

ECONOMIC GROWTH AND THE STRUCTURE OF TAXES IN SOUTH AFRICA: 1960 - 2002^{*}

STEVEN F. KOCH^{*}, NIEK J. SCHOEMAN[°] AND JURIE J. VAN TONDER[♦]

Abstract

One tenet of taxation is its distorting effect on economic behaviour. Despite the economic inefficiencies resulting from taxation, it is widely believed that taxes impact minimally on the economy's growth rate. Evidence in developing countries generally supports this view. In this paper, we present evidence that tax distortions in South Africa may be much more severe. Using tax and economic data from 1960 to 2002 and a two-stage modelling technique to control for unobservable business cycle variables, we examine the relationship between total taxation, the mix of taxation and economic growth. We find that decreased tax burdens are strongly associated with increased economic growth potential; in addition, contrary to most theoretical research, decreased indirect taxation relative to direct taxation is strongly correlated with increased economic growth potential. J.E.L. Classification: H21, 047 Keywords: tax burden, tax mix, translog, Data Envelopment Analysis

1. INTRODUCTION

ELEMENTARY ECONOMIC ANALYSIS of taxation primarily focuses on the tax burden. Under most situations, the primary burden of a tax is a decrease in economic activity, referred to as deadweight loss. A simple extension of the standard model, allowing for taxes on all goods and activities, implies a reduction in economic activity in every market in the economy, and, therefore, taxes would be expected to negatively affect economic growth in an economy. However, that simple analysis ignores a number of other issues. Most importantly, if the government uses the collected tax revenues to fund investment in social goods, especially goods resulting in external benefits (infrastructure, education and public health, for example), the economic growth rate could be positively influenced by taxation. Furthermore, if money is transferred from people with low marginal utilities of income (rich) to people with high marginal utilities of income (poor), while revenues are additionally used to fund public investment, then the economy can gain from this 'double-dividend' of taxation. Therefore, measuring the

The authors would like to thank two anonymous referees for their thorough and helpful comments. Their comments have greatly improved this paper. The authors would also like to thank Renee van Eyden, Moses Sichei, Marc Ground, and Cristina Moolman for their help with the empirical modelling, and Zurica Cluasen-Robinson for her help uncovering relevant tax policy materials. In addition, Neil Cohen, Jan van Heerden, James Blignaut, and participants at the 2003 Biennial Conference of the Economic Society of South Africa provided useful insights, which helped improve this paper. No attempt is made to implicate anyone, other than the authors, for any errors that may still remain in the paper.

^{*} Corresponding author; Associate Professor of Economics, Department of Economics, University of Pretoria, Pretoria 0002, Republic of South Africa, steve.koch@up.ac.za

[°] Professor of Economics, Department of Economics, University of Pretoria, Pretoria 0002, Republic of South Africa, niek.schoeman@up.ac.za

[♦] Senior Lecturer in Economics, retired, Department of Economics, University of Pretoria, Pretoria 0002, Republic of South Africa.

economic effect of taxation ought to be a simple exercise in determining whether or not the benefits of government expenditures exceed the costs of taxation.

Unfortunately, it is not easy to directly determine the net benefits of taxation and, therefore, to determine whether or not taxes are benevolent. For example, if taxation pushes economic activity underground, we would find that it lowers economic growth when, in fact, it is merely shifting economic activity from the measured economy to the unmeasured economy, *i.e.*, we are overstating the negative effects of taxation on economic growth. On the other hand, if many markets are characterized by low elasticities, so that economic activity is not significantly affected, but the government purchases imported goods with the tax revenues, then GDP and economic growth will be lower due to the dual leakages, taxation and importation. Therefore, a complete analysis of the economic effects of the fiscus on an economy would examine the impacts of expenditures and taxes. The results reported in this paper represent the first stage of research into these issues conducted on the South African economy. Rather than comparing the benefits of government expenditure with the costs of taxation, we examine the relationship between taxation and economic growth.

Any analysis of the relationship between taxation and economic activity must account for other variables. In particular, economic growth in an economy could be high due to international factors; in the case of South Africa, inflation in the developed world in the late 1970s and early 1980s led to increased demand for gold, which, in turn, led to increased economic growth. Unfortunately, it is impossible to include data on all of the things that might have contributed to or detracted from economic growth in South Africa during the time period of our analysis. For that reason, in this paper, we report the results from a two-stage model that controls for non-included variables in a different way. The two-stage procedure is similar in concept to instrumental variables estimation, although the application is different, due to parametric considerations, from two stage least squares.

We proceed by investigating South African tax policy, the expected effect of those tax policies and relevant research in section 2. In section 3, we discuss the analytical framework used to measure the impact of taxes on economic growth. We provide a preliminary analysis of the data, including the control for unobservable economic variables, in section 4. We present and discuss the results of the analysis in section 5, and provide concluding remarks in section 6.

2. BACKGROUND

(a) Economic Growth and Taxes: A. Review of the Literature

Theoretically and empirically, it has been shown that taxes affect the allocation of resources, and, often, distort the underlying behaviour of economic agents. Regarding economic growth, taxes influence the labour-leisure trade-off and investment decisions. Due to the importance of labour and capital in determining economic growth, it is surprising that the relationship between economic growth and taxes has not featured more prominently.

In what is now referred to as Harberger's superneutrality conjecture, Harberger (1964: 62-63) stated, "...this boils down to the question of how significantly the rate of growth could be influenced by plausible changes in the mix of direct and indirect taxation. I think that the answer is not very much." He further showed that changes in the mix of direct and indirect taxes do not alter labour supply or investment rates

sufficiently and influence rates of economic growth only negligibly. Harberger's superneutrality conjecture has been supported theoretically as well as empirically. Hall (1968) develops a savings-consumption model finding that tax changes will only lead to transitory changes in growth. Hall, who applies a neoclassical growth model, relies on exogenous technical change and population growth which, by assumption, are not likely to be significantly influenced by the economy's tax structure.¹

Models of endogenous growth, however, may provide a theoretical link between economic growth and tax policy.² For example, Lucas (1990), Jones and Manuelli (1990), King and Rebelo (1990) and, more recently, Yamarik (2001) all argue that economic growth is retarded by taxation. Analyses by Pecorino (1993, 1994) suggest economic growth could be increased significantly, from 1.53 per cent per annum to 2.56 per cent per annum in the US, if the tax mix were shifted away from income taxes towards non-distorting consumption taxes. However, Stokey and Rebelo (1995) and Mendoza, Milesi-Ferrett, and Asea (1997), who also make use of endogenous growth models in their analyses, find negligible negative effects of taxation on economic growth in developed economies. As an example of the small effects, Engen and Skinner (1996) report that a 5 per cent reduction in average tax rates in the US would likely add 0.25 per cent per year to economic growth.³ An important feature of these models is the assumption that taxes are returned to consumers, efficiently — an assumption that may not be realistic in developing countries.

Although a consensus appears to be emerging regarding the impact of tax policy on economic growth in the developed world, primarily the US, less analysis has taken place in the developing world. However, the research that has been undertaken suggests that the impact of taxation in developing economies is larger than it is in developed economies. Marsden (1990) groups 20 developing countries into high tax and low tax regimes and finds that the low tax group averaged 7.3 per cent growth, but the high tax group only 1.1 per cent. Wang and Yip (1992) show that the structure of taxation is more important than the level of taxation in explaining economic growth in Taiwan from 1954 to 1986. Their empirical estimates show significant and negative impacts of specific taxes on economic growth, but the effect of total taxation is not significant. Kim (1998) compares economic growth and taxation in the US with economic growth and taxation in Korea. According to his analysis, 35 per cent of the difference between US and Korean economic growth can be explained by differences in the tax structure between the two countries. Kerr and MacDonald (1999) find mixed evidence that the ratio of indirect taxes to direct taxes negatively and significantly affects economic growth in seven Asian economies. On the other hand, Tanzi and Shome (1992) uncover no obvious uniformities between the tax policies of eight Asian economies concluding, "...tax structure may become largely irrelevant when macroeconomic

¹ More specifically, if exogenous technical progress is the main determinant of economic growth, tax policy can only affect long-run income and not long-run economic growth, primarily because capital accumulation only covers depreciation and population growth in these models.

² Endogenous growth models allow for continued capital accumulation, beyond depreciation and population growth in steady-state, *e.g.*, capital accumulation depends upon the net return to investment, which is affected by tax policy.

³ Although the yearly effect is small, accumulation of that quarter percent over 36 years from 1960 implies an overall increase of 7.5 per cent of GDP, approximately \$500 billion in 1996 (calculation reported in Engen and Skinner, 1996).

problems become predominant, and the distortions created by the tax system become of a second order magnitude..."

Due to the structural problems in African economies and the results of Tanzi and Shome's analysis, we might expect the effects of taxation to be minimal in Africa. Although Africa has received less attention than Asia, Skinner (1987) estimates the effect of taxation in Sub-Saharan Africa over the period 1965 to 1982. He finds that personal and corporate income taxes have a significant and negative effect on economic growth; trade taxes also reduce economic growth, indirectly, in the region, while sales and excise taxes have no significant effect on economic growth. Based upon Skinner's analysis, we tentatively conclude that the tax structure may not be largely irrelevant on the continent, as was implied by Tanzi and Shome.

For a number of reasons, the impact of taxation in the developed world is likely to be different from the impact in the developing world, especially in Africa, and, therefore, taxation in Africa, which has received little attention, merits further study. Importantly, developing countries do not have the infrastructure to adequately police tax compliance; thus, shifts in tax policies in developing countries, especially increases in income taxes, are likely to push economic activity underground.⁴ Furthermore, governments in developing countries may not return taxes back to the public in an efficient manner (*e.g.*, by not adequately investing in public goods),⁵ or governments might be corrupt or otherwise not trustworthy (*e.g.*, by squandering resources on lavish residences, by changing tax policies in an *ad hoc* manner, or taking control of economic resources).⁶ Finally, government agents have the incentive to increase the tax base of taxed activities. In the case of developing countries, which often rely on corporate taxes imposed on large (often state-owned) companies, the tax structure provides incentives to increase the profits of these companies, often to the detriment of competition, which could have significant economic growth effects.⁷

(b) South African Tax Policy: 1960-2002

Tax policy in South Africa has been scrutinized and revised continuously since 1960.

Given the political and structural changes that have occurred since the complete democratisation of the country in 1994, fiscal policy will be dissected into two time periods.

(i) Fiscal Policy Preceding 1994 Preceding 1994, South Africa operated under apartheid, and the government continually increased expenditures on defence, in an effort to stabilize the country through covert military operations. Government expenditure

⁴ This inframarginal behaviour is not limited to developing economies, Small and Cartaga (n.d.) estimate that a one unit increase in the tax burden (from 29-30 per cent) in New Zealand leads to a 0.1 per cent increase in the size of the informal economy.

⁵ Skinner (1987) finds that a 5 per cent increase in public investment, financed through taxation, reduces growth by a approximately 0.6 per cent in Sub-Saharan Africa between 1974 and 1982.

⁶ McMillan and Masters (2000) develop a model of economic growth and government policy based on time-consistent behaviour showing that government commitment devices improve the incentives for economic agents to invest, beyond subsistence levels, and, thus, are likely to improve economic growth.

⁷ Gordon and Wilson (1999) develop a theoretical model showing that incentives within government are likely to be just as important in explaining government behaviour as are incentives in explaining other economic agent behaviour.

increased from 20 to 27.5 per cent of GDP, during the period 1970 to 1994, while total taxation increased from 17 to 22 per cent of GDP.⁸ Between 1970 and 1994, budget deficits averaged 3.6 per cent of GDP, with a maximum of 7.3 per cent in 1993. Fortunately, minimum reserve requirements provided a captive market for borrowing, which alleviated the need to collect additional revenue. Nonetheless, due to a substantial increase in revenue collection, the debt/GDP ratio gradually declined to 29.6 per cent in 1982, from 43.6 per cent in 1970, after which it increased again to 43.5 per cent in 1994.⁹ Government appointed a few commissions to investigate the fiscal situation and provide future policy guidance, with the Franszen Commission (1970) pointing to the potential negative impact of increased tax burdens.¹⁰

As far as indirect taxes are concerned, government initially relied on sales duties with high rates and a very narrow base. By 1978, the sales duties had been replaced by a 4 per cent general sales tax (GST). The GST broadened the indirect tax base and allowed for the reduction in marginal personal income tax rates.

Another commission, the Margo Commission, undertook a similar review of fiscal policy in 1987. The Commission operated during a period of rampant inflation and foreign disinvestments, a result of international pressure against apartheid. The Commission recommended a number of changes, although they were similar in nature to the proposals of the Franszen Commission.¹¹ Two of the most important changes regarding taxes in South Africa resulted from this report: the GST was dropped in favour of an invoice-based value added tax (VAT), and a reduction in company tax rates to 35 per cent (although the reduction might have been mitigated by the simultaneous introduction of the secondary tax on companies (STC), which was an incentive for companies to retain earnings for investment purposes).

(it) Fiscal Policy from 1994 Following the transition to complete suffrage in 1994, fiscal policy was redefined and, in order to assist the government with tax policy, a new commission, the Katz Commission, was appointed. Various tax law changes and amendments followed, all aimed at broadening the tax base, reducing government borrowing pressures, closing loopholes, and improving the neutrality of the tax base, all aimed at improving economic performance. The government adopted the residence principle of taxation from the beginning of 2001 and, shortly before, introduced foreign dividend taxation, successfully extending the tax base to include foreign source income. The intention was, in addition to expanding the base, to improve fairness and establish a global presence for South African corporations.

The government also pursued various supply-side policies, allowing for accelerated depreciation allowances and tax holidays as part of its macroeconomic strategy for

⁸ All percentages are extracted from the South African Reserve Bank (www.reservebank.co.za).

⁹ The impact of absorbing the former Homelands debt between 1990 and 1995 raised the ratio from 36.9 to 49 per cent.

¹⁰ In particular, the Franszen Commission recommended: a reduction in the progressiveness of the direct tax structure, abolishment of the source basis of taxation, a shift toward indirect taxation, a broadening of the income tax base through redefinition; all, but the last proposal, were adopted

¹¹ The Margo Commission recommended: fringe benefit taxation, lower and fewer personal income tax rates with fewer deductions, equal treatment of men and women (especially, marriage neutrality), no capital gains taxes, a modification of GST, a capital transfer tax, and retention of the source basis of taxation.

growth, employment, and redistribution (GEAR). However, a capital gains tax was introduced, potentially reducing the supply-side benefits of other tax changes. Importantly, though, the improvements in neutrality would have had the potential for significant supply-side benefits, both in terms of GDP and economic growth.

Since 1994, the budget deficit was reduced from 7 per cent of GDP to an expected 2.3 per cent of GDP in 2003, primarily due to improvements in revenue collections. The debt/GDP ratio declined from 49.1 per cent in 1995 to an expected 37.0 per cent in 2004. Despite the increase in public savings, as a result of the increase in the tax base, better revenue collections and other tax changes, private savings had fallen. The decrease in private savings has offset any increase in public savings. Due to the minimal total savings change over the last decade, it is unlikely that any supply-side benefits, resulting in increased economic growth, have been wrought from the improved fiscal position of government.

3. ANALYTICAL FRAMEWORK

Borrowing from the endogenous economic growth framework (Lucas, 1988) and Data Envelopment Analysis (Koopmans, 1951; Farrell, 1957), we consider a two-stage procedure to estimate the relationship between fiscal policy and economic growth. The initial stage of the model uses Data Envelopment Analysis (DEA) to provide estimates of exogenous factors for which we do not have data, while the second stage uses the first stage estimates to normalize the economic growth rates, yielding unbiased estimates of the relationship between potential economic growth and taxation. Branson and Lovell (2001) developed the two-stage procedure, although we modify the second stage estimating equation to take into account South African features of the scaling factors and the time series features that are apparent in the data, while also considering a different empirical specification.

(a) *A. Simple Growth Model*

Suppose that the South African economy is governed by a constant returns to scale production function of the form $Y_t = F(A_t, K_t, N_t)$, where A_t represents technology at time t , K_t represents the nation's capital stock at time t , and N_t represents its human capital at time t . Taking the natural log of the production function, differentiating with respect to time and manipulating slightly yields the following growth equation:¹²

$$y_t = \sigma_a a_t + \sigma_k k_t + \sigma_n n_t \quad (1)$$

where, due to CRS, $\sigma_a + \sigma_k + \sigma_n = 1$. The lower case letters in equation (1) represent log growth rates of their upper case counterparts, and the subscripted represents the input elasticities for inputs $i = \{a, k, n\}$

In order to incorporate endogenous growth concepts, we presume that tax policy directly and indirectly affects the growth rates of each of these production inputs, as well as their appropriate elasticities, as suggested by Engen and Skinner (1996). Intuitively, income, business, consumption taxes and user fees alter the incentives to invest in physical and human capital, and, therefore, will alter the growth rates of

¹² We do not formally develop a model of endogenous growth. However, because we do not assume exogenous technical progress, we are analysing a model more akin to endogenous than exogenous growth.

human and physical capital inputs, as well as technical progress. Furthermore, changes in tax policy are also likely to influence the relative cost of physical and human capital and research and development expenditures; therefore, changes in tax policy are expected to affect the input elasticities for human capital, physical capital and technical progress, as well.

We consider, as suggested by Branson and Lovell (2001), two separate measures of tax policy. One is the tax burden (denoted b), or the ratio of total real tax revenues to real GDP. The other is the tax mix (denoted m), or the ratio of indirect taxes to direct taxes. Because these tax policies may influence any or all of the variables on the right hand side of equation (1), we will examine economic growth as a function of these two tax policies and other economic growth determinants (represented by the vector Z):

$$y_t = H(b_t, m_t; Z^t) + \varepsilon_t. \quad (2)$$

Empirically, equation (2) is difficult to estimate due to the fact that other important factors, as represented by Z , cannot be included in the model, because they cannot be observed. If the variables in Z were uncorrelated with the tax burden and the tax mix, we could estimate equation (2) without concern for bias. However, the assumption of no correlation between the unobserved variables in Z , the tax burden, and the tax mix is not reasonable.¹³ One option for dealing with presumed correlation is estimation with the use of instrumental variables; however, finding an instrument that is correlated with Z , but not with the tax mix or tax burden, is difficult (see footnote 13). For that reason, it is desirable to find an alternative approach.

(b) Data Envelopment Analysis

One approach that lends itself well to the problem, although not parametric, is based on Data Envelopment Analysis (DEA).¹⁴ As the name suggests, the technique envelops the data so that observations on the "edge of the envelope" represent economic frontiers. Once the "edge of the envelope" has been uncovered, it is possible to determine how far the remaining observations are from the frontier using a simple scaling factor. In our analysis, we are searching for the smallest reciprocal tax burden consistent with the observed growth rate, given all other tax burdens and growth rates observed in the economy over the time horizon. The effect of the model in this scenario is that the scaling factors can be used to normalize production, which in this case is economic growth. Therefore, normalized economic growth is really potential economic growth.

If we observe the real GDP growth rate (g), the ratio of GDP to direct taxes (Y/D), and the ratio of GDP to indirect taxes (Y/I) from 1960 to 2002, we can solve the following linear programme:¹⁵

¹³ For example, oil shocks, which in the past have led to inflation jitters around the world, and thus, increased the demand for gold, have positively affected growth in South Africa. Mineral extraction fees and profits taxes, especially for mining companies would also have risen during these time periods. Therefore, it is hard to imagine a case where changes affecting economic growth do not also affect tax collection.

¹⁴ Because the analytical technique is a linear programme, there is little scope for statistical investigations of the results computed in the first stage of our analysis.

¹⁵ See Branson and Lovell (2001). The programme is solved using Frontier Analyst®, from Banxia Software.

$$\begin{aligned}
& \underset{\theta, \lambda}{\text{Min}} \quad \theta^t \\
& \text{Subject to:} \quad \theta^t \cdot \left(\frac{Y}{D} \right)^p \geq \sum_t \lambda^t \cdot \left(\frac{Y}{D} \right)^t \\
& \quad \theta^t \cdot \left(\frac{Y}{I} \right)^p \geq \sum_t \lambda^t \cdot \left(\frac{Y}{I} \right)^t \\
& \quad \sum_t \lambda^t g_y^t \geq g_y^p \\
& \quad \lambda^t \geq 0 \quad \forall t \in \{1, \dots, p, \dots, T\} \\
& \quad \sum_t \lambda^t = 1.
\end{aligned} \tag{3}$$

The programme given by (3) is solved $T=43$ times, once for each year in the data. For the year denoted with a "p", the program tries to find the largest increase in that year's indirect and direct tax burden consistent with the constraints. The first two constraints require that the increase in the direct (indirect) tax burden, as measured by the reciprocal direct (indirect) tax share of income, cannot exceed a linear combination of all other years' tax burdens, equivalently measured.¹⁶ The third constraint requires that a linear combination of all other years' growth rates cannot be exceeded by the year "p" growth rate. The final $T+1$ constraints force the linear combinations to be convex and non-negative.

The construction of the problem requires only positive inputs and outputs, while resulting in solution values of $\theta^t < 1$ for all years. Given the fact that real growth rates are occasionally negative, an alternative specification is analysed. The procedure used, based on input reciprocals, is invariant to output translations (Lovell and Pastor, 1995); therefore, we subtract the minimum growth rate (a negative number) from all growth rates (which makes all growth rates positive) and proceed with the analysis.

Regarding interpretation, the resulting θ^t indicates how well the economy performed, despite the current year's direct and indirect tax burden. A more useful interpretation is that it measures the degree to which the economy is performing below where it ought to be performing, given the current fiscal state. For example, a value of unity means that the economy managed its growth rate (the growth rate was not exceeded by a convex combination of other years' growth rates), even though that year's total tax burden was relatively large (not exceeded by a convex combination of any other years' tax burdens). In other words, non-tax influences on economic growth are more favourable, as θ^t approaches unity.¹⁷ Smaller values represent an economic growth rate and a total tax burden exceeded by a convex combination of other years'

¹⁶ The linear program is solved using the reciprocal shares of direct and indirect taxes to real GDP. Both, the tax mix and the tax burdens can be recovered from these two reciprocals, e.g., the tax mix is the ratio of the reciprocal direct tax share of income to the reciprocal indirect tax share of income: $m = (Y/D)/(Y/I)$.

¹⁷ The procedure is similar in concept to removing business cycle fluctuations that are, in this case, related to the fiscal situation in the economy.

growth rates and tax burdens, such that economic growth in that year was low despite low tax burdens, implying economic conditions were unfavourable in that year.

Following the calculation of all θ^t , the economic growth rate is normalized to correct the data for the relatively favourable and unfavourable economic conditions and other non-tax influences, which affect the business cycle and tax collections. Estimation, using the normalized growth data, follows a simple double-log equation, translog and Cobb-Douglas specifications, and controls for potential time-series problems, especially non-stationarity and serial correlation.

(c) *Empirical Model*

The DEA computes a scaling factor for every year, θ^t , which is normalized on the unit simplex. Although it is not possible to observe Z^t , it is possible to observe θ^t , which is used as a proxy. Unlike Branson and Lovell (2001), the computed scaling factor is used to filter GDP fluctuations out of the system, so that the second stage equation (4) is used to estimate the tax determinants of potential GDP growth:

$$y_t - \ln \theta^t = h(b_t, m_t) + \eta_t \quad (4)$$

In specification (4), η_t represents the error term and y_t is the log growth rate of real GDP, while the restriction that the coefficient of the natural log of the scaling factor is unitary has been imposed.¹⁸ The estimated specification (5) is a translog function of the tax burden and the tax mix, and allows for recession-specific dummy variables (*DUM*).¹⁹

$$\begin{aligned} y_t - \ln \theta^t = & \beta_0 + \beta_1 \ln b_t + \beta_2 \ln m_t + \frac{1}{2} \beta_3 [\ln m_t]^2 \\ & + \beta_4 (\ln b_t \cdot \ln m_t) + DUM \beta_5 + \eta_t \end{aligned} \quad (5)$$

From the translog specification in equation (5), time-varying elasticities for changes in potential growth with respect to changes in the tax burden and the tax mix can be calculated. Those elasticities are:²⁰

$$\begin{aligned} \varepsilon_{(y-\ln \theta)b}^t &= \beta_1 + \beta_4 \ln m_t \\ \varepsilon_{(y-\ln \theta)m}^t &= \beta_2 + \beta_3 \ln m_t + \beta_4 \ln b_t \end{aligned} \quad (6)$$

The Cobb-Douglas specification is also considered as a special case of equation (5):

$$y_t - \ln \theta^t = \alpha_0 + \alpha_1 \ln b_t + \alpha_2 \ln m_t + DUM \alpha_3 + v_t. \quad (5)$$

In the Cobb-Douglas formulation, the tax mix and tax burden elasticities are assumed to be constant, so that:

¹⁸ Although we do not report estimates from models not imposing the unit coefficient restriction, the restriction is statistically valid; for graphical validation of the assumption, Fig. 5.

¹⁹ Normally, the translog specification would include $(\ln b_t)^2$; however, including it led to unstable estimates, primarily because of the explanatory power of $\ln b_t$ on its own. Therefore, it was left out of the equation for estimation purposes.

²⁰ Taking the natural log derivative of potential growth with respect to the log of the tax burden (or tax mix) will result in the specification.

$$\varepsilon_{(y-\ln \theta)b}^t = \alpha_1 \text{ and } \varepsilon_{(y-\ln \theta)m}^t = \alpha_2. \quad (6)$$

4. THE DATA AND DEA

(a) Taxes and GDP: 1960 to 2002

Our analysis is based on data collected from the South African Revenue Service as well as the South African Reserve Bank over the time period 1960 to 2002.²¹ The data used in the analysis includes real GDP growth, nominal GDP, and the nominal tax take (separated as direct taxes and indirect taxes); the tax mixes and tax burdens are ratios of nominal variables; inflation has no impact on those ratios. Fig. 1 illustrates real GDP growth over the period, which averaged 3.1 per cent per year (see Table 1) and includes recessions in 1977, 1982, 1983, 1985, and 1990-1992.²²

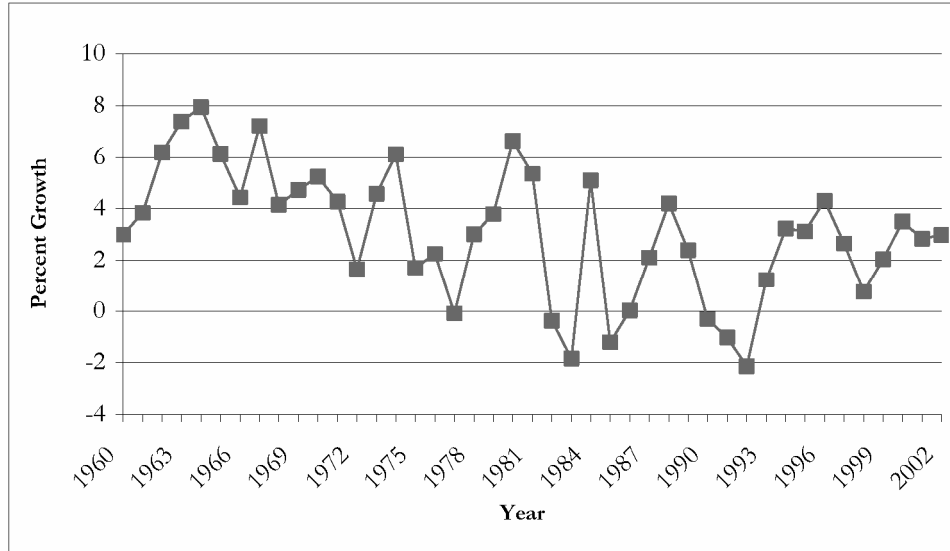


Figure 1. Real GDP Growth: 1960 to 2002

The tax burden and tax mix are illustrated in Fig. 2. From 1960 to 1990, the tax burden rose steadily from 0.10 to 0.24. Following 1990, the tax burden declined to 0.21, by the end of 1993, returning to (and surpassing) its 1990 peak by 2001. The tax mix has fluctuated between 0.37 and 0.84, averaging 0.61 over the period. The peak of 0.84 occurred in 1989; however, since 1994, the tax mix has fallen from 0.76 to 0.60, possibly reflecting SARS's recent success in collecting income tax as well as the extensive application of zero-rating within the VAT for basic foodstuffs and GEAR.

²¹ The data is from Government Financial Statistics reported by calendar years, available *via* the South African Reserve Bank (www.reservebank.co.za).

²² Dummy variables are created for each year in which a recession is observed in the South African economy.

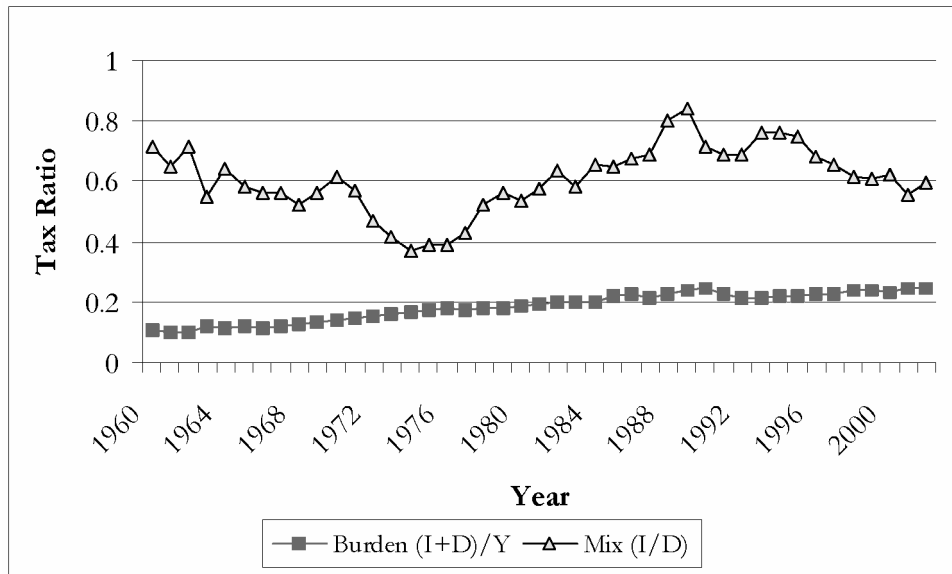


Figure 2. The Tax Mix and the Tax burden in the South African Economy: 1960 to 2002.

To complete the general picture, Fig. 3 illustrates the relationship between log real GDP growth and the log of the tax burden for all years in the data; there does not appear to be any relationship between the plotted values. However, it is important to remember that the plotted relationship in Fig. 3 does not account for other factors that are correlated with both the tax burden and the real growth rate; those missing factors will be shown, below, to be important.

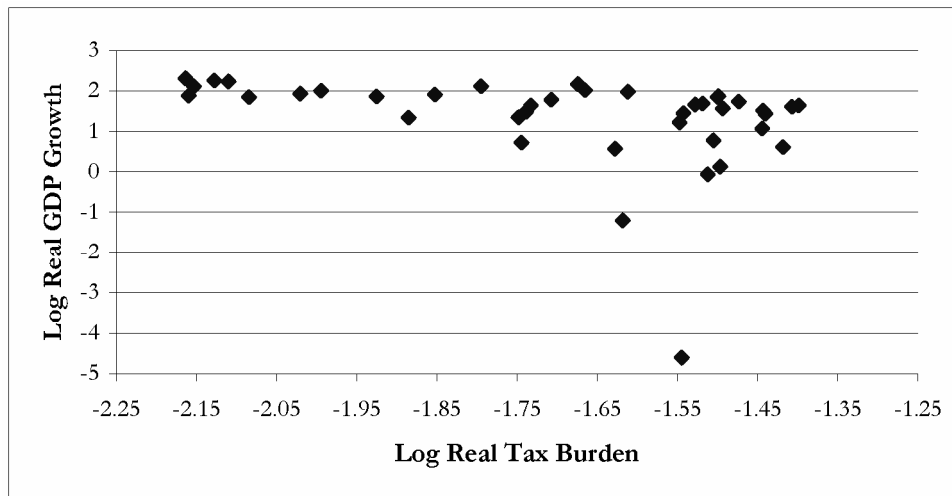


Figure 3. Log Real GDP and Log Tax Burden: No Correction Factor Applied

(b) Data Envelopment Analysis and Potential Economic Growth

Applying DEA to the data, as explained in programme (3), incorporates those unobservable variables not incorporated in Fig. 3. Unfortunately, the time horizon for this study is limited. However, over that short time horizon, South Africa underwent significant fiscal, political, and international changes, highlighted by the 1994 elections.

In this analysis, we consider the possibility that these upheavals affected the underlying economic conditions in South Africa, and, therefore, should be treated as potential structural breaks. Our treatment of these potential breaks differs from the usual econometric approach, because Data Envelopment Analysis is non-parametric.²³ Although the model does not lend itself to statistical tests for structural breaks within the data, the analysis can be subjected to reasonability checks, which were undertaken, but are not reported.²⁴ In this analysis, the reasonability checks apply DEA differently to different parts of the sample.

(i) DEA Over the Entire Time Horizon

In the reported analysis, we ignore the potential for structural breaks, assuming that the underlying economy does not change from 1960 to 2002. In other words, programme (3) was applied to the data as it is. From the application of programme (3), unitary scaling factors were calculated for 1980 and 1988, the years where the growth rate was achieved with the "fewest inputs"; in other words, economic growth in those years was achieved despite relatively high taxes,²⁵ suggesting that economic conditions were favourable. On the other hand, the worst performance, according to the analysis, occurred in 1983, 1985, and 1992, with scaling factors below 0.15; the 1992 scaling factor was only 0.0014. During these years, economic growth was not achieved despite using the most inputs; in other words, economic growth was not achieved despite relatively low taxes, suggesting that economic conditions were unfavourable.²⁶

Fig. 4 plots real GDP growth, the scaling factor, and real potential GDP growth. Within Fig. 4, the effect of applying DEA to the growth data is quite revealing; the scaling factors effectively map recessions, and, therefore, can be used to calculate potential GDP growth.

The effect of rescaling growth, from actual to potential, is highlighted in Fig. 5, which plots the log tax burden and log potential GDP growth rate. After accounting for unobservable variables, through normalization on the scaling factor θ (see the left hand side of equation (4)), a negative, nearly linear relationship now appears between the two plotted variables.

Summarized data from the non-corrected sample and the corrected sample are provided in Table 1.

(ii) Normalisation on Presumed Structural breaks Given the history of South Africa, it may not be reasonable to assume that the economy in 2002 follows the same production function as it did in 1960. For example, the South African economy was subjected to international sanctions over much of the analysed period. The worst

²³ Although a model is specified in the technique, no distributional assumptions are made, and, therefore, no statistical tests can be conducted on the values calculated within our DEA analysis.

²⁴ The results are not reported due to the similarity between those results and the results reported here. Results of alternative DEA specifications (see Footnote 26) are available from the authors upon request.

²⁵ Recall that inputs are inverse tax shares, *i.e.*, income to (in)direct taxes. Therefore, a point above the growth isoquant must be scaled down through a relative increase in taxes in order to be brought down to the growth isoquant, which is, then, efficient. The years 1995 and 2001 yielded near unit scaling factors.

²⁶ Although 1983 and 1992 were the worst years, scaling factors below 0.40 were calculated for 1960, 1961, 1972, 1977, 1982, 1986, 1990, and 1991 as well. The results, at least on the worst performers, agrees with Fig. 1. Economic growth was lowest, and often negative, in these years.

problems occurred during the 1980s, following the enforcement of financial sanctions.

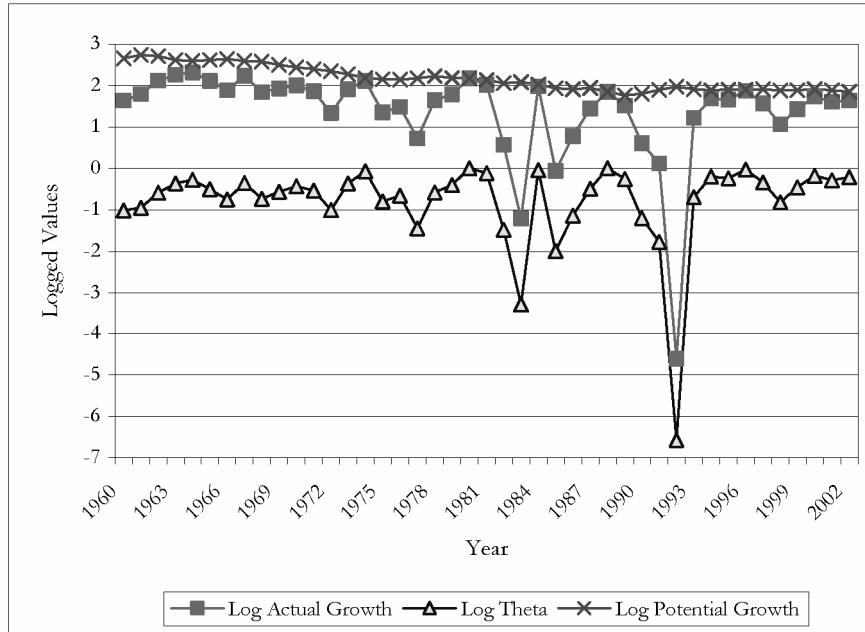


Figure 4. Log Real GDP Growth, Log Potential GDP Growth, and Log DEA Scaling Factor



Figure 5. Log Real Potential GDP Growth and Log Tax Burden: Real GDP Growth Corrected

The sanctions led to the loss of international financing capabilities and led to the "debt standstill". At this time, the government refused to honour its debt as it was. In order to pay back international obligations, the government applied policies geared towards the collection of hard currency; subsequently, a large current account surplus allowed those international obligations to be repaid. Importantly, preceding the 1994 elections, all international trade sanctions were lifted. For the preceding reasons, we consider programme (3) in two different pieces. In the first DEA, pre-1994-elections South Africa is analysed. In the second DEA, post-1994-elections South Africa is

considered.²⁷ Under this scenario, the scaling factors from each separate analysis are then used to calculate potential economic growth.

Table 1. Sample Means and Standard Deviations for Tata Used in the Analysis

Note: Standard deviations in parenthesis.

Variable	Mean and Standard Deviation	Variable	Mean and Standard Deviation
Real Growth Rate	3.0923 (2.55)	$(\ln b_t)^2$	3.1013 (1.04)
$\ln(\text{Positive Real Growth Rate})$	1.3708 (1.16)	Tax Mix – m_t	0.6086 (0.11)
Scaling Factor – θ^t	0.5807 (0.26)	$\ln m_t$	-0.5139 (0.19)
$\ln(\text{Potential Growth Rate})$ = $y_t - \ln \theta^t$	2.1645 (0.30)	$(\ln m_t)^2$	0.3005 (0.23)
Tax Burden – b_t	0.1823 (0.05)	$\ln b_t \cdot \ln m_t$	0.9061 (0.39)
$\ln b_t$	-1.7386 (0.28)		

Source: Authors calculations from SARB data and DEA analysis.

Given the DEA results from the entire period (see section 4. *(b. it)*), it should not be surprising that 1980 and 1988 were the best performing years during the pre-election epoch, while 1983 and 1992 were, again, the worst performers. The best performing post-election year was 1996, although 2000, 2001, and 2002 were not far behind. The worst post-election year was 1998, but the scaling factor for 1999 was near 0.50, well above the worst performing years preceding the 1994 elections. Although the full empirical results are not reported, Fig. 6 provides a graphical representation of the actual and potential economic growth rates, as well as the DEA calculated scaling factors, calculated from the separately applied DEA.²⁸ Once again, the scaling factors trace economic performance, so that corrected economic growth can be interpreted as potential economic growth.

²⁷ We also considered an analysis based on the implementation of the VAT, however, that time period was nearly identical to the pre-election and post-election split. The DEA and empirical analysis also yielded results nearly identical to those to be presented in this paper. Furthermore, an additional analysis was considered, based on the international sanction time period. Again, although the results are quantitatively different, the conclusions drawn are the same, and, therefore, are not also included. Results from these different analyses are available from the authors.

²⁸ As can be seen, Fig. 6 is very similar to Fig. 4. These similarities also appeared in the empirical results, which are not reported, but are available from the authors.

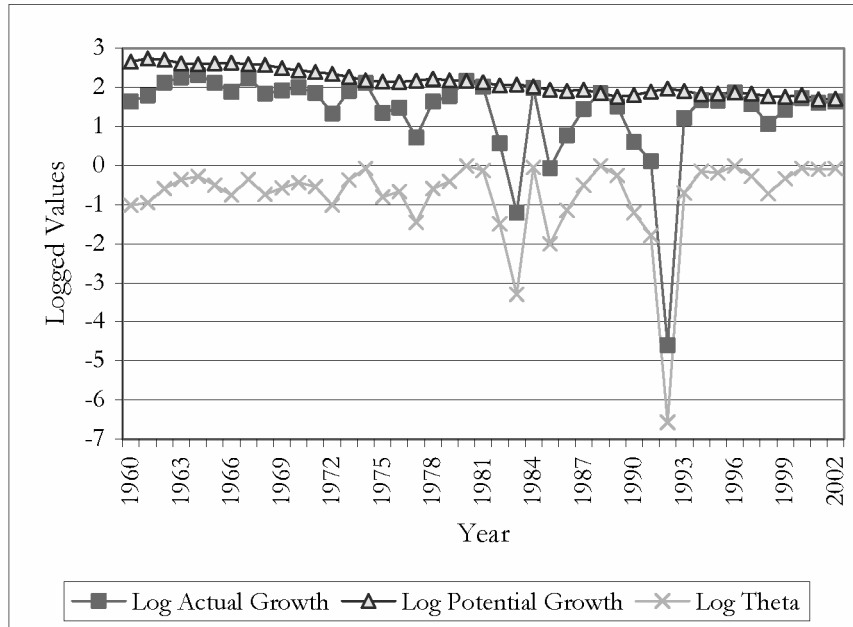


Figure 6. Real and Potential GDP Growth and Scaling F factor. DEA on Pre-1994 and Post-1994 Economy

5. EMPIRICAL RESULTS

In this section, empirical results from the second stage of the analysis are reported. All reported results are from long-run models due to the time series nature of the data. In an initial check of the data, economic growth, as expected, is shown to be stationary (see Fig. 1). The scaling factor, which is determined by random occurrences in the economy, is also stationary (see Fig. 4); however, potential economic growth is not stationary (see Fig. 4). On the other hand, the tax burden, which has increased through time, and to a lesser extent, the tax mix, which follows a random walk, are non-stationary series (see Fig. 2). ADF and Phillips-Perron tests were employed to determine the time-series properties of the variables. The results of the tests performed on the data show that all non-stationary (in levels) variables are stationary in first differences.²⁹ In all the regression specifications, below, the residuals are stationary, and, therefore, the empirical models are reasonable representations of long-run relationships. However, the standard errors from OLS regressions are inconsistent. For that reason, all the reported results are based upon the 3-step procedure developed by Engle and Yoo (1987), which corrects the estimates and standard errors of the long-run relationship.³⁰

Initially, the empirical analysis was performed without normalization (*i.e.*, actual economic growth was the dependent variable), in order to determine a comparison benchmark. Following the benchmark estimation, the analysis was continued, but made

²⁹ Although the results are not reported here in order to save space, they are available from the authors upon request.

³⁰ Our concern in this paper is with the long-run relationship, rather than the short-run dynamics inherent in the error-correction model. Therefore, we do not report, but will provide, any of the intermediate step results.

use of normalized data (*i.e.*, potential economic growth was the dependent variable). Elasticity results, based on equation (6) or (6'), using only the estimates extracted from the full-sample DEA, are presented.

(a) *Second Stage Estimates*

The primary empirical results are presented in Table 2, which contains estimates based on specification (5'), and Table 3, which contains estimates based upon specification (5). The results are presented to reflect whether or not the growth data was normalized and which empirical specification was employed.

(i) *Cobb-Douglas Specification* The four columns in Table 2 contain results for non-normalized data (in the first two columns), in which case equations (5) and (5') assume $\theta^t = 1 \forall t$, and normalized data (in the last two columns). The estimates and standard errors in the table are computed through the application of Engle and Yoo's (1987) 3-step model, in order to control for cointegration, without worrying about its specific form; the error correction parameter estimate is also included in the Table.

In the Cobb-Douglas specification, which is summarized in Table 2, the effect of the DEA normalization is quite apparent; the significance of the recession dummies disappears, while the tax burden significance increases.

Table 2. Tax Determinants of Actual and Potential Real Economic Growth: Cobb-Douglas Specification

Variables	Actual Economic Growth: Data not Normalized with DEA		Potential Economic Growth: Data Normalized with DEA	
	Dependent y_t	Dependent y_t	Dependent $y_t - \ln \theta^t$	Dependent $y_t - \ln \theta^t$
$\ln b_t$	-1.3833 ^d (0.33)	-0.8325 ^d (0.21)	-0.9031 ^d (0.02)	-1.0102 ^d (0.04)
$\ln m_t$	-0.4167 (1.04)	0.6373 (0.65)	-0.1305 ^d (0.05)	-0.1612 ^d (0.0281)
Dummy: 1977		-1.0123 ^d (0.31)		0.0278 (0.0321)
Dummy: 1982		-1.0799 ^d (0.30)		-0.0164 (0.0306)
Dummy: 1983		-2.8512 ^d (0.30)		0.0552 (0.0301)
Dummy: 1985		-1.6394 ^d (0.30)		0.0037 (0.0320)
Dummy: 1990		-0.9112 ^d (0.31)		0.0689 (0.0338)
Dummy: 1991		-1.4439 ^d (0.31)		0.0608 (0.0338)
Dummy: 1992		-6.2015 ^d (0.31)		0.0649 (0.0320)
Error-Correction Parameter	-0.8603 ^d (0.16)	-1.5808 ^f (0.81)	-0.3603 ^d (0.12)	-0.1927 ^g (0.12)
Stationary Residuals: ADF	-5.416 ^a	-6.656 ^b	-5.586 ^b	-5.998 ^b
Observations	43	43	42	42

^a- MacKinnon (1996) 1 per cent critical value = -3.597. ^b- MacKinnon (1996) 1 per cent critical value = -3.601. ^d- Significant at 1 per cent. ^e- Significant at 5 per cent. ^f- Significant at 10 per cent. ^g- Significant at 10 per cent.

Because potential economic growth, calculated from the DEA scaling factors, controls for recessionary influences on taxes and growth, the estimated relation between taxation and economic growth is stronger (*i.e.*, the noise associated with other influences has been filtered out of the system). The primary conclusion from the analysis is that increases in the tax burden are strongly associated with decreases in actual and potential economic growth. On the other hand, the tax mix is not related to changes in actual economic growth, although increases in the tax mix are associated with decreases in potential economic growth.

(*it*) *Translog Specification* The results presented in Table 3 are based upon the translog specification in equation (5).

Table 3. Tax Determinants of Actual and Potential Real Economic Growth: Translog Specification

Variables	Actual Economic Growth: Data not Normalized with DEA		Potential Economic Growth: Data Normalized with DEA	
	Dependent	Dependent	Dependent	Dependent
	y_t	y_t	$y_t - \ln \theta^t$	$y_t - \ln \theta^t$
$\ln b_t$	-0.2936 (0.86)	-1.1086 (0.75)	-0.9285 ^d (0.01)	-0.9210 ^d (0.01)
$\ln m_t$	3.8582 (3.84)	4.9325 (3.44)	-0.7349 ^d (0.03)	-0.7607 ^d (0.06)
$(\ln m_t)^2$	-0.6973 (8.55)	6.2285 (7.38)	-1.5628 ^d (0.06)	-1.5216 ^d (0.12)
$\ln b_t \cdot \ln m_t$	2.6372 (2.02)	0.1625 (1.76)	0.1628 ^f (0.02)	0.1681 ^d (0.03)
Dummy: 1977		-0.9815 ^d (0.32)		-0.0124 (0.01)
Dummy: 1982		-1.0897 ^d (0.31)		-0.0127 (0.01)
Dummy: 1983		-2.8637 ^d (0.31)		0.0021 (0.01)
Dummy: 1985		-1.6529 ^d (0.31)		-0.0141 (0.01)
Dummy: 1990		-0.9307 ^d (0.32)		-0.0136 (0.01)
Dummy: 1991		-1.4558 ^d (0.31)		-0.0151 (0.01)
Dummy: 1992		-6.2068 ^d (0.31)		0.0128 (0.01)
Error Correction Parameter	-0.8211 ^d (0.17)	-1.2420 ^g (0.79)	-0.8149 ^d (0.16)	-0.7660 ^d (0.21)
Stationary Residuals ADF	-5.508 ^a	-6.266 ^b	-5.291 ^a	-5.287 ^a
Observations	43	43	43	43

^a- MacKinnon (1996) 1 per cent critical value = -3.597. ^b- MacKinnon (1996) 1 per cent critical value = -3.601. ^d- Significant at 1 per cent. ^e- Significant at 5 per cent. ^f- Significant at 10 per cent. ^g- Significant at 15 per cent.

As with the estimates in Table 2, the estimates in Table 3 are also based on Engle and Yoo's (1987) 3-step model. The error correction parameter is also included in the table for reference. Once again, the effect of normalizing economic growth is apparent in the table, as the recession-specific dummy variables no longer explain economic growth, while tax policy strongly and negatively impacts on potential economic growth.

Intuitively, we would not expect a recession to impact on potential economic growth, which is the implication of the results. Furthermore, as argued earlier, economic growth could be influenced by tax policy, since it is likely to affect the growth of physical capital, human capital and technology, as well as the elasticity of substitution for those productive inputs. The results presented in the final two columns of Table 2 and Table 3 support the preceding tax implication. Importantly, increased tax burdens are associated with lower potential economic growth, while increases in the tax mix, contrary to other research (see Pecorino 1993, 1994; and Skinner, 1987), are associated with reductions in potential economic growth, as well. Intuitively, the results presented in these tables suggest that there is no 'free' tax, and, quite likely, there is no 'double-dividend' of taxation in the South African context.

(b) Computed Elasticities and 'Recent Fiscal Policy

(i) Computed "Elasticities Table 4 presents the range of computed growth elasticities with respect to the tax burden in the economy. The Table presents (in the first two columns) estimates for the tax burden elasticity based upon equation (6'). Elasticities based upon the translog specification (6) are listed in the last two columns of the Table. Regardless of the normalization, the (potential) economic growth elasticity with respect to the tax burden is negative and nearly unitary.³¹ The tax burden elasticity of—1.01 in the last column of Table 4, based upon equation (6), implies that each 1 per cent increase in the tax burden leads to a 1 per cent decrease in potential economic growth.

Table 4. Elasticity of Growth with Respect to the Tax Burden

Summary Statistic	Cobb-Douglas Specification		Translog Specification	
	Actual Growth ^a	Potential Growth ^b	Actual Growth ^a	Potential Growth ^b
Mean	-0.83	-0.90	-1.19	-1.01
Minimum	-1.27	-0.94	-1.27	-1.09
Maximum	-0.39	-0.86	-1.14	-0.96

"- Estimates taken from specification including recession-specific dummy variables, due to significance of those dummies. *- Estimates taken from specification without recession-specific dummy variables, due to insignificance of those dummies.

Source: Authors' calculations based upon equation (6) in the text. Minimum and Maximum make use of upper and lower bounds on the confidence intervals from the estimates, while the mean is over all observations.

In Table 5, the elasticity of (potential) economic growth with respect to the tax mix is presented. As can be seen from the range of the estimates, the tax mix elasticity is less precisely calculated than the tax burden elasticity. In terms of actual growth, the tax mix elasticity might be positive, however, with potential economic growth, the tax mix elasticity is more likely to be negative. The tax mix elasticity of -0.22, based upon

³¹ Minimum and maximum values are based upon 95 per cent confidence intervals surrounding all the point estimates. We also created elasticity estimates for every year in the data, so that the statistics in the table are summarized over the entire time horizon.

equation (6), implies that a 5 per cent increase in the tax mix will result in a 1 per cent decrease in potential economic growth.

Table 5. Elasticity of Growth with Respect to the Tax Mix

Summary Statistic	Cobb-Douglas Specification		Translog Specification	
	Actual Growth ^a	Potential Growth ^b	Actual Growth ^a	Potential Growth ^b
Mean	0.63	-0.13	1.45	-0.21
Minimum	-0.72	-0.23	-1.52	-0.70
Maximum	2.00	-0.03	3.62	0.53

^a - Estimates taken from Specification including recession-specific dummy variables, due to the significance of those dummies. ^b - Estimates taken from specification without recession-specific dummy variables, to eliminate concern over serial correlation, due to insignificance of those dummies.

Source: Authors' calculations based upon equation (6) in the text. Minimum and Maximum make use of upper and lower bounds on the confidence intervals from the estimates, while the mean is over all observations.

(it) *Recent Fiscal Policy: Changes Since 1994* To place the estimates in perspective, the tax mix in South Africa, since 1994, has fallen from 0.761 to 0.598, a decrease of 21.4 per cent, which, according to our results, has had a positive impact on economic growth in the country. The decrease in the tax mix is, according to our estimates, associated with an increase in South Africa's *measured* potential economic growth rate of a cumulative 4.7 per cent.³² However, over the same period of time, the tax burden in the economy increased 12.8 per cent (from 21.9 per cent of GDP to 24.7 per cent of GDP), which, given our calculated elasticities, is correlated with a 12.9 per cent reduction in *measured* potential economic growth. Combining the effects from the change in the tax mix with the change in the tax burden, fiscal policy from the 1994 elections is related to a reduction in *measured* potential economic growth by a cumulative 8.2 per cent.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

In this paper, we have presented an analysis of the relationship between potential economic growth and fiscal policy in South Africa from 1960 to 2002. The analysis is predicated on a model developed by Branson and Lovell (2001), which involved capturing unobservable information through Data Envelopment Analysis. We performed the analysis with South African data, modified their estimating functions and presented results based on those estimates.

The research presented here supports the conclusion that higher taxes are strongly correlated with reduced economic growth potential and that recent attempts by the South African government to reduce taxes could pay economic growth dividends, although the improvements in tax collections and the new skills levy might mitigate those dividends. Surprisingly, compared to previous research, the research presented here also supports the conclusion that recent decreases in the tax mix have been good for economic growth. The effect of recent reductions in income taxes should result in a decrease in the tax burden, which is good for the economy, but also increase the tax

³² We are not able to account for underground economic activity, and, therefore, we refer to economic growth here as measured potential economic growth, rather than, simply, potential economic growth.

mix, which is bad for the economy. Due to the estimated elasticities (the tax burden elasticity is 5 times the tax mix elasticity), any negative effect from an increase in the tax mix, due to an increase in direct taxes, should be more than offset by the positive effect associated with a reduction in the tax burden.

Finally, the preceding results also suggest that the economic impact of taxes in a developing economy is significantly different than in a developed economy. The main differences between South Africa and other developed economies shows in the calculated negative tax mix elasticity. The results imply that tax policy has not been pro-growth. One possible reason for this anti-growth conclusion could be that public resources are not returned to the economy in an efficient manner and/or are not invested in appropriate public goods, so that the double-dividend of taxation cannot be realized. In addition, it is possible that increases in taxes represent a more regulatory approach to the economy, thus discouraging investment. Finally, it is possible that taxation drives economic behaviour underground, so that the reported estimates are overstated. Therefore, future research to uncover the underlying effects of taxation is needed.

REFERENCES

- BRANSON, J. AND CAK. LOVELL. (2001). "A Growth Maximising Tax Structure for New Zealand." *International Tax and Public Finance* 8(2): 129-146.
- ENGEL, EM. AND J. SKINNER. (1996). "Taxation and Economic Growth." *National Tax Journal* 49(4): 617-642.
- ENGLE, R. AND BS. YOO. (1987). "Forecasting and Testing in Cointegrated Systems." *Journal of Econometrics* 35(1):43-59.
- FARRELL, MJ. (1957). "The Measurement of Productive Efficiency." *Journal of the Royal Statistical Society, Series A, General*, 120, Part 3: 253-281.
- FRANZEN COMMISSION (1970). "Third Report of the Commission of Inquiry into Fiscal and Monetary Policy in South Africa (Chairman: DG Franzen)." RP24/1969. Pretoria: Government Printer.
- FULLERTON, D., JB. SHOVEN, AND J. WHALLEY. (1983). "Replacing the U.S. Income Tax with a Progressive Consumption Tax." *Journal of Public Economics* 20(1): 3-23.
- GORDON, RH. AND JD. WILSON, "Tax Structure and Government Behavior: Implications for Tax Policy." *NBER Working Paper No. 7244*, pp.19.
- HALL RE. (1968). "Consumption Taxes Versus Income Taxes: Implications for Economic Growth." *Proceedings of the 61st Tax Conference*, San Francisco, CA.
- JONES, LE. AND RE. MANUELLI (1990). "A Convex Model of Equilibrium Growth: Theory and Policy Implications." *Journal of Political Economy* 98(5.1): 1008-1038.
- KATZ COMMISSION (1994). "Interim Report of the Commission of Inquiry into Certain Aspects of the Tax Structure of South Africa (Chairman: MM Katz)." Pretoria: Government Printer.
- (1997). "Fourth Interim Report of the Commission of Inquiry into Certain Aspects of the Tax Structure of South Africa (Chairman: MM Katz)." Pretoria: Government Printer.
- KERR, IA. AND GA. MACDONALD (1999). "Economic Growth and Taxation Mix in Selected Asian Economies." *Paper Presented to the 12th World Congress of the International Economic Association*, Buenos Aires, Argentina.
- KIM, S-J. (1998). "Growth Effects of Taxes in an Endogenous Growth Model: To What Extent do Taxes Affect Economic Growth?" *Journal of Economic Dynamics and Control* 23(1): 125-158.
- KOOPMANS, TC. (1951). "An Analysis of Production as an Efficient Combination of Activities." in Koopmans, T.C., ed., *Activity Analysis of Production and Allocation*, Cowles Commission for Research in Economics, Monograph No. 13, New York, Wiley.
- LOVELL, CAK. AND JT. PASTOR. (1995). "Units Invariant and Translation Invariant DEA Models." *Operations Research Letters* 18(3): 147-151.
- LUCAS, RE. (1990). "Supply Side Economics: An Analytical Review." *Oxford Economic Papers* 42(2): 293-316.
- MARGO COMMISSION (1987). "Report of the Commission of Inquiry into the Tax Structure of the Republic of South Africa (Chairman: CS Margo)." RP34/1987. Pretoria: Government Printer.
- MARSDEN, K. (1990). "Taxes and Growth." in Bird, R.M., and O. Oldman, eds., *Taxation in Developing Countries*, The Johns Hopkins University Press, Baltimore, MD, USA.
- McMillan, MS. and WA. Masters (2000) "Africa's Growth Trap: A Political-Economy Model of Taxation, R&D, and Investment." *Center for International Development Working Paper No. 50*, pp. 45.
- MLRREES, JA. (1971). "An Exploration in the Theory of Optimum Income Taxation." *Review of Economic Studies* 38(114): 175-208.
- (1976). "Optimal Tax Theory: A Synthesis." *Journal of Public Economics* 6(4): 327-358.
- PECORINO, P. (1993). "Tax Structure and Growth in a Model with Human Capital." *Journal of Public Economics* 52(2): 251-

271.

____ (1994). "The Growth Rate Effects of Tax Reform." *Oxford Economic Papers* 46(3): 492-501.

SKINNER, J. (1987). "Taxation and Output Growth: Evidence from African Countries." *NBER Working Paper* #2335, pp. 42.

SMALL, J. AND P. CARAGATA (ND.) "The Effect of Aggregate Tax Levels on Output Growth in New Zealand." *Unpublished Manuscript University of Victoria*.

SOLOW, RM. (1956). "A Contribution to the Theory of Economic Growths" *Quarterly Journal of Economics*, February:65-94.

TANZI, V. AND P. SHOME (1992). "The Role of Taxation in the Development of East Asian Economies." in Ito, T., and

A.O. Krueger, eds., *The Political Economy of Tax Reform*. The University of Chicago Press, Chicago, IL, USA.

WANG, P. AND CK. YIP (1992). "Taxation and Economic Growth: The Case of Taiwan." *American Journal of Economics and Sociology* 51(3): 317-331.

YAMARIK, S. (2001). "Nonlinear Tax Structures and Endogenous Growth." *The Manchester School* 69(V): 16-30.