditure growth including, for example, the expansion of administrative and protective functions, increases in welfare expenditure and lobbing by large corporations. The implication of this is that government expenditures grow faster than the output of the economy, thus causing a slowdown in the growth rate. When government expenditure is relatively low, an increase in the tax ratio increases the growth ratio, while in the case of a large government, the reverse is true. Government expenditure beyond the optimum level is risky because governments then ran the risk of spending less efficiently and wasting funds at the cost of the private sector.

Government expenditure is financed by taxes, seignorage, borrowings, fiscal reserves and the sale of assets. Government's key public policy challenge is to design a tax system that maximises growth with increased revenue while minimising the excess burden. These optimum levels (a tax ratio that maximises both growth *and* revenue) can be estimated econometrically.

Actual tax ratios beyond these optimum levels cause an excessive tax burden, which hinders economic growth and deprives the public of their wealth (Marsden, 2008).

Income tax is classified, firstly, as a tax on income and profits (personal income tax, company tax, secondary tax on companies, tax on retirement funds, etc.) and secondly, as a tax on property. The income tax burden is imposed directly on individuals and companies. Expenditure taxes consist of domestic taxes on goods and services (VAT, specific excise duties, levies on fuel, etc.). Expenditure taxes are taxes imposed on commodities or market transactions and the consumer indirectly bears the tax burden (Budget Review, 2005).

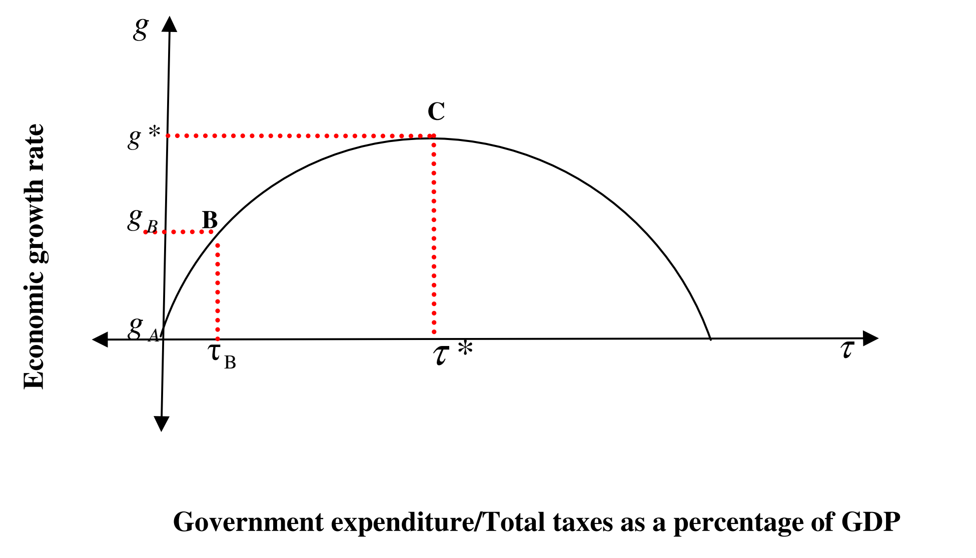
The tax mix is the ratio of income and expenditure taxes to GDP. The optimal combination of the income and expenditure tax mix seems to be a contentious issue. However, evidence from the literature indicates that expenditure taxes distort economic growth, investment and savings less and should therefore form a greater proportion of the tax mix ratio. The optimum mix of income and expenditure taxes is a fundamental policy choice (Dahlby, 2001). The actual mix of income and expenditure taxes varies widely between different countries. In industrialised countries, income taxes are the dominant source of income, whereas in developing countries expenditure taxes and taxes on international trade are dominant. Countries such as France and Ireland prefer more equal mixes of income and expenditure taxes. Each country's tax mix will depend on the economy's social requirements, infrastructure and workforce (Bahl, 2008).

2.2. Optimum level of taxes to maximise growth

In a paper by Chao *et al.* (1998), an investigation into the relationship between economic growth and the level of government expenditure in Canada is illustrated in Figure 1.

The GDP growth rate is shown on the vertical axis and government expenditure/total taxes as a percentage of GDP are on the horizontal axis. At a zero level of government expenditure (government is absent), the growth rate is g_A (no rule of law exists i.e. a state of chaos). At this zero rate of government expenditure, output is at a low level with little incentive to save and invest. With increasing expenditure on (for example) national defence, a legal system and education, economies of scale become evident. The BC line in the curve shows that the proportional increase in government expenditure is less than the proportional increase in economic growth. Eventually, the marginal rate of return on such additional government expenditure reaches level zero at point C. Thus the optimum level of government expenditure as a percentage of GDP is reached at τ^*, after which the marginal return on such expenditures in terms of value added becomes negative.

Figure 1: The relationship between economic growth and public expenditure/taxes



Source: Chao *et al*. (1998)

The Ricardian equivalence theory suggests that the current generation might be under-taxed if government borrows (debt financing) instead of only levying taxes to finance government expenditure. Rising public debt will result in higher future taxes. Therefore, debt financing only spreads the tax burden over more than one generation. Should taxes be used to finance expenditures instead, the current generation would rather bear the burden. Thus, the Ricardian equivalence theorem holds that it is indifferent whether tax or debt financing is used, since the current generation would increase their private savings by reducing their private consumption, realising that such loans would have to be repaid in future from tax revenue (Black, 2006). The impact of this is that the multiplier affects are neutralised and the stimulation of the economy by public intervention is largely constrained.

Schoeman (1995) refers to Barro's provocative hypothesis that government funding by means of taxes or new debt might be irrelevant, since private individuals could discount the intergenerational effects of government debt policy by spending less (saving more). The Barro hypothesis is extended in a study where the public sector is incorporated into a simple, constant-returns endogenous-growth model. Barro (1990) points out that a potentially positive linkage exists between government expenditure and economic growth, but that the size of government *does* matter. When government is relatively small, a positive relationship exists between government expenditure as a percentage of GDP and the growth rate; but when government is relatively larger, this relationship becomes negative.

Mitchell (2001) finds evidence that economic performance is sensitive to the level of taxation. Therefore a lower tax rate enhances the level of compliance: more people pay their taxes. Mitchell concludes that lowering tax rates improves investment, savings and incentives to work and also enhances the immediate and long term development of small business and entrepreneurship. However, higher tax rates lower the price of leisure and thereby reduce the levels of saving, investment and labour productivity, probably resulting in lower levels of production. Mitchell states that capital supply mainly originates from higher income tax payers – and they are the ones who are more sensitive to the level of tax rates. By implication, a lowering of marginal tax rates would induce higher savings, thereby broadening the capital base and thus increasing the growth potential of the economy. The general notion seems to be that government expenditure on public goods (infrastructure, education, health, defence) improves the productivity of human and fixed capital, which in turn would increase economic growth and thereby raise individual living standards (Scully, 1991). Such expenditures have to be financed and the effect of taxation on economic growth depends on the magnitude of these government expenditures.

In a paper on the size of government, Clemens *et al*. (2002) support the Grossman hypothesis (1988) that a negative relationship exists between government expenditure and economic growth. They also cite a study by Vedder *et al.* (1998), who find that a decrease in federal government expenditure would be growth-enhancing and estimate that the growth of the United States economy would be optimised if government expenditure as a percentage of GDP were fixed at around 17.5% of GDP. Clemens *et al*. (2002) also cite a study by Peden *et al.* (1989), who set the estimated optimal level of government expenditure as a percentage of GDP at 17% for the US, warning that any increase beyond this optimal point would dampen economic growth. The studies referred to seem to agree that an inverse relationship exists between the level of government expenditure and economic growth, at least when government expenditure has exceeded a certain critical level.

This inverse relationship between government expenditure and economic growth is also confirmed by Pevcin (2004), who did a panel regression on 12 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Sweden and the United Kingdom) for the time period 1951-1995. In this study the average optimum size of government ($\frac{\text{government expenditure}}{\text{gdp}}$) ranges between 36.6 and 42.1%. Pevcin concludes that countries with a higher level of government expenditure experience lower rates of economic growth.

Scully (1991) also elaborates on the relationship between the level of government expenditure/taxes and economic growth. He states that government expenditure grows to a certain optimum point, after which productivity and economic growth are reduced. He finds that tax rates affect not only government revenue but also economic efficiency. High tax rates divert resources from the private sector, encourage tax avoidance and evasion and channel resources into a less productive ‘shadow’ (or informal) economy to escape the high taxes. According to Scully, countries that increase government revenue at the expense of economic growth expose their taxpayers to a form of double taxation. The first tax is paid according to the tax jurisdiction and the second ‘tax’ is a lowering of their standard of living, caused by lower economic growth. The study concludes that, after a 40 year period of optimum levels of taxation, a country would enjoy more than three times as much economic growth.

Scully (1991) estimates that, for the US, the optimal level of federal, state and local government expenditure/taxation combined is around 19 to 23%. The Scully model estimates a growth-maximising tax rate for the years 1927-1994 at an average 19.7% of GDP for New Zealand (Caragata, 1998). Mackness (1999) estimates the optimum size of the tax rate for Canada at about 20 to 30% of the GDP. Mavrov (2007) finds the optimum ratio for government expenditure as percentage of GDP in Bulgaria to be 21.4%. All of these studies find that the optimum tax rate is much lower than the actual tax rate in these countries.

Mirrlees (1971) suggests that government expenditure could be growth-enhancing or growth–retarding, depending on its end use. The outcome is determined by the nature of the expenditure, as well as the way in which it is financed.

According to the literature, the growth-maximising ratio will always be smaller than the revenue-maximising point and the difference between these two optimum points reflects excessive government expenditure (Mitchell, 2001). Pevcin (2004) argues that excessive government expenditure is the most important factor responsible for slow economic growth. If taxes are too high, people may choose not to work harder and instead take risks with their available income. Tax payers might even choose to leave the country if there are lower taxes elsewhere, thus causing a brain drain in the economy. In a scenario of excessive government expenditure, tax evasion and fraud become more evident and therefore fuel the underground economy (De Vlieghere *et al.,* 2005).

Lower tax rates change economic behaviour. The trade-off between tax ratios and tax revenue became known as the Laffer curve (Laffer, 2004). Linsey (1997) argues that the Laffer curve never indicated that a tax ratio that maximises revenue would necessarily be equal to the optimum ratio that maximises growth. The welfare of the individual has to be prioritised above the objective of maximising revenue, as explained by the correlation between tax rates and economic growth in the Armey curve. The Armey curve illustrates that, as the tax ratio increases beyond an optimum point, the growth-enhancing features of government expenditure start to diminish; and therefore additional government expenditure will lead to lower wealth creation, since more scarce resources will be withdrawn from the private sector, where they could have been used more productively. The shape of the Armey curve is similar to the shape of the Laffer curve; however, the optimum level in the Armey curve is reached long before that in the Laffer curve (Vreymans, 2005). The Laffer curve demonstrates the optimum relationship between the tax ratio and tax revenue in the short term, but the Armey curve represents the tax rate that maximises growth in the long run (De Vlieghere *et al.*, 2005).

Other literature studies such as Heijman *et al*. (2005), Chao *et al*. (1998), Scully (1991) and Scully (1996) estimate that the tax ratio that maximises growth is lower than the actual average tax ratio and find that the average tax burden for most countries lies on the downward-sloping portion of the Laffer curve – and therefore the actual tax ratio has a negative impact on economic growth.

Mitchell (1996) states that the goal of a tax policy should not be to maximise tax revenue but rather to maximise growth. The optimum tax level to maximise revenue does not correspond with the tax level at which social objectives such as wealth and job creation are optimised.

De Vlieghere *et al.* (2005) state that the long-term interest of the public lies in growth-enhancing policies. The public would rather choose optimum tax ratios with the aim of maximising economic growth that will increase tax revenue in the long run. The optimum tax ratio varies between countries because they are at different levels of development, with different levels of infrastructure and cultural differences.

According to Vreymans *et al.* (2005), government revenue increased after the Flemish government had lowered its gift and inheritance taxes. Thus the Laffer curve effect was clearly visible, as well as an increase in welfare, as illustrated by the Armey curve. The combined Laffer-Armey curve effect on lower income taxes is also evident from the Irish economy. The growth-maximising ratio (Armey curve) and tax revenue maximising ratios (Laffer curve) for Ireland are 30 and 45% respectively. The 15% excessive government taxes beyond the Armey optimum is a loss in wealth for Ireland (De Vlieghere *et al.*, 2005).

Since 1994, South African tax reform has focused mainly on the growth and sustainability of the economy. Over the years South Africa's main source of revenue has been income taxes, which in 2007 constituted 68% of total revenue. South Africa's corporate and individual tax ratios were significantly reduced following the tax reforms of 1994. The company tax rate had decreased from 40% in 1993 to 30% in 1999. In 2005 the rate was further reduced to 29 % and in 2008 to 28%. The top marginal personal income tax was reduced from 45% to 40% (Budget Review, 2008). However, in line with international best practice, the proportion of income taxes should decline while the proportion of expenditure taxes should increase (De Vlieghere *et al.*, 2005). The problem with relatively high income tax is that it contributes to higher levels of tax evasion and lowers productivity, as explained earlier. A change from income tax to expenditure taxes can be observed in the period from 1975 to 2007.

For example, in 1975, for every R1 collected in expenditure taxes, in South Africa, R2.70 was collected by means of income tax; while in 2007, the rates changed to only R1.74 in income tax for every R1 collected in expenditure taxes (Black, 2006).

Joffe (2008) points out that South Africa's tax mix has changed significantly over the years. Corporate tax revenue has increased between 1998/99 and 2007 from 13% to 28% of total revenue despite lower company taxes (which decreased from 35% to 28%). He comments on the impact of tax rates on revenue collection by quoting a statement by the Minister of Finance that "as an avowed social democrat, the scariest aspect of all this is that we prove the correctness of the Laffer curve with each move".

2.3. Tax reform

2.3.1. Introduction

According to Feldstein (1975), tax reform starts by addressing the principles of a 'good' tax such as equity and efficiency. In order to achieve these objectives, taxes have to be optimised. An optimum tax rate is best designed to avoid distortion and inefficiency and thus to optimise economic growth and government revenue (Mirrlees, 2006).

Optimum tax forms an internal part of the broader fiscal scenario that determines the objectives with revenue collection. Tax relief and investment help with the social and economic needs for long-term growth, job creation and skills development. Thus, to create a stable fiscal framework, debt cost should be lowered and tax revenue increased. If government borrowings decrease, interest expenditure will be lower and more resources will be available for non-interest expenditures. Therefore the vulnerability of the economy to capital market instability will be reduced. Tax relief for the tax-paying public improves tax-payer morale, increases disposable income and eases the pressure on household budgets. Tax relief also eases the pressure of wage cost to firms, increases fixed investment and economic development and promotes the development of small enterprise. Thus the aim of tax reform should also be to improve domestic savings, raise investments, reduce borrowings, obtain an affordable level of government consumption spending and contribute to lower inflation with a sustainable balance of payouts (Feldstein, 2006).

As a guideline to prudent macro economic policies, including fiscal policy, the IMF introduced a fiscal restructuring program which later became known as the 'Washington Consensus' model. The program was mainly devised to renew economic growth performance in the Latin American counties in the 1980s. One of the many guidelines for tax policy was that budget deficits should be no more than 3% of GDP and be financed without inflationary taxes. Public expenditure were to be redirected more towards socio-economic needs (Williamson, 2004).

More recently the Maastricht policy guidelines have been used to benchmark macro-policies, including fiscal policies. They now form part of the Growth and Stability Pact, a treaty of the European Union. One of those guidelines limits annual government deficits to less than 3% of the GDP. Also, government debt must not exceed 60% of the GDP. However, although the Maastricht guidelines provide a useful framework, they are not necessarily the final doctrine (Maastricht, 1997).

2.3.2. Tax reform in developed countries

2.3.2.1. New Zealand

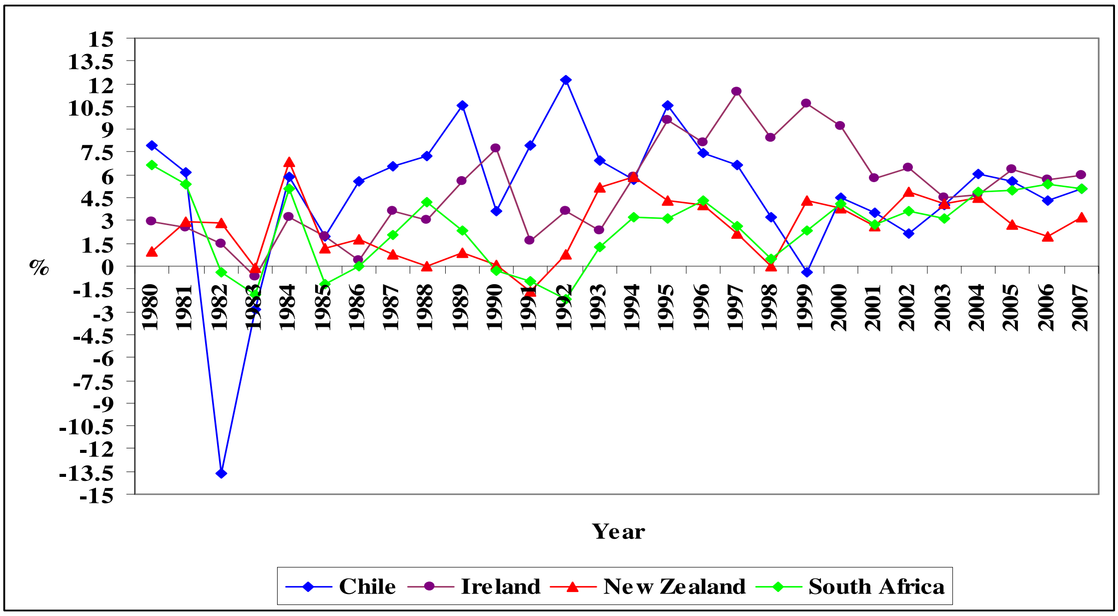
According to Branson *et al*. (2001), the liberalisation of the New Zealand economy began in the early 1980s. New Zealand's tax system failed to deliver sufficient revenue to finance government expenditure, so tax reforms were started in 1984. GDP declined by 1.5%, while inflation and unemployment increased. After 1993, growth and inflation started to increase, except during the Asian financial crisis in 1998.

The first reform was the reduction of tax brackets from five to three. The top marginal personal income tax rate was lowered from 66% to 48%. From 1984 tax revenue started to increase and was sufficient to finance government expenditure. Borrowings subsequently decreased from 21.8% to 2.9% of GDP. The second tax reform was from 1987 to 1990. The reform of the tax system introduced a flatter tax rate. The tax mix ratio (income tax to expenditure tax) remained high despite the introduction of GST. Tax revenue to GDP averaged 30% and increased to 33.2%. The ratio of income taxes to total tax revenue had increased to 75%, but decreased to 67% after the tax reform. The tax burden increased from 30% to 35% during the period 1988 to 1995 and the number of tax brackets reduced from three to only two. A single nominal personal income tax rate of 33% was announced. Income taxes and borrowings decreased, but the tax reform was regarded as unfair because goods and services taxes increased regressively. New Zealand's tax reform has been radical with fewer tax brackets, which has allowed the tax structures to be neutral in tax decisions and to increase revenue collection despite lower tax rates (Stephens, 1993).

The mean tax mix ratio (income tax: expenditure tax) was about 2.0 in the 1960s and for the period 1960 to 1980 the ratio increased to 2.5. With the introduction of GST the tax mean decreased to only 2.0. In 1995, the tax mix was 1.8, with income taxes comprising 64% of total tax revenue (Branson *et al*., 2001).

Figure 2 summarises the annual year-on-year GDP percentage changes for Chile, Ireland, New Zealand and South Africa. New Zealand's first tax reform was in 1984 and produced low growth rates. Government expenditure peaked in 1988 at over 45 per cent of GDP, with a low growth rate of 1.4 per cent. From about 1992 expenditure had declined by 10 per cent and, the growth rate started to increase – until the Asian financial crisis hit in 1998, after which the growth rate fell to -0.04%. Thereafter the growth rate began to increase and stabilised at 3.2 per cent in 2007.

Figure 2: GDP growth (constant prices)



Source: IMF

2.3.2.2. Ireland

Ireland has the second-highest income per capita and the lowest overall tax burden, in the EU. Its economy has grown rapidly, moving Ireland from the second poorest country to the second richest country in Europe. Ireland's wealth increased four times faster over an 18 year period, compared with the French and Belgian economies. Ireland's weak growth performance was mainly due to excessive public expenditure and a demotivating tax structure (De Vlieghere *et al*., 2006).

During the 1980s Ireland experienced excessive budgets deficits, weak economic growth, unemployment and excessive public spending. In 1985, Ireland changed its fiscal policies radically by lowering the tax burden. In a period of three years, public expenditure decreased by 20%, with a concomitant increase in private wealth. Thus Ireland changed from a Keynesian policy approach to a production-stimulating approach to stimulate consumption through low taxes and interest rates. Their production-stimulating policy consisted of a substantial reduction of the total tax burden on labour and a flatter tax structure through lower income taxes. Such a tax policy motivates people to work overtime, stimulates entrepreneurship and encourages people to take more risks (De Vlieghere *et al*., 2006).

Ireland lowered its welfare taxes from 37% in 1985 to 19.3% in 2001. The reduction in corporate tax rates also improved the entrepreneurial climate. The Irish corporate tax in 1985 amounted to 50%; in 2002 it was reduced to 16%. The Laffer-effects seem to be strong. The reduction in tax has broadened the tax base, with less tax evasion and fraud. Also, Ireland has demonstrated the combined Laffer-Armey effects on income taxes. Tax receipts have continued to increase as the tax burden has decreased and new jobs grew by 31% between 1985 and 2002 (Vreymans *et al*., 2004).

According to Vreymans (2004), in preventing public expenditure from rising, Ireland used the budget freeze concept – meaning that the budget is only allowed to increase in real terms. The advantage of a budget freeze is that it provides a simple way to reduce the size of government and public management is disciplined to manage within the limits of available resources, thereby restoring public confidence and promoting economic growth. By introducing tax credits and broader tax bands and by cutting tax rates, the income tax system became fairer. Irish taxation as a percentage of GDP was 29% in 2003, compared with 35% in 1985. The marginal tax rate for individuals was reduced from 47.1% in 1997 to 41% in 2007. Corporate tax rate stayed at 12.5% from 2003. In 2007 the VAT rate was 21% of GDP, (Budget Review, 2007).

Figure 2 illustrates the percentage change in the growth rate of Ireland. After 1985 the economic growth rate started to increase. In 1999 the growth rate peaked at 10.7% and stabilised at 6% in 2007.

2.3.3. Selected developing countries

2.3.3.1. Chile

By the end of the 1960s, Chile's economy had experienced major economic imbalances that included large deficits, appreciation of the real exchange rate, large foreign borrowing and double digit inflation rates. Its two main sources of fiscal revenue are tax collection and copper-related revenue. The debt crisis of the early 1980s caused interest rates to increase and terms of trade deteriorated and foreign borrowing became problematic. Chile depended on foreign borrowing and therefore had no choice but to increase taxes to finance such borrowings. The highest marginal tax rate for individuals and the corporate tax rate during pre-1983 tax reform, were 58% and 46% respectively (Hsieh *et al*., 2006).

Post-1984, tax reform with policy changes was imposed to stabilise the economy and to reduce political uncertainty by means of a lowering in the tax rates on retained earnings. This caused the internal funds of firms to increase, which led to increases in investment and productivity. Also, the depreciating exchange rate caused exports to increase. Chile's main export product is copper, which comprised 48% of total exports in the 1980s. The price of copper fell by 39% between 1980 and 1982, causing Chile's external debt to increase by 25%. After the 1984 tax reform, the highest marginal tax rate for individuals was 50% and the corporate tax rate was 10%. Lower corporate taxes caused investment to grow (Corbo, 1992).

In 1990, Chile became a democratic state under new leadership with its tax reform program a role model for policy success in the developing world. President Patricio Aylwin's primary objective was to reconcile economic growth with social justice and therefore improving on the revenue levels, became an important objective. Firstly, the corporate tax rate was increased from 10% to 15%, with a tax on profits paid out as dividends. Secondly, personal income tax brackets were increased with more progressiveness in the higher income categories. Tax revenue as a percentage of GDP fell from 27% in 1975 to 16.2% in 1990 and income taxes also decreased significantly. Thirdly, the agricultural, transport and mining sectors were taxed on actual and not on estimated profits. Fourthly, VAT was increased from 16% to 18%. Thus, the tax burden was mainly carried by the economically advanced sectors, with two-thirds of the burden on the business sector and high income earners and the other third on sales taxes on consumption. Public expenditure was mainly focused on the poor through increased spending on education and housing and on infrastructure improvements. Tax reforms gradually shifted the burden from production activities to consumption. In 1996, Chile had a government surplus of 3.9% with higher output levels and growth rates (Boylan, 1996).

In 2000, Chile introduced a structural fiscal surplus rule (1% of GDP) that imposes a ceiling on government expenditure and assumes a potential economic growth rate of 5%. As a result of the fiscal surplus rule, net public debt decreased to 6% of GDP in 2004, from nearly 34% of GDP in 1990 (OECD, 2005).

Chile achieved a fiscal surplus of 7.8% of GDP, with tax revenue as a percentage of GDP at 25.8% in 2006, due to higher copper prices and a counter-cyclical fiscal policy. In 2007, the marginal tax rates for individuals, corporate institutions and VAT, were 40%, 17% and 19%, respectively (Roubini, 2007).
Figure 2 illustrates the Chilean economic growth rate. The country experienced negative growth rates during the 1980s, with a growth rate as low as -13.6% mainly because of the world debt crisis and Chile's dependence on foreign borrowings. Overall government expenditure declined from 34 % of GDP in 1982 to less than 20 % of GDP in 1995. In 1990, Chile introduced a new

round of tax reforms under new leadership, with the growth rate peaking at 12.3% in 1992. Thereafter, the growth rate decreased to 4% in 2006, mainly due to the low copper price, but it increased again to 5.1% in 2007 (Tanzi *et al.,* 2000).

2.3.3.2. South Africa

Tax reform in South Africa mainly resulted from the recommendations of three main commissions: the Franzsen Commission (1968), the Margo Commission (1987) and the Katz Commission (1994). The main objectives of all three commissions were to reduce income tax ratios and shift the tax burden more towards expenditure taxes, expecting the shift to increase productivity and social welfare and, therefore, economic growth as well. Thus, South Africa's tax system went through a number of reforms during this period with the economy exposed to much turbulence because of the political situation. It reached a critical level in 1985, when the debt standstill severely hampered growth and thus the tax base as well.

The Franzsen Commission pointed out that by the late 1960s, only 8% of the population were paying income taxes, with only about 6% responsible for two thirds of total tax revenue. The Commission recommended a reduction in the progressiveness of taxes on individuals and the top marginal rates for individuals were reduced from 66% to 60%. A capital gains tax of 20% was recommended, but rejected by Parliament. In 1978, sales duties were replaced by a general sales tax (GST) of 4%. GST was followed by the introduction of Regional Services Council levies in 1985 (Browne, n.d.).

The Margo Commission also recommended that the tax base be broadened and tax rates reduced. The intention was to reduce the brain drain, improve tax morale and create jobs. Government introduced taxes on fringe benefits, lowered personal income tax brackets and again rejected capital gains tax. GST was replaced by a VAT of 10% in 1991 and capital transfer taxes replaced estate duty and donation taxes. In 1993, company tax was lowered and secondary tax was introduced. Companies were encouraged to reinvest their profits. The VAT rate increased to 14% in April 1993 (Margo Commission Report, 1987).

During the period from 1990 to 1994, government expenditure in South Africa was relatively high at an average of 27% of GDP, with the budget deficit at more than 7% of GDP. Public debt amounted to 41.9% of GDP. Since then, however, major legislative and regulatory reforms have been implemented to redirect expenditure towards more productive spending and adjusting the tax base. Institutional reforms included the introduction of a Budget Council and

Budget Forum to coordinate budgetary and financial policies. The Public Finance Management Act was also implemented to improve accountability and transparency (Calitz, 2000).

The Katz Commission was appointed at the time of a new political dispensation for South Africa, when international trade sanctions were gradually lifted. As a determinant of the ideal level and size of government intervention, the poverty challenge was prioritised by the Katz Commission (First Interim Report, 1994). The Commission's recommendations were to improve tax administration and so the South African Revenue Service (hereinafter referred to as "SARS") was established as a separate entity and given more autonomy. A single rate structure with six brackets for personal income was introduced. Gambling services were subject to VAT. Capital gains tax was introduced and residence-based income replaced source-of-income tax. Company taxes were lowered for small businesses, with accelerated depreciation allowances introduced for investment in under-developed urban areas. Legislation was introduced to deal with foreign exchange control, amnesty and accompanying tax treatment. The Commission was guided by the requirement to adhere to Government's policy objective of ensuring that the total tax burden did not exceed 25% of GDP. Accordingly, tax policy suggestions and tax assignment decisions had to conform to this objective (Katz Commission, 1999).

According to Calitz (2002), fiscal discipline became stricter, with expenditure allocations directed more towards health and education (but not yet infrastructure). The South African tax base was broadened, but income taxes were more progressive. The restructuring of tax policy was done gradually rather than in a 'big bang' style. In June 1996, the government adopted a five-year macro-economic programme called Growth, Employment and Redistribution (hereinafter referred to as "GEAR"). This programme's goal was to achieve sustained annual real GDP growth of 6% or more by the year 2000, with increased job opportunities and investment. The latter objectives were not achieved, but the growth rate increased from its negative base in 1990, to more than 4.1% in 2000, as shown in Table 1. The deficit decreased from 3.5% in 1997, to 1.5% in 2001, with the interest on public debt decreasing from 6.1% to 4.9% over the same period. Tax as a percentage of GDP increased from 22.9% in 1997 to 24% in 2001, due to the broadening of the tax base and efficient tax collection. Interest rates declined due to a reduction in borrowings, which encouraged investment.

After 2001, an expansionary fiscal policy was adopted. Economic growth increased and the burden of debt service cost decreased. Public expenditure increased due to greater investment in infrastructure and skills. Tax revenue increased as a result of the improvement in revenue collection and a further broadening of the tax base. The stronger growth rate also boosted government revenue, to the extent that the budget deficit changed into a surplus (Calitz, 2002).

In his 2002 speech on tax reform experience in South Africa since 1994, the Minister of Finance stated that the fiscal achievements were "stabilisation of the tax burden at approximately 25% of GDP" and "a decline in government consumption expenditure as a percentage of GDP, from 20% in the mid-1990s to 18% in 2001" (Budget Review, 2002).

Table 1: Tax revenue, government expenditure and economic growth rates

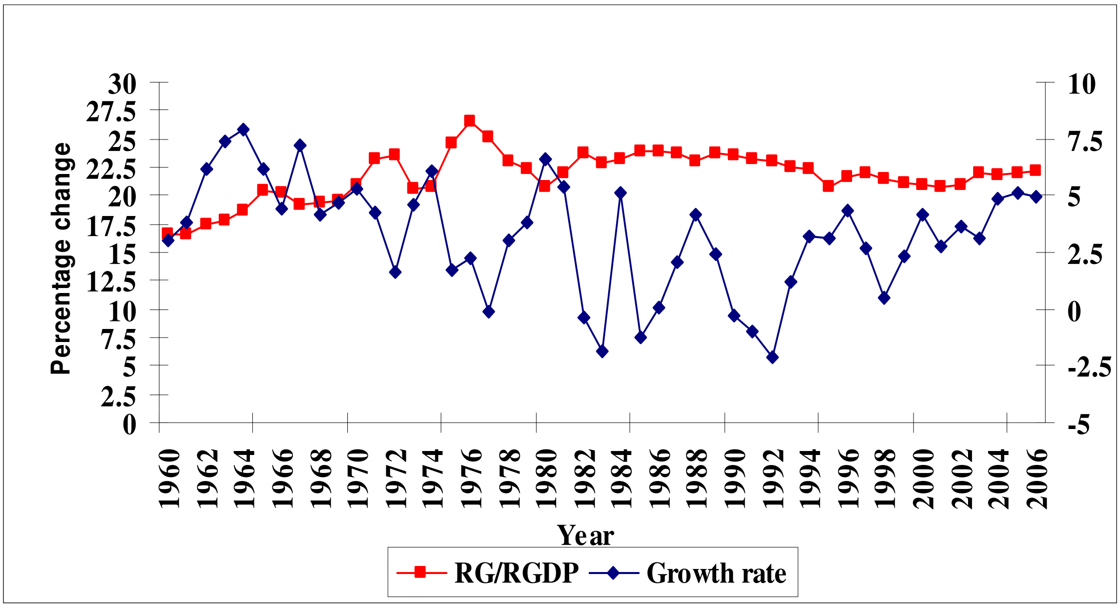
Series	*Code*	*1981*	*1984*	*1990*	*1995*	*2000*	*2004*	*2007*
Tax on individuals as a percentage of total revenue	KBP4429J	20.7	31.7	32.2	40.6	42.1	33.1	30.1
Tax on companies as a percentage of total revenue	KBP4430J	34.5	22.9	22.6	13.1	16.0	23.2	29.4
VAT as a percentage of total revenue	KBP4431J	13.6	23.3	24.4	26.0	25.0	28.3	27.2
Tax revenue as a percentage of GDP	KBP4433J	20.2	20.9	24.7	22.2	22.5	23.5	26.9
Expenditure as a percentage of GDP	KBP4434J	22.1	24.3	25.5	27.1	24.4	25.5	26.1
GDP growth	KBP6006Z	5.4	5.1	-0.3	3.1	4.1	4.8	5.1

Source: SA Reserve Bank (various sources)

By 2005, tax relief of R78 billion had been granted to individuals and companies. These measures contributed to optimistic consumption expenditure and a growth in capital formation. By 2007, South Africa was in a stronger fiscal position and government could invest more in social and economic development. In addition to that, investment in infrastructure – such as stadiums for the 2010 FIFA World Cup event and public transport – stimulated the economy. High commodity prices and domestic demand have boosted corporate profitability, resulting in increased corporate tax collections and consumer spending, with robust VAT collections. Personal income tax receipts also increased with growth in employment and remuneration. The cost of debt services declined and the sustained economic growth and revenue performance allowed for a budget surplus of 0.6% of GDP in 2007/2008 (Budget Review, 2008).

Table 1 gives an indication of the change in the tax burden between 1981 and 2007. Personal income tax comprised 42% of total tax revenue in 2000, but its share declined to 30% in 2007. Company tax was 16% in 2000, but increased to 29.4% as a percentage of total revenue. Corporate and individual rates were significantly reduced after 1994 (Budget, 2008).

Figure 3: Government expenditure as percentage of GDP and the economic growth rate

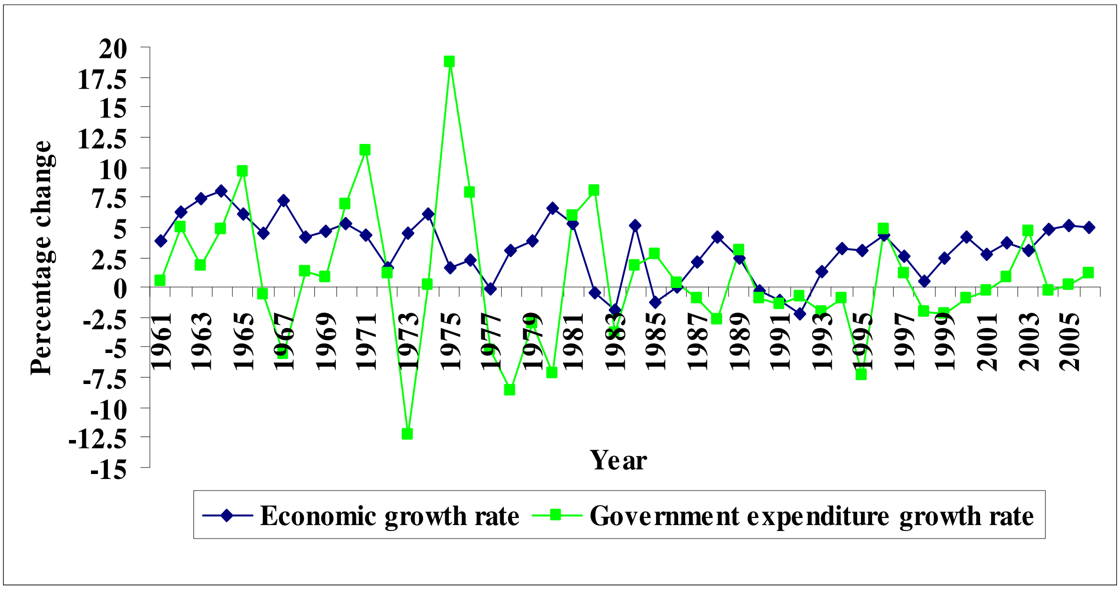


Source: SA Reserve Bank (various sources)

In Figure 3 the real economic growth rate and real government spending as a percentage of GDP are illustrated for the years from 1960 to 2007. The graph shows that during the period 1960 to 1965, the economic growth rate was relatively high, with relatively low levels of government spending. After 1970, the level of government expenditure started to increase and stayed around an average of 26% between 1985 and 2007. During the 1980s, South Africa experienced high inflation rates and foreign disinvestment and growth rates fluctuated, with a low growth rate of -1.9% in 1983. After the introduction of a new political dispensation and tax reform in 1994, the growth rate began to increase, reaching 5.1% in 2007. This tendency is similar to the findings of Devarajan *et al.* (1996), according to which governments in developing countries spend on average 26% of GDP.

In Figure 4 the real economic growth rate is compared with the real government expenditure growth rate for the years from 1961 to 2007. It is interesting to note that the graph shows an inverse relationship between the economic growth rate and the change in government expenditure. For example, in the years 1966 to 1970 and 1976 to 1982, the inverse relationship is clear, perhaps indicating a margin of pro-cyclical expenditure by government.

Figure 4: Change in government expenditure and the economic growth rate



Source: SA Reserve Bank (various sources)

3. COMPARATIVE ANALYSIS OF OPTIMUM TAXES

3.1. International Analysis

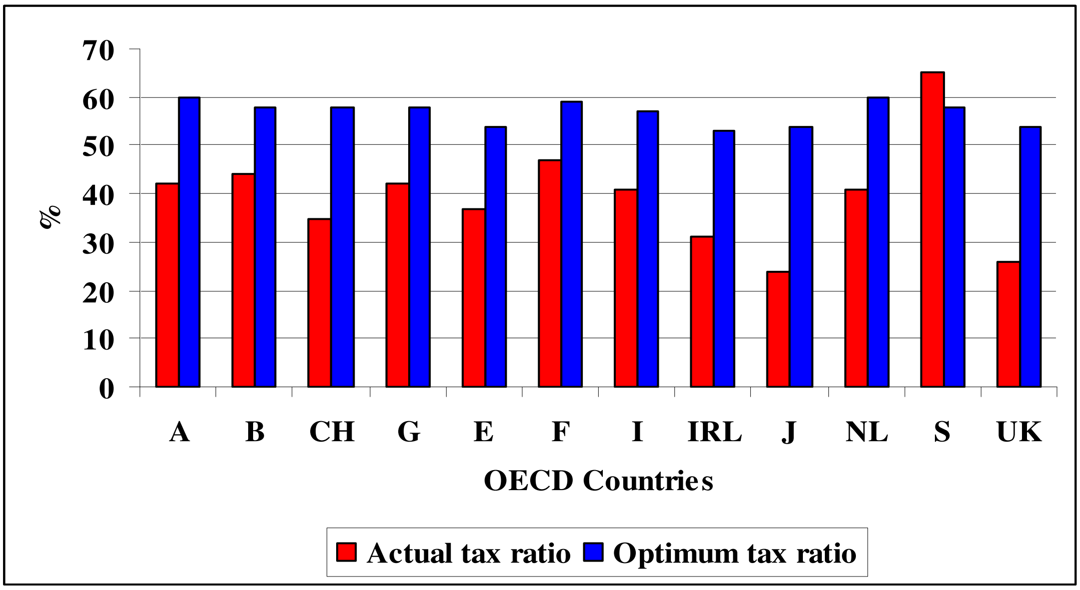
Table 2 summarises tax ratios for six OECD countries. Scully (1998) calculated the growth (τ^*) and revenue maximising (τ^{**}) tax ratios for all six countries. The actual tax ratios as percentage of GDP (τ) range between 27.9% and 49.4%. All six countries have revenue maximising tax ratios above 55% of GDP. The growth maximising tax ratios range from 16.6% to 25.2% of GDP. The actual tax ratios for the UK and the US tend towards the growth maximising tax ratio, but lie to the right hand side of the optimum point. In Sweden and France the actual tax rate is closer to the revenue maximising rate. In New Zealand and Ireland the actual tax ratio lies between the two optimum points that maximise revenue and growth. It is interesting to note that the growth rate in New Zealand averaged more than 5%. The tax mix ($\frac{\text{income tax}}{\text{expenditure tax}}$) is below the mean of 1 for all countries except Sweden and New Zealand, indicating that expenditure tax is the dominant source of tax revenue. The tax mix mean ratio for New Zealand (4.1) exceeds the mean of 1; thus the dominant source of tax revenue there is income taxes.

Table 2: Tax ratios[1] for six countries [2]

	US	UK	I	S	F	NZ
Year	**1996**	**1996**	**1996**	**1996**	**1996**	**1996**
Tax burden τ	27.9	35	41.2	48.5	46	37
Tax burden τ^*	21.8	25.2	20.8	16.6	18.9	19.7
Tax burden τ^{**}	60.77	62.57	60.37	58.31	59.47	59.86
Income tax ratio	45	36.57	35.19	39.38	36.1	80.2
Expenditure tax ratio	55	63.43	64.81	38.38	63.9	19.8
Tax mix	0.82	0.58	0.59	1.03	0.56	4.05
Economic growth	4.8	3.8	4.1	4.7	4.4	5.1

Source: Scully (2000) and own calculations

Figure 5: Actual tax ratios and optimum tax ratios to maximise tax revenue for OECD countries[3]



Source: Heijman *et al.* (2005)

According to Pevcin (2004), the optimum tax ratios for European countries range between 35% and 40%. Countries with government expenditure below this optimum point have higher growth ratios for every additional unit of government expenditure and countries with

[1] τ (actual tax ratio), τ^*(optimum tax ratio maximize growth as percentage of GDP), τ^{**}(optimum tax ratio maximize revenue as percentage of GDP).
[2] US-United States, UK-United Kingdom, I–Italy, S-Sweden, F-Finland, NZ-New Zealand.
[3] A-Austria; B-Belgium; CH-Switzerland ; G-Germany; E- Spain; F-France; I- Italy; IRL- Ireland; J-Japan; NL-The Netherlands; S-Sweden; UK-United Kingdom.

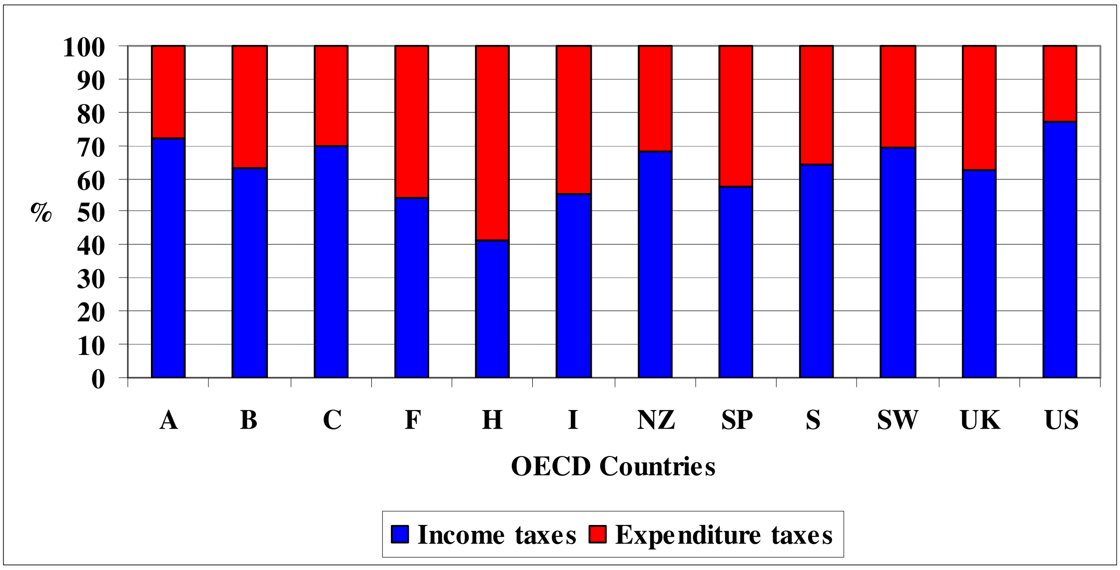
government expenditure above this optimum level show slower economic growth for every additional unit of government expenditure.

Marsden (2008) reviews the performance of 20 OECD countries. He compiles two groups. The first group represents smaller governments with taxes below 40% of GDP. The second group represents larger governments with taxes higher than 40%. In 1996, smaller governments decreased their personal income tax ratios from 36% to 30% and their corporate tax ratios from 30% to 22%. As a result, the average tax ratio decreased from 40% to 31.6%; and Marsden claims that this caused gross capital formation to increase from 25% to 28% of GDP, with investment growing from 3.8% to 5.9%. All the macro-economic factors were positively influenced and therefore the economic growth rate increased. Also, in the Marsden model, although larger governments decreased their tax ratios, they stayed above the 40% level, with the result that larger governments did not grow as much as smaller governments. Marsden also stated that there is a tendency for larger governments to run budgetary deficits, whereas the smaller ones are more inclined to run surpluses. From Marsden’s study it appears that, with lower government expenditure, higher levels of economic growth can be expected, with lower debt and more jobs opportunities.

De Vlieghere *et al.* (2006) quote a study by Gwartney and Mullally with similar results for countries with government expenditures lower than 25% of GDP. These countries grew on average by 7.5%, while countries with government expenditure close to 40% grew only by 3.5% and countries with government expenditure higher than 40% only grew by 2.9%.

Figure 6 compares the tax mix structures of twelve OECD countries in 2005. It is evident that differences exist in the mix between income and expenditure taxes. Obviously each country has different economic circumstances and each went through different tax reforms to design a tax system to suit its needs best. From the figure it is clear that in Hungary, a less developed country, expenditure taxes are the major source of income (58.9%), while in the United States income tax is the predominant source of income for the government (76.9%). Tax mean ratios in France and Ireland are very close to 1; thus the income tax and expenditure taxes carry almost equal weight in the tax base. For the twelve OECD countries, the average income tax / expenditure tax ratios are 62.8% and 37.2% respectively.

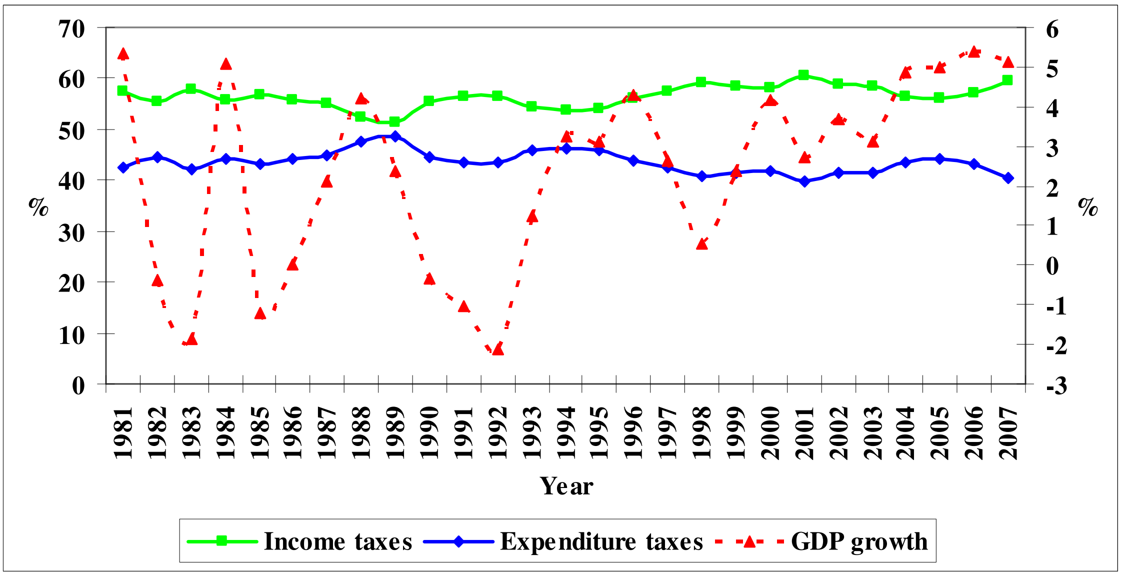
Figure 6: Income and expenditure tax ratios of OECD countries[4] in 2005



Source: OECD, 2005

3.2. Tax ratios in South Africa

Figure 7: Income taxes, expenditure taxes and GDP growth ratios in South Africa



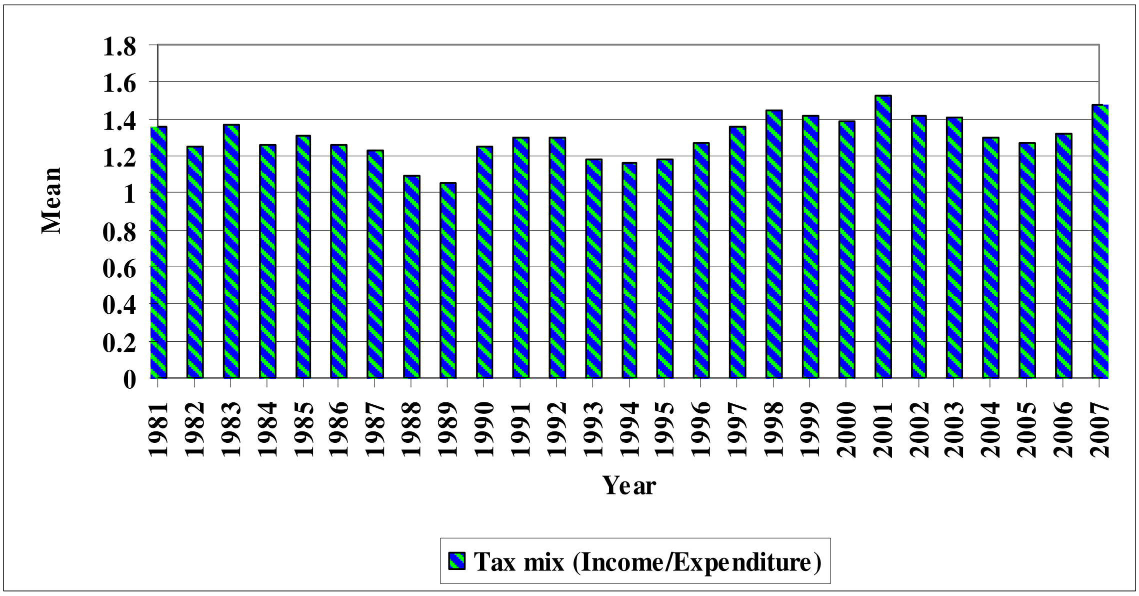
Source: SA Reserve Bank (various sources)

Figure 7 illustrates the income and expenditure tax ratios and economic growth rates for South Africa from 1981 to 2007. The ratio $\frac{\textit{income tax}}{\textit{total tax}}$ gradually decreased during the period 1981 to

[4] A-Australia, B-Belgium, C-Canada, F-France, H-Hungary, I-Ireland, NZ-New Zealand, SP-Spain, S-Sweden, SW-Switzerland, UK-United Kingdom, US-United States.

1989. It fluctuated between 1989 and 2007, but increased to 59.5% in 2007. The average income tax and expenditure tax ratios are 56.5% and 43.5% respectively. The highest growth rate of 5.4% was in 2006, with income tax at 57% and the expenditure tax rate around 43%.

Figure 8: Tax mix mean for South Africa



Source: SA Reserve Bank (various sources)

Figure 8 illustrates that the tax mix mean for South Africa is above 1, meaning that income tax is the dominant source of tax revenue. In 1989, the share of income taxes reached its lowest level of 51.3% and in 2001 it increased to 60.4%. In 1989 the tax mix mean was 1.05; thus the income tax and expenditure tax ratios were almost equal. Thus it seems that, despite some fluctuations in the ratio, income tax has continued to be the dominant source of income for government.

Table 3: A comparison of periods of expansion/reduction with the size of government expenditure

Expanding government	Begin	End	Change	Growth end period
1967-1987	19.16	27.53	+ 8.37	2.1
Shrinking government	**Begin**	**End**	**Change**	**Growth end period**
1987-2000	27.53	24.45	- 3.08	4.1

Source: SA Reserve Bank (various sources) and own calculations

Table 3 compares the periods of expansion and reduction in the size of government expenditure in South Africa. An increase in government expenditure as a percentage of GDP – from 19.2% in 1967 to 27.5% in 1987 – should be seen against the background of an increase in the growth ratio of only 2.1%. This situation was reversed in the period 1987 to 2000. As government expenditure decreased, South Africa's economic growth increased to 4.1% annually. These expansions and reductions in government expenditure in South Africa compare favourably with similar results in the Gwartney study (1998) of Ireland, New Zealand and the United Kingdom. Again, the conclusion seems to be that smaller governments are associated with higher growth ratios.

4. HOW TO DETERMINE THE OPTIMUM LEVEL OF TAXES IN AN ANALYTIC FRAMEWORK

4.1. The relationship between tax rates and economic growth

The model used here is based on that of Scully (1991), using a simple, constant-returns endogenous non-linear Cobb-Douglas production function. The rate of real economic growth is related to the fraction of output that is a function of a two sector economy – namely, the government (rg_t) and non-government ($(1-\tau)rgdp_t$) sectors. It is structured to assume a balanced budget, with real government expenditure = real government revenue ($rg_t = \tau(rgdp_t)$).

Non-linear Cobb-Douglas production function:

$$Y_t = \alpha(rg_t)^{\beta}((1-\tau)rgdp_t)^{\delta} \tag{1}$$

Growth rate:

$$1+eg_t = \frac{rgdp_t}{rgdp_{t-1}} \tag{2}$$

Substitute (1) in (2)

$$1+eg_t = \frac{rgdp_t}{rgdp_{t-1}} = \alpha(rg_t)^{\beta}(1-\tau)^{\delta}(rgdp_t)^{\delta}(rgdp_{t-1})^{-1} \tag{3}$$

where

α	= total factor productivity
$rgdp_t$	= real gross domestic product (GDP) current period
$rgdp_{t-1}$	= real gross domestic product (GDP) previous period

rg_t = real government expenditure current period

eg_t = economic growth rate current period

τ = tax ratio

Cobb-Douglas production function in logarithm form:

$$\ln(1+eg_t) = \ln(\frac{rgdp_t}{rgdp_{t-1}}) = \ln\alpha + \beta\ln(rg_t) + \delta\ln(1-\tau) + \delta\ln(rgdp_t) - \ln(rgdp_{t-1}) \quad (4)$$

Differentiate growth rate w.r.t. real government expenditure

$$\frac{\partial\ln(1+eg_t)}{\partial rg_t} = \beta(rg_t)^{-1} \qquad > 0 \qquad (5)$$

$$\frac{\partial^2\ln(1+eg_t)}{\partial rg_t{}^2} = -\beta(rg_t)^{-2} \qquad < 0 \qquad (6)$$

Thus a positive relationship exists between real government expenditure and the growth rate, but at a diminishing rate. By increasing real government expenditure (holding productivity and employment constant), the growth rate will rise – but less than when real government expenditure is lower.

Differentiate growth rate w.r.t tax rate (τ)

$$\frac{\partial\ln(1+eg_t)}{\partial\tau} = -\delta(1-\tau)^{-1} \qquad < 0 \qquad (7)$$

$$\frac{\partial^2\ln(1+eg_t)}{\partial\tau^2} = -\delta(1-\tau)^{-2} \qquad < 0 \qquad (8)$$

Thus, there is a negative relationship between the tax rate and the growth rate, but at an increasing rate.

4.2. Optimum tax ratio that maximises growth

By definition $rg = \tau(rgdp)$ substitute into (1) and simplify

$$\begin{aligned} rgdp_t &= \alpha(\tau(rgdp_t))^{\beta}((1-\tau)rgdp_t)^{\delta} \\ &= \alpha(\tau)^{\beta}(1-\tau)^{\delta}(rgdp_t)^{\beta+\delta} \qquad (9) \end{aligned}$$

Substitute (9) in (2):

$$1 + eg_t = \frac{rgdp_t}{rgdp_{t-1}} = \alpha(\tau)^{\beta}(1-\tau)^{\delta}(rgdp_t)^{\beta+\delta}(rgdp_{t-1})^{-1} \tag{10}$$

Constant returns to scale $\beta + \delta = 1$

Therefore:

$$1 + eg_t = \frac{rgdp_t}{rgdp_{t-1}} = \alpha(\tau)^{\beta}(1-\tau)^{\delta}(rgdp_t)\ \ (rgdp_{t-1})^{-1} \tag{11}$$

The logarithm form of (11):

$$\ln(1+eg_t) = \ln\alpha + \beta\ln(\tau) + \delta\ln(1-\tau) + \ln(rgdp_t) - \ln(rgdp_{t-1}) \tag{12}$$

Differentiate (12) w.r.t. tax:

$$\frac{\partial\ln(1+eg_t)}{\partial\tau} = \beta(\tau)^{-1} + [\delta(1-\tau)^{-1}(-1)] = 0 \tag{13}$$

$$\frac{\beta}{\tau} = \frac{\delta}{1-\tau}$$

$$\frac{1-\tau}{\tau} = \frac{\delta}{\beta}$$

$$\frac{1}{\tau} - 1 = \frac{\delta}{\beta}$$

$$\frac{1}{\tau} = \frac{\beta}{\beta} + \frac{\delta}{\beta}$$

Optimum tax rate that maximises growth: $$\tau^* = \frac{\beta}{\beta+\delta} \tag{14}$$

4.3. Optimum tax mix ratio that maximises growth

Growth maximising income tax ratio as a percentage of GDP

$$\tau_i^* = B_{optimum\ tax\ ratio\ maximize\ growth} * B_{income\ tax\ as\ a\ proportion\ of\ g} \tag{15}$$

Growth maximising expenditure tax ratio as a percentage of GDP

$$\tau_e{}^* = B_{optimum\ tax\ ratio\ maximize\ growth} {}^* B_{expenditure\ tax\ as\ a\ proportion\ of\ g} \tag{16}$$

4.4. Optimum tax ratio that maximises revenue

Substitute (9) into $rg_t = \tau(rgdp_t)$ *:*

$$rg_t = \tau(\alpha(\tau)^{\beta}(1-\tau)^{\delta}(rgdp_t)^{\beta+\delta}) \tag{17}$$

Take logarithms of equation (17):

$$\ln rg_t = \ln\tau + \ln\alpha + \beta\ln\tau + \delta\ln(1-\tau) + (\beta+\delta)\ln(rgdp_t) \tag{18}$$

From (18) differentiate rg_t *w.r.t.* τ *and set equation equal to zero:*

$$\frac{\partial \ln(rg_t)}{\partial\tau} = (\tau)^{-1} + \beta(\tau)^{-1} + \delta(1-\tau)^{-1}(-1) = 0$$

$$\frac{1+\beta}{\tau} = \frac{\delta}{1-\tau}$$

$$\frac{1-\tau}{\tau} = \frac{\delta}{1+\beta}$$

$$\frac{1}{\tau} = \frac{\delta}{1+\beta} + 1$$

$$\frac{1}{\tau} = \frac{1+\beta}{1+\beta} + \frac{\delta}{1+\beta}$$

$$\frac{1}{\tau} = \frac{1+\beta+\delta}{1+\beta}$$

Optimum tax ratio that maximises revenue: $$\tau^{**} = \frac{1+\beta}{1+\beta+\delta} \tag{19}$$

The rate at which revenue is maximised exceeds the rate that maximises growth. This is the case given the manner in which the equations for these two optimum rates are calculated. The revenue maximising equation adds one to both the numerator and the denominator and adds proportionately more to the numerator (beta plus delta) than to the denominator (beta). Hence, the revenue maximising ratio must always exceed the growth maximising ratio.

4.5. Data

Table 4: Data and description

Series	*Abbreviation*	*Description*	*Transformation used*
KBP7032J	**cpi**	Consumer Price Index	Yearly index, Base year 2000 = 100
KBP6006J	**Y or gdp**	Gross domestic product at market prices	Yearly, current prices
KBP6008J	**consg**	Final consumption expenditure by general government	Yearly, current prices
KBP6180J	**capt**	Gross capital formation	Yearly, current prices
KBP6181J	**capg**	Gross capital formation: general government	Yearly, current prices
KBP6007J	**consng**	Final consumption expenditure by households: Total	Yearly
KBP6013J	**x**	Exports of goods & services	Yearly
KBP6014J	**z**	Imports of goods & services	Yearly
KBP6251J	**dir**	Taxes on income, profits and capital gains	Yearly, current prices
Calculated	**zg**	Imports of goods & services: general government	15%[5] * 50% * consg
Calculated	**zng**	Imports of goods & services: non-government	z - zg
Calculated	**capng**	Gross capital formation: non government	capt - capg
Calculated	**ind**	Taxes on expenditure	g - dir
Calculated	**g**	Government expenditure	consg + capg -zg
Calculated	**ng**	Non government expenditure	consng + capng + x -zng
Calculated	**rgdp**	Real gross domestic product	(gdp/cpi)*100
Calculated	**rg**	Real government expenditure	(g/cpi)*100
Calculated	**rng**	Real non government expenditure	(ng/cpi)*100
Calculated	**rdir**	Real income tax	(dir/cpi)*100
Calculated	**rind**	Real expenditure tax	(ind/cpi)*100
Calculated	**tax** (τ)	Tax ratio	(g/gdp)*100
Calculated	**growth**	Rate of economic growth	rgdp/(rgdp(-1))
Calculated	**dum**	Political change	1:1995

Source: SA Reserve Bank (various sources)

[5] The average of goods and services imported by government

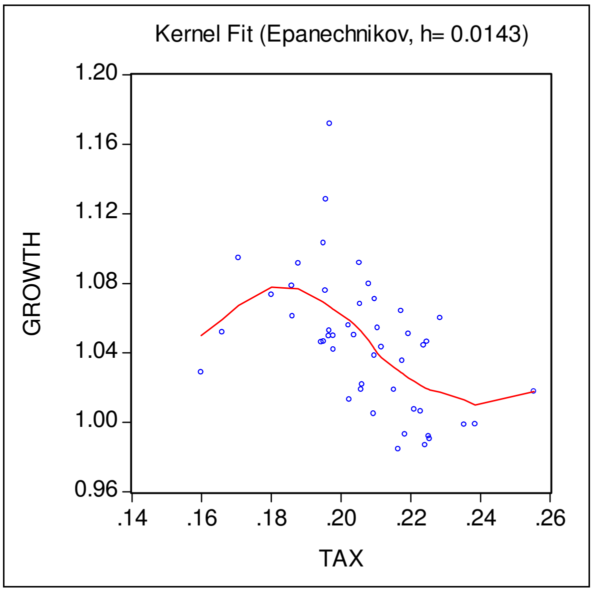
The parameters used in the model were estimated, using yearly time series data for the period 1960 to 2007, from the South African Reserve Bank (www.resbank.co.za).

5. EMPIRICAL RESULTS

5.1. Empirical analysis

In Figure 9 the rate of economic growth is on the y-axis and the $\tau = \frac{g}{gdp}$ ratio is on the x-axis. The individual points represent annual observations of these two variables for the period 1960 to 2007. A Laffer curve can be visualised in the inverted U through the points in the graph. It is clear that most of the tax ratios over the period lie to the right hand side of the optimum turning point of the curve. Thus an increase in the τ rate resulted in a decrease in the growth rate at an increasing rate.

Figure 9: The tax ratio and economic growth rate in South Africa: Scatter of annual observations



Informal tests suggest that all the data series used for estimating growth are non-stationary I(1). Differencing the series once, ADF unit root test confirmed stationarity of the series, (all series are I(0)). See Appendices A, B and C for the empirical analysis.

Ordinary Least Square Regression procedure is used for the modelling. All data retrieved and used in the model is at current (nominal) prices and transformed to real values by using the CPI index.

5.2. Model 1

5.2.1. Cointegration model 1

Cointegration involves combing economic data series (although I(1)) through a linear combination into a single series, which is itself stationarity. This process shows which variables affect RGDP in the long run. The following functional relationship was found to hold:

$$RGDP = f(\overset{+}{RG}, \overset{+}{RNG})$$

5.2.2. Long-run estimation

The signs and magnitudes of the variables in the long-run equation do conform to *a priori* expectations. It is expected that an increase in real government expenditure (lnrg) will increase economic growth until it reaches a maximum optimum point. Beyond that point, growth will rise but less than when real government expenditure is lowered.

Table 5: Output coefficients for the long run cointegration equation

Dependent variable	**lnrgdp**
Variables	**Coefficient**
lnrg	0.186690
lnrng	0.803281
c	0.608571

Source: Own calculations

An increase in real non government expenditure (lnrng) will have a positive impact on economic growth. A one percent increase in real government expenditure would lead to a 0.19 percent increase in economic growth and a one percent increase in real non government expenditure tax would lead to a 0.80 percent increase in economic growth.

Test for cointegration

H_0 : no cointegration
H_1 : cointegration

Table 6: Testing stationarity of the cointegrating residuals

Series	**Model**	**Lags**	**τ**
res_lr	Constant, no trend	0	-3.664807

Source: Own calculations

The variables are cointegrated at a 10% level of significance, as -3.6648 is smaller than the calculated MacKinnon[6] critical value of -3.5859, thereby rejecting the null hypothesis at a one percent level of significance, indicating cointegration.

5.2.3. Error correction model

A model incorporating the short-run effects on economic growth corrects the stochastic residuals from the long-run cointegrating regression. The results are shown in Table 7.

All the variables included in the ECM were originally I(1). Differencing them once transformed them into I(0) series. The error correction coefficient is negative and statistically different from zero. The Adjusted R squared value indicates that 81.1% of the variation in growth is being explained by the ECM.

Table 7: Regression output of the Error Correction Model for rgdp

Dependent variable Δlnrgdp				
Variable	***Coefficient***	***Standard Error***	***t-Statistic***	***p-Value***
res_lr_{t-1}	-0.507818	0.124869	-4.066798	0.0002
Δlnrg	0.265041	0.036169	7.327874	0.0000
Δlnrng	0.726176	0.044348	16.37433	0.0000
R squared= 0.818894 Adjusted R squared = 0.810662 S.E. of Regression = 0.015838				

Source: Own calculations

All the perfunctory tests were performed on the ECM, with the following results:

Table 8: Selected diagnostic results of the short-term model estimating growth

Purpose of test	*Test*	*Test statistic*	*p-value*	*Conclusion*
Normality	Jarque-Bera	JB = 8.59	0.99	Normally distributed
Serial Correlation	Ljung-Box Q	$LB_Q = 1.44$	0.48	No serial correlation
	Breusch-Godfrey	$nR^2 = 0.22$	0.89	No serial correlation
Heteroscedasticity	ARCH LM	$nR^2 = 0.003$	0.95	No heteroskedasticity
Specification	Ramsey RESET	LR = 0.23	0.63	Indicative of stability

Source: Eviews 5

With the diagnostic results at a 5% level of significance, except for the White test for heteroskedasticy which was not, all other tests performed were significant with the result that it

[6] see Appendix D

is reasonable to conclude that the residuals do satisfy the assumptions of the classical normal linear regression model.

5.3. Model 2

5.3.1. Cointegration model 2

The model indicates which variables affect government expenditure in the long run. It was found that:

$$RG = f(\overset{+}{RDIR}, \overset{+}{RIND}, dum)$$

5.3.2. Long-run estimation

The signs and magnitudes of the variables in the long-run equation do conform to a priori expectations. It is expected that an increase in real income tax (lnrdir) and real expenditure tax (lnrind) will increase real government expenditure.

Table 9: Output coefficients for the long run cointegration equation

Dependent variable	**lnrg**
Variables	**Coefficient**
lnrdir	0.580805
lnrind	0.408551
dum	0.027479
c	0.801335

Source: Own calculations

A one percent increase in real income tax would lead to a 0.58 percent increase in real government expenditure and a one per cent increase in real expenditure tax would lead to a 0.41 percent increase in real government expenditure.

Test for cointegration

H_0 : no cointegration
H_1 : cointegration

Table 10: Testing stationarity of the cointegrating residuals

Series	**Model**	**Lags**	**τ**
Res_g	Constant, no trend	0	-4.374807

Source: Own calculations

The variables are cointegrated at a 5 % level of significance, as -4.374807 is smaller than the calculated MacKinnon[7] critical value of -3.9227, thereby rejecting the null hypothesis at a 5 per cent level of significance, indicating cointegration.

5.3.3. Error correction model

A model incorporating the short-run effects on economic growth corrects the stochastic residuals from the long-run cointegrating regression. The results are shown in Table 11.

All the variables included in the ECM were originally I(1). Differencing them once transformed them into I(0) series. The error correction coefficient is negative and statistically different from zero. The Adjusted R squared value indicates that 94.3 % of the variation in real government expenditure is being explained by the ECM.

Table 11: Regression output of the Error Correction Model for rg

Dependent variable Δlnrg				
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**p-Value**
res_g_{t-1}	-0.734425	0.140171	-5.239477	0.0000
Δlnrdir	0.534544	0.026730	19.99764	0.0000
Δlnrind	0.403149	0.017687	22.79342	0.0000
Δlnrg(-1)	0.100714	0.037865	2.659844	0.0110
R squared = 0.946961 Adjusted R squared = 0.943173 S.E. of Regression = 0.013582				

Source: Own calculations

All the perfunctory tests were performed on the ECM, with the following results:

Table 12: Selected diagnostic results of the short-term model estimating rg

Purpose of test	Test	Test statistic	p-value	Conclusion
Normality	Jarque-Bera	JB = 3.59	0.17	Normally distributed
Serial Correlation	Ljung-Box Q	$LB_Q = 6.27$	0.99	No serial correlation
	Breusch-Godfrey	$nR^2 = 4.67$	0.09	No serial correlation
Heteroscedasticity	ARCH LM	$nR^2 = 0.728$	0.39	No heteroskedasticity
	White test	$nR^2 = 19.33$	0.15	No heteroskedasticity
Specification	Ramsey RESET	LR = 0.33	0.56	Indicative of stability

Source: Eviews 5

[7] see Appendix D

Thus given the diagnostic results at a 5 percent level of significance, it is reasonable to conclude that the residuals do satisfy the assumptions of the classical normal linear regression model.

5.4. Optimum tax mix ratio that maximises growth

The coefficients of the econometric model 1 and model 2 are now used to calculate the income tax and expenditure tax ratios for South Africa:

Growth maximising income tax ratio as a percentage of GDP

$$\tau_i * = 18.67\% * 58.08\% = 10.8\%$$

Growth maximising expenditure tax ratio as a percentage of GDP

$$\tau_e * = 18.67\% * 40.86\% = 7.6\%$$

5.5. Optimum tax ratio that maximises growth

From equation (14):

$$\tau^* = \frac{\beta}{\beta + \delta}$$

$$= \frac{0.1867}{0.1867 + 0.8032} * 100$$

$$= 18.9\ \%$$

5.6. Optimum average tax ratio that maximise revenue

From equation (19):

$$\tau^{**} = \frac{1+\beta}{1+\beta+\delta}$$

$$= \frac{1+0.1867}{1+(0.1867+0.8032)} * 100$$

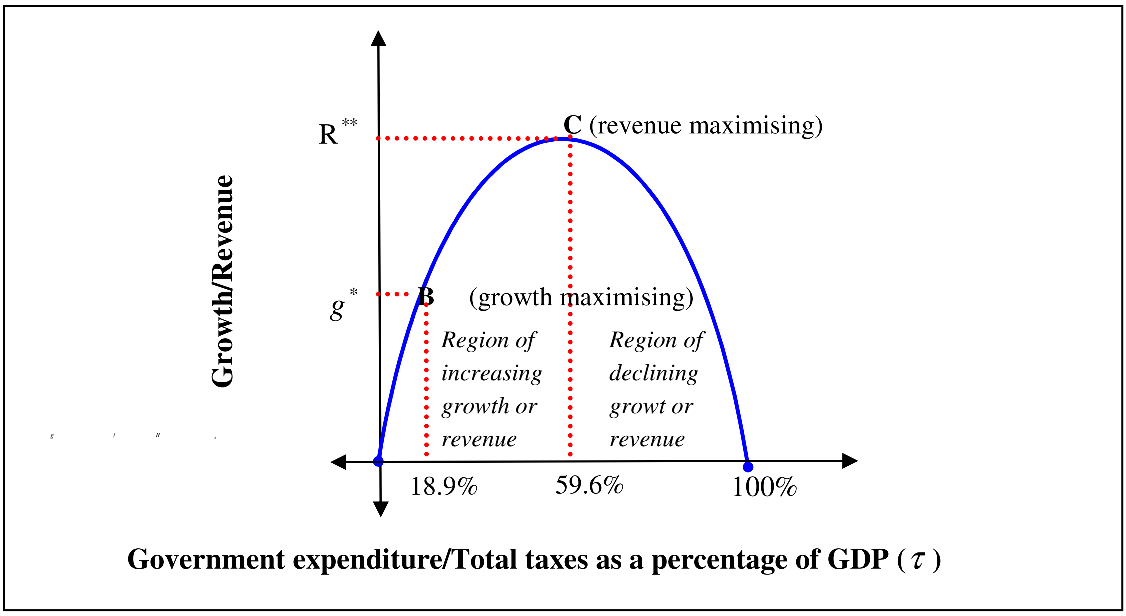
$$= 59.6\ \%$$

The results show that the tax ratio that maximises revenue is greater than the tax ratio that maximises growth.

5.7. Laffer-Armey effect for South Africa

Figure 10 illustrates the Laffer-Armey curve effect (see also Mitchell, 2002), which shows that the revenue maximising tax ratio is not the growth maximising tax ratio and that there is in fact a large gap between these ratios. The revenue maximising point is τ^{**}= 59.6% and the growth maximising point is τ^{*}= 18.9%. Thus 'excessive' government expenditure is 40.7% (59.6% - 18.9%), which could be detrimental to the future prosperity of the South African economy. As stated by De Vlieghere et al. (2006), the interest of the wealthy and the poor alike lies in growth enhancing policies (Armey curve), not in revenue maximising policies.

Figure 10: The optimum tax ratio to maximise growth and tax revenue for South Africa



According to the model, the optimum tax rate is 18.1%. The actual level of tax as a share of GDP for 2006 was 26%; in 2007 it increased to close to 28%. Thus the tax ratio that maximises growth is substantially lower than the realised rate. The optimum rate calculated is consistent with the findings of Scully (2000), with rates between 19% and 23% for the United States and New Zealand. It is also consistent with the findings of Mavrov (2007) in Bulgaria, with an optimum ratio of 21.4% for government expenditure as percentage of GDP.

The growth maximising tax ratio of 18.9% might seem too low, but according to the literature reviewed, if growth is enhanced by such a low tax ratio and the revenue base is expanded accordingly, the loss in revenue will be recovered in the long run by increased revenue. However, the optimum tax mix, with 58.1% consisting of income taxes and 40.9% of expenditure taxes to maximise the economic growth rate, seems to be very close to the actual tax mix in 2008. Thus, instead of fiddling too much with current tax mix between income and expenditure taxes, the focus should rather be on lowering the actual tax burden.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

In view of the skewed distribution of wealth in South Africa and poverty in general, it is of crucial importance that government (among others) provides public goods such as infrastructure, health, education and national security to the nation. However, such expenditures reach an optimum level, after which they become a drain on the economy's growth performance. The reason for this is that scarce resources are channelled away from more productive sectors, with the result that economies of scale of government endeavours turn negative.

The overall findings support the supply side approach, indicating that the size of government expenditure (in a balanced budget approach) does have an impact on the efficiency and growth of the economy. After examining the actual tax ratios of South Africa and other countries, it is evident that expansionary government expenditure tends to harm economic growth. Tax reform has to consider the optimum tax ratios and tax mix for South Africa to maximise growth and revenue, with a lowering in income tax and a move towards expenditure taxes. From the findings in this study, the tax mix ratio seems to be close to the optimal levels.

The analysis shows that the optimum tax ratio to maximise growth amounts to 18.9 per cent (which is lower than the current actual ratio of 28%) and the revenue maximising tax ratio is 59.6%. Excessive taxation – about approximately 30% – arises because the tax ratio that maximises revenue exceeds the ratio that maximizes growth. Thus, the finding indicates that the current average tax ratio for South Africa might be on the downward sloping portion of the Laffer curve. The tax burden, therefore, has a negative impact on economic growth. As part of tax reform, policy makers should consider the adjustment of tax rates to return to their optimum level.

The main agenda for tax reform should be to narrow the excessive gap. This is possible by imposing fewer tax brackets to the current tax structures as well as simplifying the taxes. Lower tax rates will stimulate private sector expenditure (both current and investment), with the result that economic growth will increase, thereby expanding the revenue base.

This paper is based on a balance budget approach with government expenditure equalling revenue. During periods of low/high economic growth, a deficit/surplus can occur; therefore the deficit needs to be financed through loans and other sources of income. It is pre-empted that a $\frac{debt}{gdp}$ ratio beyond the optimum 3% level (Washington Consensus) growth maximising point will negatively influence growth. However, debt financing caused by shocks such as the current downswing in the world economy and the sudden change in fiscal scenarios – as much in South Africa as elsewhere – will have to be discounted. Thus a follow-up study will be needed to explore the possibility of finding a growth optimising $\frac{debt}{gdp}$ ratio for South Africa as well.

7. REFERENCES

Aaron, H.J., Slemrod, J.2004. *The South African Tax System: A Nation in Microcosm*. Brookings. Online: http://www.brookings.edu/articles/1999/1206africa_aaron.aspx [Downloaded 21/11/2007]

Abel, A.B., Bernanke, B.S. 2005. *Macroeconomics*. Fifth edition. Pearson Education.

Anon. 2002. *The 1991 Tax Reform in Chile*. Online: http://tiss.zdv.uni-tuebingen.de/webroot/sp/spsba01_W98_1/chile5.htm [Downloaded 21/10/2008]

Agbeyegbe T., Stotsky, J.G. and Wolde, M.A. 2004. Trade Liberalization, Exchange Rate Changes and Tax Revenue in Sub-Saharan Africa, *International Monetary Fund IMF Working paper.*

Bahl, R.W. 2008. *Tax Policy in Developing Countries Looking Back—and Forward*. Online: http://ntj.tax.org/wwtax/ntjrec.nsf/009a9a91c225e83d852567ed006212d8/b3d4882a1f914cad8525748300488048/$FILE/06-Art6.pdf [Downloaded 11/102008]

Barro, R.J. 1990. Government spending in a simple model of endogenous growth, *Journal of Political Economy,* 98, pp 103-125.

Barro, R.J. and Sala-I-Martin, X. 1992. Public Finance in Models of Economic Growth. *The Review of Economic Studies*. **59** (Oct), 645-661.

Bergoeing, R., T. J. Kehoe, and R. Soto. 2002. A Decade Lost and Found: Mexico and Chile in the 1980s, *Review of Economic Dynamics.* 5, pp 166-205.

Black, P.A., Calitz, E., & Steenkamp, T.J. 2006. *Public Economics for South African Sudents*. 2nd impression. Oxford University Press.

Boadway, R., Bruce, N., Mintz, J. 1984. Taxation, inflation and the effective marginal tax rate on capital in Canada, *The Canadian Journal of Economics*, 17(1), pp 62-79.

Boylan, D.M. 1996. *Taxation and transition: The politics of the 1990 Chilean tax reform taxation and transition.* Online: http://www.jstor.org/stable/2503846 [Downloaded 08/10/2008]

Browne, G.W.G. [n.d.] Fiscal Policy in South Africa. *Economic Policy in South Africa (Selected Essays)*: 1-25. 2nd edition. Cape Town: Haum.

Branson, J. and Lovell, C.A. 2001. A Growth Maximizing Tax Structure for New Zealand. *International Tax and Public Finance* 8(2): 129-146.

Brue, S L. 2000. *The Evolution of Economic Thought*. Sixth edition. Thompson South West.

Budget Review. 2008. Pretoria, Department of Finance.

_____. 2007. Pretoria, Department of Finance.

_____. 2006. Pretoria, Department of Finance.

_____. 2002. Pretoria, Department of Finance

Budget. Department of Finance – Ireland. 2007. Online: http://www.budget.gov.ie/2007/default.html [Downloaded 2/11/2008]

Calitz, E. 1997. Is the South African economy getting stronger or weaker? Inaugural speech. Department of Economics, University of South Africa, Pretoria.

Calitz, E. 2000. Fiscal Implications of the Economic Globalisation of South Africa. *South African Journal of Economics*. Volume 68, Issue 4, pp. 252-269.

Calitz, E. 2002. *Structural Economic Reform in South Africa: Some International Comparisions.* Online: http://www.essa.org.za/download/abstracts/c200141.PDF [Downloaded 26/10/2008].

Caragata, P.J. 1998. From Welfare State to Optimal Size of government: A Paradigm Shift for Public Policy, *Agenda*, 5(3), pp 277-287

Chao, J.C.P. and Grubel, H. 1998. Optimal levels of spending and taxation in Canada. How to use the fiscal surplus. Vancouver: Fraser Institute

Clemens, J. and Veldhuis, N. 2002. *Size of Government. Studies in Economic Prosperity*. Online: www.fraserinstitute.org/Commerce.Web/product_files/Size%20of%20Government-2OntProspSizeGov.pdf [Downloaded 21/11/2007]

Corbo, V. 1992. *Economic transformation in Latin America: Lessons for Eastern Europe.* Online: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V64-45KNJK5-14&_user=59388&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_version=1&_urlVersion=0&_userid=59388&md5=08efcd9ec17534fb6d9b8e0a6313a169 [Downloaded 7/10/2008]

Dahlby, B. 2001. *Restructuring the Canadian Tax System by Changing the Direct/Indirect Tax Mix.* Online: http://oldfraser.lexi.net/publications/tax_reform/dahlby_1.pdf [Downloaded 11/10/2008]

Devarajan, S., Swaroop, V. and Zou, H. 1996. *The composition of public expenditure and economic growth*. Research Department, The World Bank, Washington, DC 20433, USA.

De Vlieghere *et al.* 2005. *The path to sustainable growth: Lessons from 20 years' growth differentials in Europe.* Online: http://workforall.net [Downloaded 11/6/2008]

Dickey, D.A. and Fuller, W.A. 1981. Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica*, 49(4), pp 1057-1072.

Engle, R.F. and Granger C.W.J. 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing, *Econometrica*, 55(2), pp 251-276.

Fatas, A. and Mihov I. 2000. Government size and automatic stabilizers: international and international evidence. *Journal of International Economics* 55 (2001) 3-28.

Feldstein, M. 2006. *The effect of taxes on efficiency and growth.* Online: http://www.nber.org/papers/w12201 [Downloaded 23/4/2008]

Feldstein, M. 1975. On the theory of tax reform. *Journal of Public Economics* (6) 77-104. North-Holland Publishing Company.

Harris, R.I.D. 1995. *Using Cointegration Analysis in Econometric Modelling*, Prentice Hall.

Gentry, W. M. (n.d). *Optimal taxation.* Columbia University. Online: http://www.taxpolicycenter.org/UploadedPDF/1000539.pdf [Downloaded 21/7/2008]

Global Policy Network. 2004. *Highlights of Current Labor Market Conditions of South Africa*. Online: http://www.gpn.org/data/southafrica/south-africa-analysis.pdf. [Downloaded 21/11/2007]

Gwartney, J.H., Lawson, H.R. *et al.* 1999. *Economic freedom and the environment for economic growth.* Online: http://mailer.fsu.edu/~jgwartne/garnet-jgwartne/Documents/JITE_Gwartney_1999.pdf [Downloaded 11/10/2008]

Gwartney, J.H., Lawson, H.R., *et al.* 1998. *The size and functions of government and economic growth.* Online: http://www.house.gov/jec/growth/function/function.pdf [Downloaded 11/10/2007]

Heijman, W.J.M., & van Ophem, J.A.C. 2005. Willingness to pay tax: The Laffer curve revisited for 12 OECD countries. *The Journal of Socio-Economics.* 34, 714-723.

Hsieh, C. & Parker, J.A. 2006. *Taxes and growth in a financially underdeveloped country: Evidence from the Chilean investment boom.* Online: http://www.nber.org/papers/w12104.pdf [11/10/2008]

Hicks, U.K. 1961. *Public Finance*. Cambridge Economic Handbook. Cambridge University Press.

Hood, R., Husband, D. & Yu, F. 2002. *Recurrent expenditure requirements of capital projects: Estimation for budget purposes.* Online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=636300#PaperDownload. [Downloaded 30/4/2008]

IMF. *IMF data and statistics*. Online: http://www.imf.org/external/data.htm [11/10/2008]

Joffe, H. 2008. *South Africa: Rise of corporate tax in mix a worry*. Online: http://allafrica.com/stories/200803180358.html [Downloaded 11/10/2008].

Katz Commission. 1999. *Interim Reports of the Katz Commission into Certain Aspects of the Tax Structure of South Africa*, Government Printer, Pretoria.

Kennedy, P.E. 2000. On measuring the Growth-Maximizing Tax Rate. *Pacific Review*, 5(1): 89-91.

Koch, S. F., Schoeman, N.J. and Tonder, J.J. 2005. Economic growth and the structure of taxes in South Africa: 1960-2002. *The South African Journal of Economics*. 73(2):190-210.

Kerr, R. 1997. *Tax Policy: Where to from here?* Online: http://www.nzbr.org.nz/documents/speeches/speeches-97/tax-policy-where-to.doc.htm [Downloaded 2/7/2008]

Laffer, A. 2004. The Laffer Curve: Past, Present and Future. *Executive Summary Backgrounder*. **1765** (June).

Lindsey, L.B. 1997. *Revenue Maximising Taxation is Not Optimal*. Online: http://www.house.gov/jec/fiscal/tx-grwth/lindsey/lindsey.htm [Downloaded 28/9/2008]

Niskanen, W.A. (n.d). *The Economic Burden of Taxation.* Online: http://www.dallasfed.org/research/pubs/ftc/niskanen.pdf [Downloaded 28/9/2008]

Maastricht. 1997. *Maastricht Guidelines on Violations of Economic, Social and Cultural Rights.* Online: http://hei.unige.ch/~clapham/hrdoc/docs/Maastrichtguidelines.html. [Downloaded 21/10/2008]

Mahon, J.E. 2004. *Causes of Tax Reform in Latin America*. Online: http://www.jstor.org/stable/1555381. [Downloaded 21/10/2008]

Margo Commision. 1987. Report of the Commission of Inquiry into the tax structure of the Republic of South Africa (Chairman: C.S. Margo). RP34/1987. Pretoria: Government Printer.

Mackness, W. 1999. *Fraser Institute Study Makes the Case for Smaller More Efficient Government.* Online: http://oldfraser.lexi.net/media/media_releases/1999/19990517.html [Downloaded 11/3/2008]

MacKinnon, JG. 1991. *"Critical Values for Cointegration Tests", in Long Run Economic Relationships, R.F.Engle and C.W.J. Granger (eds.),* London, Oxford. 267-276.

Marsden, K. 2008. *Big, Not Better?* Online: http://www.cps.org.uk/cpsfile.asp?id=1013 [Downloaded 11/3/2008]

Mavrov, H. 2007. *The Size of Government Expenditure and the Rate of Economic Growth in Bulgaria.* Online: http://alternativi.unwe.acad.bg/br18/06.pdf [Downloaded 24/7/2008]

Manual, T.A. 2002. *The South African tax reform experience since 1994, Annual Conference of The International Bar Association*. National Treasury, Communications and Media, Speeches

Mirrlees, J.A.1971. *An* Exploration in the Theory of Optimum Income Taxation., *Review of Economic Studies*, Blackwell Publishing, 38(April), pp 175-208.

Mirrlees, J.A. 2006. *Welfare, incentives and taxation.* Oxford University Press.

Mitchell, D.J. 1996. How to measure the revenue impact of changes in tax rates. The Heritage Foundation, *The Heritage Foundation. Backgrounder number 1090.*

____. 2001. Lowering Marginal Tax Rates: The Key to Pro-Growth Tax Relief. *The Heritage Foundation, Backgrounder number 1443.*

Minford, P. 1997. *Growth, employment and economic reform lessons for South Africa.* Online: http://www3.interscience.wiley.com/cgi-bin/fulltext/119146730/PDFSTART [Downloaded 21/10/2008]

Ministry of Finance. 2005. Budget speech. Pretoria: Department of Finance.

OECD. 2003. *African Economic outlook*, African Economic Outlook Report.

OECD. 2005. *Economic survey of Chile 2005*. Online: http://www.minhda.cl/publicaciones.php?opc=showContenido&id=10997&nav_id=10125&contar=1&tema_id=&code=saOfLj2Dmhxqw [Downloaded 1/1/2008]

Ortiz, G. 2003. *Overcoming reform fatigue*. Online: http://www.imf.org/external/pubs/ft/fandd/2003/09/pdf/ortiz.pdf. [Downloaded 7/10/2008]

Peden, E.A. and Bradley, M.D. 1989. Government Size, Productivity, and Economic Growth: The Post-War Experience, *Public Choice* 61, pp 229-245.

Pevcin, P. 2004. *Does optimal size of government spending exist?,* University of Ljubljana, European Group of Public Administration, Study Group on Public Finance and Management

Rosen, H.S. 2005. *Public Finance.* Seventh edition. McGraw-Hill International Edition.

Roubini, N. 2007. *Fiscal Policy in Chile.* Online: http://www.rgemonitor.com/econo-monitor/197694/editor_pick__-_fiscal_policy_in_chile [Downloaded 1/11/2008]

SARB (South African Reserve Bank). Various sources of the *Quarterly Bulletin*. Pretoria.

Schoeman, N.J. 1995. Public Debt and the Economy. *South African Journal of Economic and Management Sciences.* **16** (Winter), 65-69.

Scully, G.W. 1991. Tax rates, tax revenues and economic growth. Policy Report 98. Dallas, TX: National Centre for Policy Analysis.

____. 1996. Taxation and economic growth in New Zealand, *Pacific Economic Review*, 1(2), pp 169-177.

____. 2000. The Growth-Maximising Tax Rate, *Pacific Economic Review*, 5 (February) , pp 93-96.

____. 2002. Government expenditure and quality of life. *Public Choice*, 108, pp 123–145.

____. 2003. Optimal taxation, economic growth and income inequality, *Public Choice*, 115, pp 299–312.

Stephens, R. 1993. Radical tax reform in New Zealand. *Fiscal Studies* **14** (3), 45-63.

Tanzi, V. & Schuknecht, L. 2000. Public spending in the 20th century. Cambridge University Press.

Vreymans, P.E. 2005. *Growth differentials in Europe: An investigation into the causes - Growth stimulating policies.* Online: http://workforall.net/EN_Tax_policy_for_growth_and_jobs.html [Downloaded 11/3/2008]

Vedder, R.K. and Gallaway, L. 1998. *Government Size and Economic Growth,* Washington: Joint Economic Committee.

Wendner, R. & Goulder, L. H. 2008. *Status effects, public goods provision and the excess burden*. Online: http://mpra.ub.uni-muenchen.de/8260/ [Downloaded 21/7/2008]

World Bank. 2007. *World Development Report*.

Wing, Y. 2005. Government size and economic growth: Time-series evidence for the United Kingdom, *Econometrics Working Paper: EWP0501*

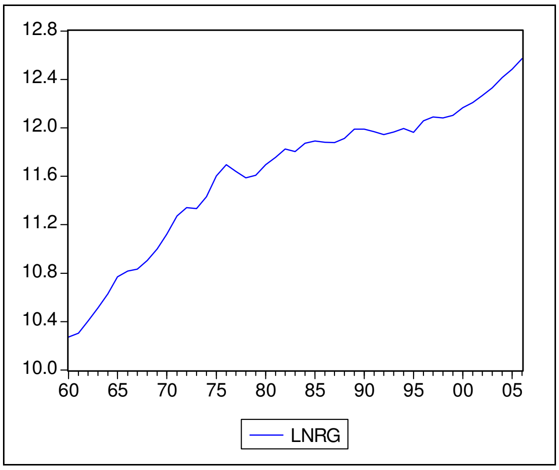
Williamson, J. 2004. *What Washington means by policy reform.* Online: http://www.iie.com/publications/papers/print.cfm?doc=pub&ResearchID=486 [Downloaded 21/10/2008]

8. APPENDICES

APPENDIX A

Real government expenditure (rg)

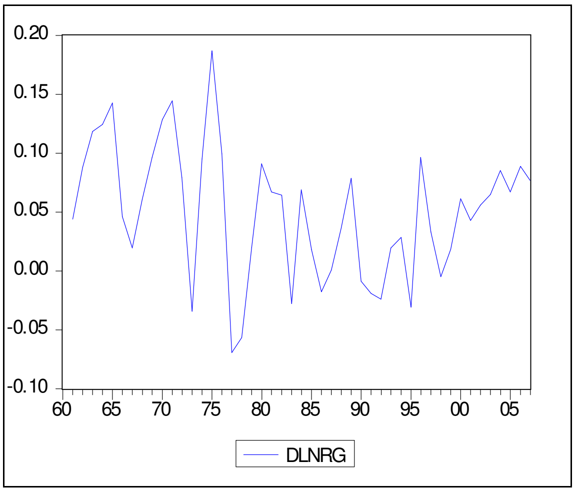
Figure 11: Natural logarithm levels of real government expenditure (LNRG)



Source: Eviews 5

Figure 11 which graphs real government expenditure in natural logarithm levels, indicates that the series does not have a constant mean and variance. The autocorrelations of the correlogram[8] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[9] proves the non-stationarity of the series.

Figure 12: Difference of the natural logarithm levels of real government expenditure (DLNRG)



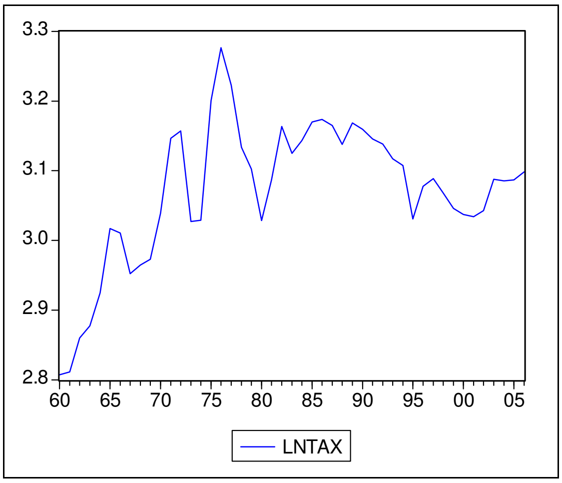
Source: Eviews 5

[8] See Appendix B
[9] See Appendix C

In Figure 12 real government expenditure in natural logarithm levels is differenced once, indicating that the series have a constant mean and variance about the trend – thus possibly stationary. The Augmented Dickey-Fuller unit root confirmed stationarity. Therefore RG~I(1).

Tax ratio (tax)

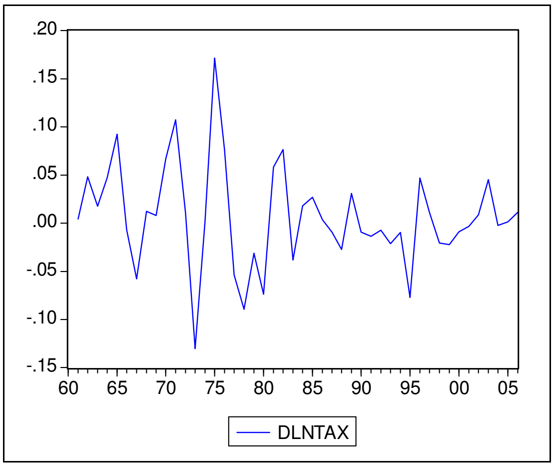
Figure 13: Natural logarithm levels of tax (LNTAX)



Source: Eviews 5

Figure 13 shows the tax ratio over time exhibiting the characteristics of a stationary time series. The autocorrelations of the correlogram[10] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root[11] test proves the non-stationarity of the series.

Figure 14: Difference of the natural logarithm levels of tax (DLNTAX)



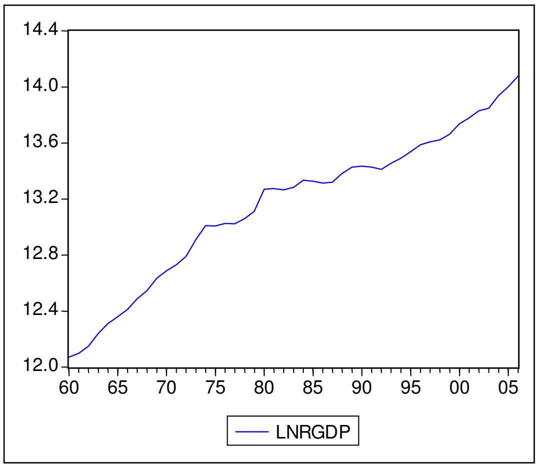
Source: Eviews 5

[10] See Appendix B
[11] See Appendix C

In Figure 14 tax in natural logarithm levels is differenced once, indicating a constant mean and variance around the trend – possibly trend stationarity. The Augmented Dickey-Fuller unit root test confirms stationarity. Therefore TAX~I(1).

Real gross domestic product (rgdp)

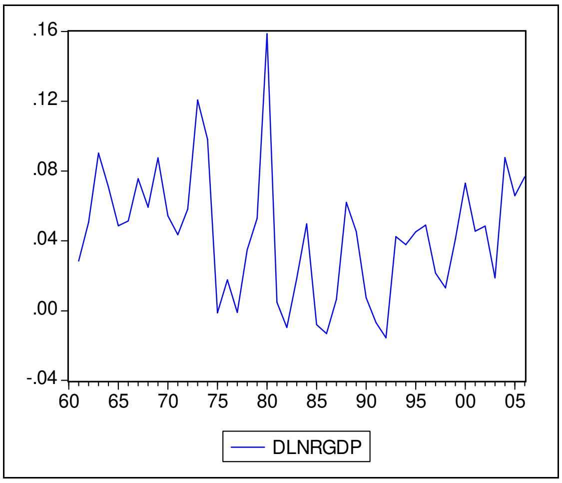
Figure 15: Natural logarithm levels of real gross domestic product (LNRGDP)



Source: Eviews 5

Figure 15 shows that real growth appears to exhibit the normal visual characteristics of a stationary time series. However, the autocorrelations of the correlogram[12] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[13] proves the suspicion of non-stationarity.

Figure 16: Difference of the natural logarithm levels of real gross domestic product (DLNRGDP)



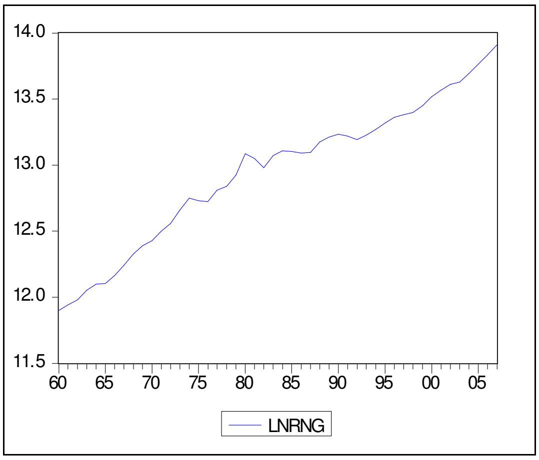
Source: Eviews 5

[12] See Appendix B
[13] See Appendix C

Figure 16 which is the graph of real GDP differenced once, indicates that the series have a constant mean and variance about the trend – indicating trend stationarity. The Augmented Dickey-Fuller unit root test confirms stationarity. Therefore RGDP~I(1).

Real non government (rng)

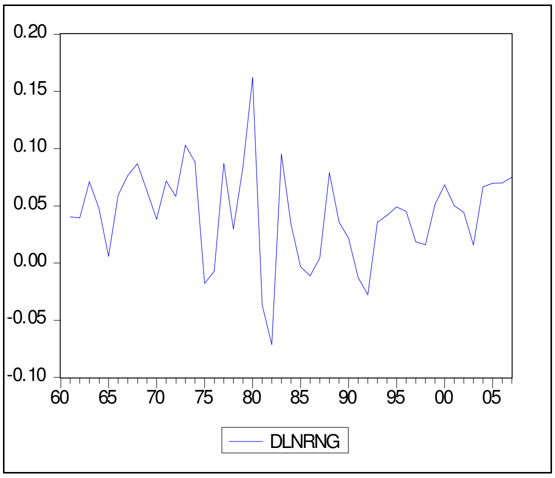
Figure 17: Natural logarithm levels of real non-government expenditure (LNRNG)



Source: Eviews 5

Figure 17 shows growth in real non government expenditure, which appears to exhibit the normal characteristics of a stationary time series. The autocorrelations of the correlogram[14] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[15] proves the suspicion of non-stationarity.

Figure 18: Difference of the natural logarithm levels of real non-government expenditure (DLNRNG)



Source: Eviews 5

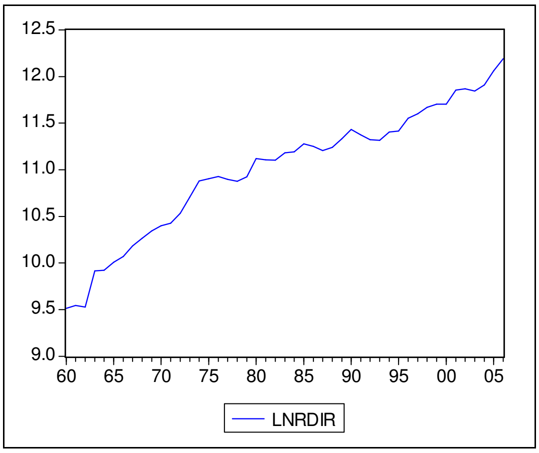
[14] See Appendix B
[15] See Appendix C

In Figure 18 real non government expenditure are differenced once, indicating that the series have a constant mean and variance about the trend – meaning it is stationary. The Augmented Dickey-Fuller unit root test confirms stationarity. Therefore RNG~I(1)

Real income tax (rdir)

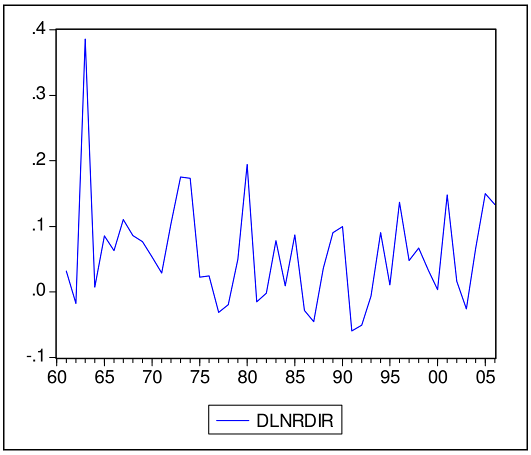
Figure 19 shows growth in real income taxes, which appears to exhibit the normal characteristics of a stationary time series. The autocorrelations of the correlogram[16] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[17] proves the suspicion of non-stationarity.

Figure 19: Natural logarithm levels of real income tax (LNRDIR)



Source: Eviews 5

Figure 20: Difference of the natural logarithm levels of real income taxes (DLNRDIR)



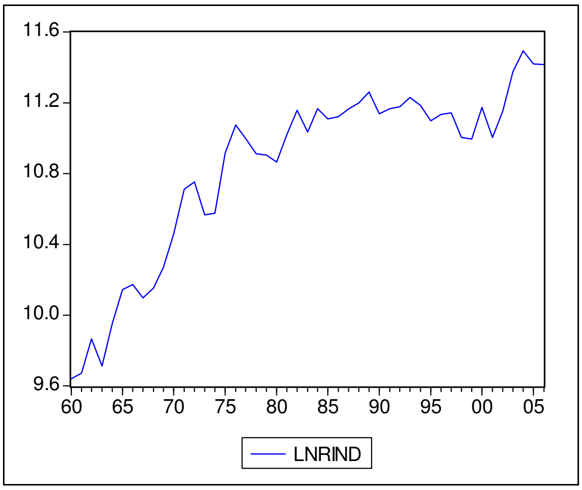
Source: Eviews 5

[16] See Appendix B
[17] See Appendix C

In Figure 20 real income taxes are differenced once, indicating that the series have a constant mean and variance about the trend – meaning it is stationary. The Augmented Dickey-Fuller unit root test confirms stationarity. Therefore RDIR~I(1)

Real expenditure tax (rind)

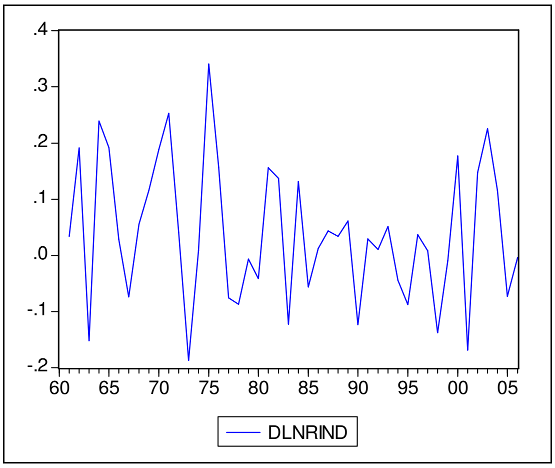
Figure 21: Natural logarithm levels of real expenditure tax (LNRIND)



Source: Eviews 5

Figure 21 shows growth in real expenditure taxes and appears to exhibit the normal characteristics of a stationary time series. The autocorrelations of the correlogram[18] take some time to taper off, thus perhaps indicating non-stationarity. The Augmented Dickey-Fuller unit root test[19] proves the suspicion of non-stationarity.

Figure 22: Difference of the natural logarithm levels of real expenditure taxes (DLNRIND)



Source: Eviews 5

[18] See Appendix B
[19] See Appendix C

In Figure 22 real expenditure tax are differenced once, indicating that the series have a constant mean and variance about the trend – meaning it is stationary. The Augmented Dickey-Fuller unit root test confirms stationarity. Therefore IND~I(1)

Dummy variable (Dum)

A dummy variable was incorporated to account for the structural break caused by the political change in 1994, which distorted the available time series.

APPENDIX B

Correlogram of lnrgdp

Date: 11/28/08 Time: 16:51
Sample: 1960 2007
Included observations: 48

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.858	0.858	37.602	0.000
. |****** |	. | . |	2	0.734	-0.009	65.706	0.000
. |***** |	. | . |	3	0.628	0.001	86.744	0.000
. |**** |	. | . |	4	0.536	-0.004	102.44	0.000
. |**** |	. | . |	5	0.460	0.006	114.24	0.000
. |*** |	. | . |	6	0.387	-0.028	122.79	0.000
. |** |	. | . |	7	0.321	-0.015	128.82	0.000
. |** |	. | . |	8	0.264	-0.008	133.01	0.000
. |** |	. | . |	9	0.210	-0.027	135.72	0.000
. |*. |	. | . |	10	0.161	-0.017	137.35	0.000
. |*. |	. | . |	11	0.118	-0.013	138.26	0.000
. |*. |	. | . |	12	0.075	-0.035	138.64	0.000
. | . |	. | . |	13	0.038	-0.015	138.74	0.000
. | . |	. | . |	14	0.009	-0.004	138.75	0.000
. | . |	. | . |	15	-0.007	0.022	138.75	0.000
. | . |	. | . |	16	-0.024	-0.019	138.79	0.000
. | . |	. | . |	17	-0.040	-0.017	138.92	0.000
. | . |	. | . |	18	-0.053	-0.005	139.14	0.000
.*| . |	. | . |	19	-0.059	0.006	139.43	0.000
.*| . |	. | . |	20	-0.061	0.007	139.75	0.000

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Correlogram of dlnrgdp

Date: 11/28/08 Time: 16:52
Sample: 1960 2007
Included observations: 47

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.312	0.312	4.8805	0.027
.*| . |	**| . |	2	-0.080	-0.197	5.2100	0.074
.*| . |	. | . |	3	-0.132	-0.046	6.1178	0.106
. |*. |	. |** |	4	0.170	0.252	7.6739	0.104
. |*. |	. | . |	5	0.151	-0.026	8.9176	0.112
. |** |	. |** |	6	0.263	0.295	12.789	0.047
. |*. |	. |*. |	7	0.193	0.103	14.928	0.037

. | . |	. | . |	8	0.043	-0.048	15.035	0.058
. |*. |	. |** |	9	0.069	0.211	15.323	0.082
. |*. |	. | . |	10	0.152	0.008	16.757	0.080
. | . |	.*| . |	11	0.029	-0.134	16.811	0.114
**| . |	***| . |	12	-0.271	-0.330	21.651	0.042
.*| . |	.*| . |	13	-0.156	-0.124	23.297	0.038
. | . |	**| . |	14	-0.049	-0.235	23.461	0.053
. |*. |	.*| . |	15	0.073	-0.076	23.845	0.068
. | . |	. | . |	16	0.011	-0.021	23.854	0.093
. | . |	. | . |	17	-0.038	-0.036	23.963	0.120
.*| . |	. |** |	18	-0.110	0.222	24.920	0.127
.*| . |	. |*. |	19	-0.118	0.116	26.058	0.129
. | . |	. |** |	20	-0.043	0.225	26.214	0.159

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Correlogram of lnrg

Date: 11/28/08 Time: 16:38
Sample: 1960 2007
Included observations: 48

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.856	0.856	37.457	0.000
. |****** |	. | . |	2	0.728	-0.020	65.123	0.000
. |***** |	. | . |	3	0.621	0.008	85.693	0.000
. |**** |	. | . |	4	0.532	0.007	101.10	0.000
. |*** |	. | . |	5	0.456	0.002	112.69	0.000
. |*** |	. | . |	6	0.387	-0.014	121.23	0.000
. |** |	. | . |	7	0.323	-0.018	127.35	0.000
. |** |	. | . |	8	0.259	-0.042	131.38	0.000
. |*. |	. | . |	9	0.196	-0.040	133.74	0.000
. |*. |	. | . |	10	0.137	-0.032	134.92	0.000
. |*. |	. | . |	11	0.087	-0.014	135.42	0.000
. | . |	. | . |	12	0.046	-0.013	135.56	0.000
. | . |	. | . |	13	0.011	-0.011	135.56	0.000
. | . |	. | . |	14	-0.026	-0.044	135.61	0.000
. | . |	. | . |	15	-0.053	0.002	135.82	0.000
.*| . |	. | . |	16	-0.069	0.010	136.18	0.000
.*| . |	. | . |	17	-0.073	0.026	136.59	0.000
.*| . |	. | . |	18	-0.078	-0.014	137.07	0.000
.*| . |	. | . |	19	-0.083	-0.015	137.64	0.000
.*| . |	. | . |	20	-0.083	0.009	138.24	0.000

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Correlogram of dlnrg

Date: 11/28/08 Time: 16:40
Sample: 1960 2007
Included observations: 47

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*** |</td><td>. |*** |</td><td>1</td><td>0.402</td><td>0.402</td><td>8.0941</td><td>0.004</td></tr>
<tr><td>.*| . |</td><td>***| . |</td><td>2</td><td>-0.121</td><td>-0.338</td><td>8.8477</td><td>0.012</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>3</td><td>-0.120</td><td>0.109</td><td>9.6022</td><td>0.022</td></tr>
<tr><td>. |** |</td><td>. |** |</td><td>4</td><td>0.222</td><td>0.271</td><td>12.233</td><td>0.016</td></tr>
<tr><td>. |*** |</td><td>. |*. |</td><td>5</td><td>0.373</td><td>0.152</td><td>19.878</td><td>0.001</td></tr>
<tr><td>. |** |</td><td>. |*. |</td><td>6</td><td>0.248</td><td>0.125</td><td>23.322</td><td>0.001</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>7</td><td>0.095</td><td>0.118</td><td>23.847</td><td>0.001</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>-0.000</td><td>-0.046</td><td>23.847</td><td>0.002</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>9</td><td>0.094</td><td>0.088</td><td>24.379</td><td>0.004</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>10</td><td>0.142</td><td>-0.050</td><td>25.634</td><td>0.004</td></tr>
<tr><td>. | . |</td><td>**| . |</td><td>11</td><td>-0.000</td><td>-0.199</td><td>25.634</td><td>0.007</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>12</td><td>0.005</td><td>0.091</td><td>25.635</td><td>0.012</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>13</td><td>0.014</td><td>-0.138</td><td>25.648</td><td>0.019</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>-0.027</td><td>-0.129</td><td>25.698</td><td>0.028</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>15</td><td>-0.148</td><td>-0.144</td><td>27.268</td><td>0.027</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>16</td><td>-0.168</td><td>-0.136</td><td>29.373</td><td>0.022</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>17</td><td>0.012</td><td>0.106</td><td>29.385</td><td>0.031</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>18</td><td>-0.026</td><td>-0.164</td><td>29.437</td><td>0.043</td></tr>
<tr><td>. | . |</td><td>. |** |</td><td>19</td><td>-0.011</td><td>0.200</td><td>29.448</td><td>0.059</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>20</td><td>-0.032</td><td>0.132</td><td>29.534</td><td>0.078</td></tr>
</table>

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Correlogram of lnrng

Date: 11/28/08 Time: 16:53
Sample: 1960 2007
Included observations: 48

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.863</td><td>0.863</td><td>38.006</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>2</td><td>0.745</td><td>0.002</td><td>66.958</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>3</td><td>0.644</td><td>0.001</td><td>89.046</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>4</td><td>0.554</td><td>-0.009</td><td>105.77</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>5</td><td>0.477</td><td>0.004</td><td>118.49</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>6</td><td>0.402</td><td>-0.038</td><td>127.72</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>7</td><td>0.333</td><td>-0.019</td><td>134.22</td><td>0.000</td></tr>
</table>

. |** |	. | . |	8	0.274	-0.005	138.74	0.000
. |** |	. | . |	9	0.220	-0.022	141.71	0.000
. |*. |	. | . |	10	0.170	-0.021	143.53	0.000
. |*. |	. | . |	11	0.124	-0.017	144.53	0.000
. |*. |	. | . |	12	0.080	-0.030	144.96	0.000
. | . |	. | . |	13	0.043	-0.011	145.09	0.000
. | . |	. | . |	14	0.011	-0.016	145.10	0.000
. | . |	. | . |	15	-0.009	0.019	145.11	0.000
. | . |	. | . |	16	-0.028	-0.016	145.16	0.000
. | . |	. | . |	17	-0.048	-0.027	145.35	0.000
.*| . |	. | . |	18	-0.059	0.013	145.63	0.000
.*| . |	. | . |	19	-0.064	0.010	145.96	0.000
.*| . |	. | . |	20	-0.060	0.020	146.27	0.000

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Correlogram of dlnrng

Date: 11/28/08 Time: 16:53
Sample: 1960 2007
Included observations: 47

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.144	0.144	1.0343	0.309
***| . |	***| . |	2	-0.344	-0.373	7.0999	0.029
. |*. |	. |** |	3	0.077	0.236	7.4122	0.060
. | . |	**| . |	4	0.014	-0.233	7.4231	0.115
. |*. |	. |*** |	5	0.129	0.400	8.3335	0.139
. |** |	. | . |	6	0.302	0.048	13.441	0.037
. | . |	. |*. |	7	0.023	0.192	13.472	0.061
.*| . |	.*| . |	8	-0.135	-0.126	14.546	0.069
. | . |	. |*. |	9	0.006	0.101	14.548	0.104
. |** |	. |*. |	10	0.199	0.127	17.021	0.074
. |*. |	.*| . |	11	0.098	-0.071	17.631	0.091
.*| . |	.*| . |	12	-0.142	-0.117	18.961	0.089
.*| . |	**| . |	13	-0.167	-0.242	20.860	0.076
.*| . |	.*| . |	14	-0.096	-0.111	21.508	0.089
.*| . |	**| . |	15	-0.083	-0.314	22.001	0.108
. | . |	. | . |	16	0.060	0.023	22.264	0.135
. | . |	.*| . |	17	0.054	-0.167	22.486	0.167
.*| . |	. |*. |	18	-0.128	0.157	23.791	0.162
.*| . |	. | . |	19	-0.077	0.043	24.274	0.186
. | . |	. |** |	20	0.019	0.227	24.304	0.229

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Correlogram of lnrdir

Date: 11/28/08 Time: 16:54
Sample: 1960 2007
Included observations: 48

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.847	0.847	36.643	0.000
. |****** |	. | . |	2	0.720	0.008	63.682	0.000
. |***** |	. | . |	3	0.605	-0.023	83.224	0.000
. |**** |	. | . |	4	0.522	0.046	98.092	0.000
. |*** |	. | . |	5	0.444	-0.022	109.07	0.000
. |*** |	. | . |	6	0.371	-0.023	116.95	0.000
. |** |	. | . |	7	0.309	-0.002	122.54	0.000
. |** |	. | . |	8	0.257	-0.001	126.51	0.000
. |** |	. | . |	9	0.204	-0.039	129.06	0.000
. |*. |	. | . |	10	0.157	-0.011	130.62	0.000
. |*. |	. | . |	11	0.112	-0.024	131.44	0.000
. | . |	. | . |	12	0.065	-0.049	131.72	0.000
. | . |	. | . |	13	0.027	-0.006	131.77	0.000
. | . |	. | . |	14	0.000	0.004	131.77	0.000
. | . |	. | . |	15	-0.011	0.026	131.78	0.000
. | . |	. | . |	16	-0.023	-0.011	131.82	0.000
. | . |	. | . |	17	-0.035	-0.013	131.91	0.000
. | . |	. | . |	18	-0.044	-0.003	132.07	0.000
. | . |	. | . |	19	-0.051	-0.007	132.29	0.000
. | . |	. | . |	20	-0.056	-0.003	132.56	0.000

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Correlogram of dlnrdir

Date: 11/28/08 Time: 16:54
Sample: 1960 2007
Included observations: 47

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.008	-0.008	0.0034	0.953
.*| . |	.*| . |	2	-0.088	-0.088	0.3967	0.820
.*| . |	.*| . |	3	-0.082	-0.084	0.7466	0.862
. | . |	. | . |	4	0.021	0.011	0.7699	0.942
. |*. |	. |*. |	5	0.131	0.118	1.7072	0.888

. |*. |	. |*. |	6	0.124	0.127	2.5685	0.861
. | . |	. |*. |	7	0.061	0.094	2.7826	0.904
.*| . |	. | . |	8	-0.062	-0.018	3.0083	0.934
. |*. |	. |*. |	9	0.068	0.096	3.2917	0.952
. |*. |	. |*. |	10	0.137	0.133	4.4601	0.924
. |*. |	. |*. |	11	0.113	0.106	5.2731	0.917
.*| . |	.*| . |	12	-0.152	-0.151	6.7880	0.871
.*| . |	.*| . |	13	-0.098	-0.100	7.4446	0.878
.*| . |	.*| . |	14	-0.095	-0.156	8.0811	0.885
. | . |	.*| . |	15	-0.021	-0.144	8.1138	0.919
. | . |	.*| . |	16	0.039	-0.098	8.2263	0.942
. |*. |	. |*. |	17	0.179	0.157	10.689	0.872
.*| . |	.*| . |	18	-0.115	-0.061	11.746	0.860
.*| . |	. | . |	19	-0.094	0.001	12.465	0.865
. | . |	. |*. |	20	0.035	0.087	12.571	0.895

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

Correlogram of lnrind

Date: 11/28/08 Time: 16:56
Sample: 1960 2007
Included observations: 48

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.865	0.865	38.251	0.000
. |****** |	.*| . |	2	0.726	-0.092	65.758	0.000
. |***** |	. |*. |	3	0.641	0.137	87.655	0.000
. |**** |	.*| . |	4	0.551	-0.085	104.19	0.000
. |**** |	. |*. |	5	0.489	0.100	117.55	0.000
. |*** |	.*| . |	6	0.428	-0.068	127.99	0.000
. |*** |	. | . |	7	0.352	-0.049	135.24	0.000
. |** |	**| . |	8	0.246	-0.190	138.88	0.000
. |*. |	. | . |	9	0.169	0.057	140.63	0.000
. |*. |	.*| . |	10	0.106	-0.072	141.34	0.000
. | . |	. | . |	11	0.046	-0.000	141.47	0.000
. | . |	. | . |	12	0.002	-0.029	141.47	0.000
. | . |	. | . |	13	-0.037	0.007	141.57	0.000
.*| . |	.*| . |	14	-0.096	-0.119	142.22	0.000
.*| . |	. | . |	15	-0.154	-0.027	143.95	0.000
.*| . |	. | . |	16	-0.176	0.037	146.27	0.000
.*| . |	. |*. |	17	-0.165	0.102	148.38	0.000
.*| . |	.*| . |	18	-0.170	-0.087	150.69	0.000
.*| . |	. | . |	19	-0.175	0.014	153.23	0.000
.*| . |	. |*. |	20	-0.157	0.066	155.34	0.000

Autocorrelation do not seem to converge very quickly therefore the series appears to be non-stationary.

Correlogram of dlnrind

Date: 11/28/08 Time: 16:55
Sample: 1960 2007
Included observations: 47

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.003	0.003	0.0003	0.986
***| . |	***| . |	2	-0.320	-0.320	5.2492	0.072
. | . |	. | . |	3	-0.033	-0.035	5.3060	0.151
. | . |	.*| . |	4	0.036	-0.074	5.3752	0.251
. |*. |	. |*. |	5	0.167	0.163	6.9056	0.228
. |** |	. |** |	6	0.225	0.247	9.7542	0.135
. |*. |	. |** |	7	0.096	0.257	10.287	0.173
**| . |	. | . |	8	-0.221	-0.055	13.162	0.106
.*| . |	. | . |	9	-0.113	-0.035	13.935	0.125
. |*. |	. | . |	10	0.159	0.010	15.513	0.114
. |*. |	. | . |	11	0.112	-0.029	16.313	0.130
. | . |	.*| . |	12	-0.004	-0.064	16.315	0.177
. | . |	. | . |	13	0.013	0.030	16.326	0.232
. | . |	. | . |	14	-0.049	0.010	16.495	0.284
.*| . |	.*| . |	15	-0.123	-0.077	17.592	0.285
. | . |	.*| . |	16	0.004	-0.089	17.593	0.348
. |*. |	. | . |	17	0.108	-0.033	18.488	0.359
. | . |	.*| . |	18	-0.037	-0.080	18.597	0.417
. | . |	. | . |	19	-0.021	0.036	18.634	0.481
. |*. |	. |*. |	20	0.066	0.112	19.006	0.521

Autocorrelations do seem to converge very quickly; therefore the series appears to be stationary.

From the correlograms of the data, the assertion that these series are integration of order one I(1) are credible.

APPENDIX C

Augmented Dickey Fuller unit root test on variables

H0 : ρ= 0 (non-stationarity)
H1 : ρ< 0 (stationarity)

Summary of Results

	Model	*Lags*	$\tau_{\tau}, \tau_{\mu}, \tau$	ϕ_3, ϕ_1	*Conclusion*
LNRDIR	Trend & Intercept	0	-2.337	3.073	Non-stationarity
	Intercept	0	-1.322	1.748	
	None	1	4.889		
LNRIND	Trend & Intercept	1	-2.233	3.337	Non-stationarity
	Intercept	1	-2.310	5.336**	
	None	0	1.660		
LNRG	Trend & Intercept	2	-2.662	7.007***	Non-stationarity
	Intercept	2	-2.426	7.576***	
	None	2	3.385		
LNRNG	Trend & Intercept	0	-1.765	1.729	Non-stationarity
	Intercept	2	-1.213	3.044	
	None	0	6.866		
LNRGDP	Trend & Intercept	0	-1.816	2.129	Stationarity
	Intercept	0	-1.312	1.723	
	None	0	8.1707		
ΔLNRDIR	Trend & Intercept	1	-6.764***	22.472***	Stationarity
	Intercept	1	-6.658***	44.3371***	
	None	1	-4.622***		
ΔLNRIND	Trend & Intercept	2	-6.906***	19.688***	Stationarity
	Intercept	2	-6.622***	27.36***	
	None	1	-6.307***		
ΔLNRG	Trend & Intercept	2	-5.313***	9.54***	Stationarity
	Intercept	2	-4.983***	12.550***	
	None	2	-1.432		
ΔLNRNG	Trend & Intercept	1	-5.593***	15.672***	Stationarity
	Intercept	1	-5.627***	31.664***	
	None	1	-3.348***		
ΔLNRGDP	Trend & Intercept	0	-4.736***	11.218***	Stationarity
	Intercept	0	-4.699***	22.08***	
	None	0	-2.532**		

*(**)[***] Statistically significant at a 10(5)[1] % level

The results of the formal unit root tests ADF clearly show that DIR, IND, RG, RNG, RGDP test stationarity (null hypothesis is not rejected) after first differencing. The assertion that these series are integrations of order one I(1) is credible.

APPENDIX D

Use the MacKinnon response surface calculation to determine the critical value for cointegration test.

$C(p) = \phi\infty + \phi 1 {*} T^{1} + \phi 2 {*} T^{2}$

10%:	C(10)	= -3.4518 + (-6.241)(47^-1) + (-2.79)(47^-2)
		= -3.5859
5%:	C(5)	= -3.7429 + (-8.352)(47^-1) + (-13.41)(47^-2)
		= -3.9267
1%:	C(1)	= -4.2981 + (-13.79)(47^-1) + (-46.37)(47^-2)
		= -4.6125

n = 3