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An Examination of the Impact of Economic Policy on Long-run Economic Growth: An Application of a VECM Structure to a Middle-Income Context

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1. Introduction

The determinants of economic growth have long interested economists. A number of variables have been found to be significant, among them the private investment rate, human capital investment rates, the political stability of a country and others. An important sub-category of such determinants is policy variables. Specifically, two such variables are government consumption expenditure and the inflation rate.

In this paper we will employ an endogenous growth model as we investigate the effects of policy on per capita GDP. We allow for the possibility of non-linearities in the relationship between government consumption expenditure and the inflation rate and GDP.

Cross-sectional studies of the determinants of economic growth find the impacts of both government consumption expenditure and the inflation rate to be negative, as shown in Table 1. A distinguishing feature of these studies is that the policy variables enter the specification linearly. Either of the feasible signs on the policy variables implies a corner solution that seems implausible. Complete reliance on private markets is challenged at least by the literature surrounding the impact of human capital on economic growth. Complete nationalization of the economy is difficult to justify on efficiency grounds. The implied interpretation of the policy variables in growth studies is that they capture piece-wise linearity. A better solution, therefore, would be to recognize the likely non-linearities explicitly. It is with this task that the present paper is concerned.

The idea is that for relatively low levels of government consumption spending and inflation, the impact on the growth rate may be positive but as the ratio of government consumption spending to GDP and the inflation rate increase they begin to have negative effects on GDP. Time series estimations of this hypothesis show that this may indeed be the case for South Africa.

This is the only known study of its kind to undertake such an investigation. While the South African literature is peppered with comments and thoughts on the role of policy with respect to economic growth there have been no empirical investigations. Further, there is no known study worldwide that examines the possibility of a non-linear impact of policy on growth.

The paper draws from both the theoretical literature on growth as well as the international empirical findings. The following section provides a brief summary of the literature. In Section 3, we extend the finding of Barro (1990) that government consumption expenditure has an optimal level beyond which it begins to reduce per capita consumption to show that it also has an optimal level with respect to the growth rate of output. We also present a brief analysis of the effects of inflation on growth.

We then allow for the possibility that policy may have an indirect effect as well as a direct effect on growth via its effects on investment. We show that government policy can affect investment, which, as shown by Levine and Renelt (1992), is one of the most robust determinants of growth.

Section 4 outlines the econometric methodology to be used, specifically the Johansen estimation approach as well as the autoregressive threshold effects methodology. We provide an outline of the models to be estimated. In Section 5 we discuss the data to be used. Section 6 outlines the univariate time series characteristics of the data and reports the empirical results. Using appropriate time series estimation techniques the empirical findings show that policy does indeed have a significant direct effect on per capita GDP in that higher levels of government spending and inflation reduce GDP. An examination of the possibility of the existence of an optimal level of government consumption spending and inflation show that there could indeed exist such threshold levels for both variables. The final estimation suggests that it is insufficient to examine only the direct effects of policy. It is necessary to examine the indirect impacts too. Section 7 concludes the paper.

2. Literature Review

The impact of government consumption expenditure on economic growth has received much empirical attention. Barro (1991) and Fischer (1993) found that government consumption expenditure has a negative effect on economic growth. Moreover, it has been shown that government consumption expenditure is negatively related to private investment (Barro 1991).[1] Levine and Renelt (1992) show that investment expenditure is one of the key determinants of economic growth and Fedderke (1999) shows that private investment and growth are more highly correlated in South Africa than any other form of investment expenditure.

As noted in the previous section, the international literature in general focuses on the direct linear impact of policy on economic growth. In addition to this, most studies reported in Table 1 are cross-sectional over a number of countries. In this section we report some of the findings in the literature.

Kormendi and Meguire (1985) conduct a cross-sectional study across forty-seven countries investigating the effects of monetary variance, risk, government spending, inflation and trade openness on growth. Specifically, with respect to government spending, they find that the mean growth rate of the ratio of government spending to output has a positive effect on GDP growth, although Levine and Renelt find the impact to be negative and insignificant. An explanation for this finding is offered in the next section.

Grier and Tullock (1989) repeat the work of Kormendi and Meguire on a larger sample of 113 countries from which they construct a pooled cross-section/time series data set-the only study included that is not cross-sectional. They test for regularities in the data rather than robustness. The finding is that both the inflation rate and government consumption

[1] See Table 1.

expenditure as a proportion of GDP are negatively related to growth. On the larger data set they find, contrary to Kormendi and Meguire, that the mean growth rate of the ratio of government spending to output has a negative and significant impact on GDP growth.

Barro (1991) investigates the effects of a large number of explanatory variables on growth. He estimates a standard growth equation, which includes investment in human capital as well as variables proxying stability. The finding is that investment in both physical and human capital is positively related to growth. The ratio of government consumption expenditure to GDP is negatively related to growth, as is instability.

As a result of the numerous empirical examinations of the determinants of growth, Levine and Renelt (1992) undertake a study examining the robustness of such determinants. The main conclusion is that the investment rate in physical capital is the most robust determinant of growth, although investment in human capital also has positive implications for growth. In addition, they find that government consumption expenditure, the mean growth rate of the ratio of government spending to output, changes in the price level and instability reduce growth, though the robustness of these findings is open to question.

Very few of the studies listed above focus on the effects of monetary policy on growth. De Gregorio (1993) compensates for this by conducting an empirical study, which examines the impacts of various types of monetary measures on growth. The main finding is that average inflation has a negative effect on the growth rate.

Easterly and Rebelo (1993) introduce another aspect of fiscal policy in an investigation of the impacts of the tax rate on GDP growth. The finding is that as the marginal tax rate increases, the growth rate declines. However, as non-tax revenue increases, the growth rate increases thus suggesting the desirability of a low tax rate. Easterly and Rebelo include the standard variables of a growth equation and find, consistent with the previous evidence, that human capital benefits growth while government consumption expenditure and instability both have negative impacts on growth.

There is thus a clear relationship between policy and growth. The effect is found to be predominantly negative in the level of government consumption expenditure and inflation, as well as negative in the variability of the two. Table 1 lists the results of a number of investigations of the effects of policy on growth as well as some other controlling variables.

Table 1. International Empirical Findings Note: All studies are cross-sectional

Policy Variables	Barro (1991)	Fischer (1993)	Levine & Renelt (1992)	De Gregorio (1993)	Baldwin and Seghezza (1996)	Kormendi and Meguire (1985)	Grier and Tullock (1989)	Easterly and Rebelo (1993)	Easterly (1993)
Government consumption expenditure as a proportion of GDP	- *	- *	- *	- *				- *	-
Government investment expenditure as a proportion of GDP	+								
Government investment expenditure as a proportion of agg. investment	+								
Growth of the government sector as a proportion of GDP			-			+	- *		
Inflation		- *	-		+	+ *	+ *		
Average inflation				- *			- *		
Variability of inflation				- *					
Average rate of change of inflation						- *	+		
Standard deviation of inflation							- *		
Marginal tax rate								- *	
Individual income taxes/personal income								- *	
Domestic taxes/consumption + investment								- *	

Other Variables included:
Initial per capita GDP, Primary School Enrolment Rates, Secondary School Enrolment Rates, Number of Revolutions and Coups, Number of Assassinations, Socialist Economic System, Mixed Economic System, the investment rate, an Africa Dummy variable, Capital Revenue as a proportion of GDP, GDP growth, Black market premium, Literacy, Human capital investment, M1 growth, Money Base Growth, Standard Deviation of Money Supply Shocks, Mean Money Supply growth.

+/- indicate the sign of the variable
* indicates significance

3. Theory

3.1 Introduction

The purpose of this paper is to examine the impact of demand-side government policy on long-run economic growth. Both the South Africa Foundation[2] and GEAR[3], when elaborating on an appropriate macroeconomic strategy for South Africa, stressed the need for fiscal discipline, the avoidance of large fiscal deficits and minimal state intervention. Both saw these measures as resulting in increased investment and through this, increased growth. By contrast, LABOUR[4] stressed the need for the removal of inequality in South Africa. This was to be achieved by increasing the role of the state through fiscal policy. Funds were to be obtained through "increased taxation of the wealthy" (Nattras, 1996). These are two opposing views of the role of fiscal policy in the growth process that have received much comment and criticism (Nattras, 1996). There are thus a number of strong opinions on the role of fiscal policy. Yet there exists very little empirical analysis on the impact of fiscal policy on long-run South African growth.

Interest in demand-side policy in the context of growth may appear strange at first sight for at least two reasons. Traditional growth theory makes no allowance for anything but growth in technology, capital and labour (Solow, 1956, 1957, Swan, 1956). Consider an aggregate constant returns to scale production function:

$$Y = A(t)\, F(K,L) \qquad (1)$$

where Y, output, is dependent on technology, A(t), and is a function of capital, K, and labour, L. We assume that technological change is neutral. This provides growth in output over time given by:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + w_k \frac{\dot{K}}{K} + w_l \frac{\dot{L}}{L} \qquad (2)$$

where $\dot{Y}$ indicates the time rate of change of output.[5] Thus the proportional rate of increase in output depends on the proportional rate of technological change and the proportional rates of change in the capital stock and number of workers employed. The weights (w_k, w_l) attached to capital and labour are their shares in national output, reflecting their importance in the production process. In the neo-classical growth model the factors that determine a country's long-run equilibrium growth rate will be those that affect the rate of technological change, labour force growth, the rate of capital formation

[2] See SAF, (1996)
[3] See GEAR, (1996)
[4] See LABOUR, (1996)
[5] Note that there are limitations to this approach. The first limitation is that it does not disaggregate factor inputs by quality classes. For a demonstration of the potential impact of this see Jorgenson and Grilliches (1967) and Jorgenson, Grilliches and Fraumeni (1987). A second limitation is the assumption that factor social marginal products coincide with observable factor prices. The final limitation is the assumption of constant returns to scale.

and the shares of capital and labour in national output. Fiscal policy may affect the savings rate and the savings rate affects output per worker. However within the neo-classical growth model, the long-run equilibrium growth rate does not depend on a nation's savings rate. The growth rate remains determined by the natural growth rate.[6]

Why then is there such an interest in government policy and its effects on growth? In what follows we will investigate the possibility of both direct policy impacts as well as indirect policy impacts on growth. We focus on two instruments of policy, namely, government consumption expenditure and inflation.

3.2 Government Consumption Expenditure

In this section we introduce government consumption expenditure as a factor of production. In the way that endogenous growth models have allowed human capital and financial capital to contribute to output, in this model government spending is considered to contribute independently to output. This may be as a result of a correction of market failures, the provision of public goods not covered by markets or because it provides infrastructure that enables private sector investment and improves the productivity of private sector capital. However, as with the case of the other factors of production, government spending is assumed to have a diminishing marginal product.

The model presented here is based on that of Barro (1990). In Barro's model the focus is on the existence of an optimal level of government expenditure with respect to per capita consumption and its associated utility.

In the discussion that follows, we demonstrate that implicit in the model is also the possibility of a direct decline in growth rates of output with rising government consumption expenditure. It will be this that forms the focus of our discussion.

Note that both these findings are quite apart from the usual arguments surrounding government failure and distortionary effects of government, which will be touched upon later.

[6] If there is an increase in the savings rate there will be an increase in the rate of capital formation as S=I in equilibrium. However, the labour force growth rate does not increase, resulting in an increase in the capital/labour ratio and a new equilibrium at a higher output per worker. At this point there will be no further increases in output per worker and the equilibrium growth rate returns to its initial level. The increase in the savings rate causes only a temporary increase in the growth rate. However, the higher savings rate has resulted in a permanent increase in output and capital per worker implying a higher standard of living.

The model begins with a production function without government interference, which is given by:

$$y = f(k) \qquad (3)$$

where y denotes output per worker and k denotes capital per worker. Under constant returns to capital:

$$y = Ak \qquad (4)$$

where A>0 is the constant net marginal product of capital. The assumption is of constant returns to a broad concept of capital that includes human and non-human capital.

We now introduce the public sector into the analysis: g is the quantity of public services provided to each household-producer where g is measured by the per capita quantity of government purchases of goods and services.[7] We consider the role of public services as an input to private production. Production now exhibits constant returns to scale in capital and public services together but diminishing returns in capital separately. Note that here the capital concept has effectively been widened to include physical capital, human capital and government consumption of goods and services, in which we continue to have "collective" constant returns to scale. It is assumed that government produces nothing and owns no capital. It merely acts as a purchaser where that entails buying a flow of output from the private sector. The fact that an increase in government consumption expenditure may have a positive impact on output implies the existence of a market failure which is corrected through the intervention of the government. This implies that government is able to increase the efficiency of resource allocation thereby increasing the marginal product of capital, the impact of which is felt in output.

The production function can now be rewritten as:

$$y = \Phi(k,g)$$

$$y/k = \phi(g/k)$$

$$y = k\,\phi(g/k) \qquad (5)$$

where ϕ satisfies the usual conditions for positive and diminishing marginal products, so that $\phi' > 0$ and $\phi'' < 0$.

[7] Services are assumed to be provided without charges. Congestion effects are abstracted from.

3.2.1 The growth rate of output

We can now analyse the impact of an increase in government consumption spending on the growth rate of output. We know from equation (5) that

$$y = k f\left(\frac{g}{k}\right)$$

Then

$$dy = f\,dk + k f'(-1)\frac{g}{k^2}dk + k f'\frac{1}{k}dg \qquad (6)$$

$$= \left(f - f'\frac{g}{k}\right)dk + f' dg$$

$$\frac{dy}{y} = \left(\frac{f}{kf} - \frac{f'}{kf}\frac{g}{k}\right)dk + \left(\frac{f'}{kf}\right)dg$$

$$= \left[\frac{f - f'\frac{g}{k}}{kf}\right]dk + \left(\frac{f'}{kf}\right)dg$$

Now

$$\frac{\partial\left(\frac{dy}{y}\right)}{\partial g} = \left[\frac{kf\left\{f'\frac{1}{k} - \left(f''\frac{g}{k^2} + f'\frac{1}{k}\right)\right\} - \left(f - f'\frac{g}{k}\right)\left(kf'\frac{1}{k}\right)}{k^2 f^2}\right]dk + \left[\frac{kff''\frac{1}{k} - f'kf'\frac{1}{k}}{k^2 f^2}\right]dg$$

$$= \frac{1}{k^2 f^2}\left[\left(ff' - ff''\frac{g}{k} - ff' - ff' + f'^2\frac{g}{k}\right)dk + \left(ff'' - f'^2\right)dg\right]$$

$$= \frac{1}{k^2 f^2}\left[\left(\left(f'^2 - ff''\right)\frac{g}{k} - ff'\right)dk + \left(ff'' - f'^2\right)dg\right] \qquad (7)$$

This expression will be negative if

$$\left[\left(\left(f'^2 - ff''\right)\frac{g}{k} - ff'\right)dk + \left(ff'' - f'^2\right)dg\right] < 0 \qquad (8)$$

Upon examining the second order conditions of Equation (7) it is not clear whether the function is concave or convex, concavity and convexity both depend on the size of the ϕ, ϕ', ϕ'', $\phi^{(3)}$ and $\phi^{(4)}$ variables. The implication is that for a positive value of dk the growth rate may be positive or negative. Letting dk=0, we find that Equation (7) is always negative implying that the growth rate of output declines as government consumption expenditure increases. There is thus the possibility that Equation (7) may be negative or positive depending on the size of g/k and whether we let dk=0 or not. It is thus possible to have either

$$\frac{\partial\left(\frac{dy}{y}\right)}{\partial g} > 0$$

$$\text{or } \frac{\partial\left(\frac{dy}{y}\right)}{\partial g} < 0$$

depending on the size of the government consumption expenditure.

This result is important in that it suggests the feasibility of an optimal level of government consumption expenditure up to which the effect of any increases in government consumption expenditure may be positive but beyond which any increases lead to a decline of the growth rate and not simply a negative linear impact of government consumption spending. This is useful in that it removes the contradiction between Barro's model, where we assume that the impact of government on output is positive, and the findings in the literature, which generally show a negative impact. It is therefore possible to have the positive effect of an increase in the growth rate of government consumption spending as a proportion of GDP, as found by Kormendi and Meguire (1985), if one considers only the linear impact of the variable on the growth rate. However, if we take into consideration the possibility of a non-linear impact, we allow for the existence of an optimal level of spending.

Thus the net impact of any government consumption spending on the output growth rate is a matter of empirical determination and can be shown to be negative even in the case of a positive marginal product of capital.[8]

3.2.2 Distortions

Despite the possible existence of an optimal level of policy the question remains of whether this level will be reached. There are two issues surrounding the achievement of the precise optimal level. Firstly, public choice theory suggests that such an achievement may be difficult. There is disagreement about the ability and desire of policy makers to achieve the optimum. Proponents of the public choice view argue that macroeconomic policy makers act to maximise their own welfare rather than social welfare.[9] Thus the goals of policy makers are not necessarily consistent with the achievement of social optimality, nor is there necessarily consistency in determining the goals of policy.

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[8] Barro considers the additional case of the impact of government spending on growth via its impact on consumption by introducing the tax rate into the analysis. He begins with the consumer utility function given by **U(C)**= $\frac{C^{1-s}-1}{1-s}$. Through the maximization of utility he shows that there is a potential level of government spending such that any further increase will see a decline in the growth rate of consumption.

[9] See Tullock (1976) and Buchanan and Wagner (1977).

Until now the argument has assumed away all negative externalities resulting from government consumption spending. It is possible that the introduction of the government sector brings with it a number of possible distortions in the sense that the introduction of government spending brings about price changes leading to possible misallocations and inefficiencies.[10]

3.3 Inflation

While the primary focus of the discussion in this paper is on the impact of government consumption expenditure, we briefly consider the role of inflation and monetary policy on growth.

Our concern is with how inflation affects long-run economic growth. De Gregorio (1993) investigates the effects of inflation on growth through its impact on investment. Inflation is taken to be exogenous. In an inflationary environment firms will reduce investment as a result of an increase in the actual price of capital goods, which includes its market price as well as the cost of holding money to purchase new capital. Firms need money to buy capital goods and a reduction in firms' real balances will increase the effective cost of buying new capital. Higher inflation may lead to excessive resources being devoted to transactions and cash management instead of the production of goods, since firms are subject to capital gains or losses when they are exposed to high or volatile inflation rates. Thus an increase in inflation will lead to an increase in the value of already existing capital and will depress investment, which, in turn, leads to a lower growth rate.

Firms produce a single good that can be consumed or invested. Production is subject to constant returns to scale such that:

$$y_t = ak_t \qquad (9)$$

where a is the constant marginal productivity of capital, k refers to a broad concept of capital that includes human and physical capital in an endogenous growth framework, and both output and capital are in labour intensive form. It is assumed that firms require money balances to purchase new equipment. Therefore the cost of investing i units is i(1 + s(m/i)), where s is a measure of transaction costs assumed to be decreasing and convex in m/i and m represents real money balances. This implies that the cost of investing i units is given by the purchase price of the investment as well as transaction costs. Since s is decreasing the implication is that the greater the amount of money balances held by the firm the lower the transactions costs. Since firms hold money they are also subject to an inflation tax. The problem of a representative firm is to maximise its value, which is the present discounted value of cash flows net of the inflation tax:

$$\max \int_0^{\infty} \left[ak - i\left(1 + s\left(\frac{m}{i}\right)\right) - m\boldsymbol{p} - \dot{m} \right] e^{-rt} dt \qquad (10)$$

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[10] In this vein, Easterly (1993) provides one application to the distortionary impacts of taxation.

subject to $\dot{k} = i$,and where π is the inflation rate and r is the discount rate.

Instantaneous revenue is the value of production, ak. Total outlays per unit invested are equal to 1+s(m/i). Firms are subject to an inflation tax of $mp + \dot{m}$ where mp denotes how firms' money balances are eroded due to inflation and $\dot{m}$ denotes the rate of change of money balances. Firms can lend and borrow at an interest rate r. Equation (10) indicates that as the inflation tax increases, the difference between output and the costs to the firm of inflation narrow, thereby reducing the profit of the firm. This implies a reduction in the contribution of additional capital to profit. This reduction in turn will see a decrease in the investment rate and thus the growth rate.

3.4 Indirect Impact

Thus far we have looked at both the direct effect of fiscal policy on long run economic growth, as well as an indirect impact of inflation on growth via investment expenditure. However we have not considered in detail the role policy plays with respect to investment, which remains the core determinant of growth. We now turn to a discussion of this question.

As long as investment remains the core determinant of long-run growth, a crucial concern for policy makers must be not only the possibility that policy intervention may impact on output growth directly, but that it may influence investment also as in the case of the inflation analysis above. This possibility is noted in the discussion in Fedderke, Henderson, Kayemba, Mariotti and Vaze (2001) which suggests that the impact of the South African government's fiscal policy in the 1970's and 1980's may well have been distortionary, lowering private sector investment expenditure. We further investigate the plausibility of this hypothesis in the analysis that follows. A full understanding of the policy impact on growth must isolate the net impact on growth - both direct and indirect.

It is for this reason that we examine the effects of policy on investment as well as on growth. Among the determinants of investment are the rate of return on investment and the user cost of capital. It is these variables that policy is able to affect through adjustments to the interest rate and the corporate tax rate. Fedderke (2000) has shown that these variables are significant determinants of investment in the South African manufacturing industry. The implication of this is that policy makers, by virtue of being able to influence the rate of return and the user cost, are able to substantially affect the investment rate.

However this power is bounded by the impact of uncertainty. Regular, unexpected, policy adjustments contribute toward investor uncertainty since the rate of return and user cost cannot be guaranteed. The literature has shown uncertainty to be a significant determinant of investment.

Yet, uncertainty may have two possible impacts on investment. As the early investment literature indicates, uncertainty would be of concern whenever firms make irreversible investment decisions.[11] Under the assumption of constant returns to scale production technology, and assuming uncertainty pertains to output prices, the marginal product of capital is convex in the uncertain output price such that rising uncertainty raises the marginal valuation of an additional unit of capital and hence stimulates investment.

The modern investment literature suggests that under asymmetric adjustment costs uncertainty may lead to a reduction of investment.[12] Irreversibility of investment decisions implies that there may be a return to waiting so that the decision not to invest at the present point in time can be thought of as the purchase of an option. The value of waiting arises from the fact that in an uncertain environment investing now rather than when more information is known has an opportunity cost associated with it. The result is that uncertainty generates a reward for waiting and hence, that increases in uncertainty have the possibility of lowering investment. Thus the modern literature recognizes two possible effects of uncertainty on investment: a positive effect whereby investing now carries with it information and a negative effect arising from the opportunity cost of investing now rather than in the future. The net effect of uncertainty on investment is thus ambiguous.

A rise in uncertainty raises the threshold at which investment will be triggered, suggesting a negative link between investment and uncertainty. However, uncertainty may also raise the volatility of profit flows, such that the higher threshold level of profitability is satisfied more frequently than in a certain environment, generating more frequent bursts of investment expenditure. In this case, the effect of increased uncertainty may be to raise investment expenditure on average. Thus aggregate investment expenditure during any discrete time interval may or may not increase.

Despite this ambiguity, the impact of uncertainty on investment in the South African context has empirically been found to be negative. Fedderke (2000) and Fielding (1997, 1999) find that in South Africa uncertainty has a negative impact on investment.

Thus when introducing an investment equation into the analysis of the direct and indirect effects of policy on output we need to include some measure of uncertainty since policy works hand-in-hand with uncertainty in affecting investment. Policy makers tread a fine line between designing and implementing policy that stimulates investment and thereby increasing the threshold below which investment does not take place due to increased uncertainty.

[11] For a discussion of the early literature see Aiginger (1987), Hartman (1972) and Nickell (1978).
[12] See Dixit and Pindyck (1994) and Price (1995)

4. Econometric Methodology

The expectation of up to two long-run relationships in the data, a direct impact and an indirect impact, suggests the use of the Johansen VECM estimation technique.[13] A vector error-correction (VECM) framework is employed, where for k variables there are r possible cointegrating relationships, such that $0 \leq r \leq k-1$. This gives a k-dimensional VAR:

$$z_t = A_1 z_{t-1} + \ldots + A_m z_{t-m} + \mu + \delta_t \qquad (11)$$

where m denotes lag length, μ denotes the deterministic I(0) elements and δ a Gaussian error term. Since the data consists of non-stationary variables we are restricted to I(1) elements. Reparametrisation allows the following VECM specification:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k+1} + \boldsymbol{m} + \boldsymbol{d}_t \qquad (12)$$

The existence of r cointegrating relationships implies the hypothesis that:

$$H_1(r) : \Pi = \alpha\beta' \qquad (13)$$

where Π is $p \times p$, and α, β are $p \times r$ matrices of full rank. $H_1(r)$ is thus the hypothesis of reduced rank of Π. Where r>1, issues of identification arise.[14] Specifically, this may occur when investigating the indirect impacts of government consumption spending on GDP through its effects on investment.

We estimate three models determining the effects of policy on per capita GDP.

4.1. Linear "Reduced" Direct Impact

We begin with the approach followed in the growth literature by examining the "reduced" direct linear impact of policy on GDP. We do this by estimating an equation in which we regress the private investment rate, two types of human capital and the policy variable on per capita GDP. We find the existence of one cointegrating vector in the data and are thus required to make one just-identifying restriction, which we do by normalizing on per capita GDP. The long-run parameters are given by:

[13] See Johansen (1991) and Johansen and Juselius (1990).
[14] See Wickens (1996), Johansen and Juselius (1990, 1992), Pesaran and Shin (1995a, 1995b), Pesaran, Shin and Smith (1996).

$$\Pi z_{t-k+1} = \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \\ \alpha_{31} \\ \alpha_{41} \\ \alpha_{51} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \end{bmatrix} \begin{bmatrix} y \\ I \\ H_{k1} \\ H_{k2} \\ P \end{bmatrix}_{t-k+1} \quad (14)$$

where y denotes per capita GDP, I the private investment rate, H_{k1} a human capital measure, H_{k2} another human capital measure and P the policy variable, either government consumption expenditure or the inflation rate.[15] Cointegrating relationships are provided by $\varepsilon_i = \beta_{11}y + \beta_{12}I + \beta_{13}H_k + \beta_{14}H_{k2} + \beta_{15}P$ with the α_{ij} providing the loading terms. We estimate a third relationship under this specification in which we include both policy variables simultaneously.

4.2.Non-linear "Reduced" Direct Impact

The second model again investigates the direct impact of policy given a reduced set of variables. However, we now include an indicator term, which we use when testing for the existence of a non-linearity.

In order to test for an optimal level of government consumption expenditure we employ the threshold autoregressive estimation procedure. This technique suggests the estimation of:

$$y_t = \beta_0 + (\beta_{11} + \beta_{12} I(P_{t-1} - \theta))P_t \quad (15)$$

where y is per capita GDP, P is the policy variable and $I(P_{t-1} - \theta)$ is an indicator variable. The indicator variable is created by selecting a potential optimal level of the policy variable denoted by θ. θ is then subtracted from the original data series denoted P_{t-1}. All values of the new series that are greater than zero are set equal to one and all values less than zero are set equal to zero such that $I(P_{t-1} - \theta)$ is a dummy variable with values of zero and one.

In order to determine what the threshold level might be, we add the β_{11} and β_{12} coefficients. The lowest government spending to GDP ratio that causes the sum to become negative indicates the threshold beyond which any further increases in the ratio lead to decreases in per capita GDP.[16]

[15] Lower case letters denote the variable in per capita terms.
[16] See Potter (1995) and Koop, Pesaran and Potter (1996)

We continue to find the presence of one cointegrating vector in the data. Thus the long run parameters are given by:

$$\Pi z_{t-k+1} = \begin{bmatrix} \mathbf{a}_{11} \\ \mathbf{a}_{21} \\ \mathbf{a}_{31} \\ \mathbf{a}_{41} \\ \mathbf{a}_{51} \\ \mathbf{a}_{61} \end{bmatrix} \begin{bmatrix} \mathbf{b}_{11} & \mathbf{b}_{12} & \mathbf{b}_{13} & \mathbf{b}_{14} & \mathbf{b}_{15} & \mathbf{b}_{16} \end{bmatrix} \begin{bmatrix} y \\ I \\ H_{k1} \\ H_{k2} \\ P \\ IP \end{bmatrix}_{t-k+1} \qquad (16)$$

where IP is the indicator variable and the other variables are defined as before.

4.3 Indirect Non-linear Impact

The third model we estimate incorporates the possibility of an indirect impact of policy on per capita GDP via policy's impact on investment as well as the standard direct impact of policy on GDP. We again allow for the possibility of a non-linear impact on both investment and on per capita GDP.

In the case where r = 2 the long run parameters are given by:

$$\Pi z_{t-k+1} = \begin{bmatrix} \mathbf{a}_{11} & \mathbf{a}_{12} \\ \mathbf{a}_{21} & \mathbf{a}_{22} \\ \mathbf{a}_{31} & \mathbf{a}_{32} \\ \mathbf{a}_{41} & \mathbf{a}_{42} \\ \mathbf{a}_{51} & \mathbf{a}_{52} \\ \mathbf{a}_{61} & \mathbf{a}_{62} \\ \mathbf{a}_{71} & \mathbf{a}_{72} \\ \mathbf{a}_{81} & \mathbf{a}_{82} \end{bmatrix} \begin{bmatrix} \mathbf{b}_{11} & \mathbf{b}_{12} & \mathbf{b}_{13} & \mathbf{b}_{14} & \mathbf{b}_{15} & \mathbf{b}_{16} & \mathbf{b}_{17} & \mathbf{b}_{18} \\ \mathbf{b}_{21} & \mathbf{b}_{22} & \mathbf{b}_{23} & \mathbf{b}_{24} & \mathbf{b}_{25} & \mathbf{b}_{26} & \mathbf{b}_{27} & \mathbf{b}_{28} \end{bmatrix} \begin{bmatrix} y \\ I \\ H_{k1} \\ H_{k2} \\ U \\ UC \\ P \\ IP \end{bmatrix}_{t-k+1} \qquad (17)$$

where y denotes per capita GDP, I the investment rate, H_{k1} the first human capital measure, H_{k2} the second human capital measure, U instability, UC the user cost of capital, and P and IP are the policy variable and indicator variable, respectively. Cointegrating relationships are provided by $\mathbf{e}_i = \mathbf{b}_{i1}y + \mathbf{b}_{i2}I + \mathbf{b}_{i3}H_k + \mathbf{b}_{i4}H_{k2} + \mathbf{b}_{i5}U + \mathbf{b}_{i6}UC + \mathbf{b}_{i7}P + \mathbf{b}_{i8}IP$, with the α_{ij} providing the loading terms. Exact identification requires r^2 restrictions. Since we have r=2 we require 4 just-identifying restrictions. In terms of the preceding theoretical exposition the equation can be over-identified by means of:

$$\Pi z_{t-k+1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \\ \alpha_{61} & \alpha_{62} \\ \alpha_{71} & \alpha_{72} \\ \alpha_{81} & \alpha_{82} \end{bmatrix} \begin{bmatrix} 1 & \beta_{12} & \beta_{13} & 0 & 0 & 0 & \beta_{17} & \beta_{18} \\ 0 & 1 & 0 & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27} & \beta_{28} \end{bmatrix} \begin{bmatrix} y \\ I \\ H_{k1} \\ H_{k2} \\ U \\ UC \\ P \\ IP \end{bmatrix}_{t-k+1} \quad (18)$$

where the appropriate over-identifying theoretical restrictions have been incorporated. This allows for two channels of influence of government consumption expenditure on output: the impact of government consumption expenditure and the indicator term on investment, β_{27} and β_{28}; the impact of investment, β_{12}, on per capita GDP, and the two measures of government consumption expenditure, β_{17} and β_{18}, on per capita GDP.

5. Data

We employ a time series data set that runs from 1935-1992 for Models 1 and 2 and from 1947-1992 for Model 3.[17]

The variables employed by this study to investigate the effects of policy on output are:

- Government consumption expenditure as a ratio to GDP-*GOVCGDP*. Government consumption expenditure consists of remunerations, depreciation of fixed capital and intermediate consumption less fees and charges. It does not include expenditure on education. Observations for the years 1935 - 1945 were obtained from *Union Statistics for 50 Years (1910-1960)*. Later observations were obtained from the South African Reserve Bank.

- The inflation rate, calculated from CPI and obtained from the same sources-*INFLAT*.

In addition we include a number of variables that have become standard in the growth literature as well as variables standard to an investigation of investment. All variables were obtained from *Union Statistics for 50 Years (1910-1960)* and the South African Reserve Bank, unless otherwise specified.

- Real per capita GDP at factor cost-*LNPCGDP*. Since the econometric methodology allows for the investigation of both long-run and short-run effects, the dependent variable is per capita GDP allowing the impacts of policy on growth to be given by the short-run dynamics of the model.

[17] In Model 3 we introduce the User Cost of Capital which is only available from 1947.

- The investment rate (*INVR*) is calculated from net changes in the stock of machinery and equipment for South Africa.

As specified in the theoretical section of this paper and as applied in modern growth studies, investment in human capital is as vital as investment in physical capital. Both the models of Barro (1990) and De Gregorio (1993) consist of capital stock that comprises physical and human capital, consistent with endogenous growth theory. We look at two measures of human capital:

- *WENROL* measures the school enrolment rate for "white" pupils. The variable is specified as the enrolment rate of the relevant age cohort, obtained from census data. This variable serves as a measure of the quantity of human capital. We ignore the other race groups due to the limited effectiveness of education policies in the Apartheid era.[18] The data was obtained from Fedderke (2001).

- As a measure of the quality of human capital we include PDEGRPOP, which measures the proportion of Mathematics and Science degrees to the whole population. The data was obtained from Fedderke, De Kadt and Luiz (2001b).

Model 3 incorporates two more variables following the discussion in Section 3.4:

- LNINST serves as a measure of uncertainty and captures political instability in South Africa from 1935-1992. The series is taken from Fedderke, de Kadt and Luiz (2001a).

- The user cost of capital is represented by COSTCAP as calculated in Fedderke, Henderson, Kayemba, Mariotti and Vaze (2001).

A stationary variable is also included, namely capacity utilization, which is defined as the deviation of actual output from potential capacity output.[19] This is included as a measure of the rate of return on investment (see Price, 1995).

We include a dummy variable for the years 1971-1992 as investigations of the data suggest a structural break in the inflation rate in 1970 when there was an increase in inflation.[20]

[18] For an investigation of these series see Fedderke, De Kadt and Luiz (2000a).
[19] Calculated by means of a Hodrick-Prescott filter.
[20] The tax rate has been excluded from the study. In a simple bivariate analysis it was determined that the correlation between government consumption expenditure and the tax rate in South Africa over the period 1935-1992 is 0.96871 suggesting that one may be substituted with the other. In addition, Easterly (1993) suggests that government consumption may be used as an indicator of taxes.

6. Empirical Results

6.1 Univariate Time Series Characteristics of the Data

Table 2. Summary of the Univariate Time Series Characteristics of the data

Variable Name	Description	Augmented Dickey Fuller Test Statistics	
		~I(0)	~I(1)
LNPCGDP	Real GDP per capita	-2.2378	-5.4156*
INVR	Investment/GDP	-2.0868	-5.8116*
INFLAT	Inflation rate	-.77560	-6.6199*
GOVCGDP	Government consumption/GDP	-1.4270	-5.5486*
PDEGRPOP	Proper degrees per capita	-.2648	-10.73*
WENROL	White scholar enrollment rates	-1.0924	-4.4036*
LNINST	Instability index	-2.5240	-8.948*
COSTCAP	User cost of capital	-1.4952	-5.8178*
CU	Capacity utilization	-5.8165*	

Table 2 summarizes the time series characteristics of the data to be used in the analysis. * indicates significance and thus, in all but one case, the acceptance of the null-hypothesis of non-stationarity under the I(0) test. Since all variables are either non-stationary, integrated of order I(1) or stationary we use the Johansen estimation technique. Variables beginning with LN are in log-transform.

6.2 Empirical Results

In this section we present estimation results for the three models specified above.

6.2.1 Linear "Reduced" Direct Impact

Tables 3 and 4 report the results of estimations of Model 1 where we examine the direct linear impact of policy on per capita GDP. The trace and maximal eigenvalue statistics (Table 3) show that there is only one cointegrating vector in the data in each case. There is thus need for only one just-identifying restriction and we have implemented this by normalising on the dependent variable, per capita GDP.

All three estimations are consistent with the literature despite the reduced form of the equations estimated. The investment rate and human capital variables all have the expected positive effect on per capita GDP.[21] The first two estimations of Table 4 show the direct impact of government consumption spending and inflation on per capita GDP respectively, while the last employs a specification with both policy variables. The results of estimations 1 and 2 show that both government consumption expenditure and the inflation rate have negative and significant effects on output. Extending the model to include both variables in the estimation shows that both government consumption spending and inflation continue to have a negative impact on per capita GDP. Model 1 thus suggests an unambiguous negative impact of government consumption spending and inflation on GDP.

We can also analyse the growth equation given by the error correction specification.[22] The dynamics of the model imply an increase in the growth rate of output resulting from an acceleration in government consumption expenditure and inflation reminiscent of the Kormendi and Meguire (1985) result. The long-run results indicate that increases in government consumption expenditure and inflation lead to declines in output and thus that the economy moves to a lower steady state. The dynamics indicate that the movement to the new steady state is not linear beginning with an increase in the growth rate of output as government consumption expenditure and inflation increase, followed by a decline in the growth rate of output as the new steady state is approached.

The ECM in Table 4 reports the parameter of the error correction term with its probability value. The size of the coefficients implies a slow adjustment process to equilibrium. Note that we are estimating a “reduced” growth equation and thus that the small ECM coefficient may be due to an under-specification of the model.

The policy implication from these estimations is that South Africa needs to keep both government consumption expenditure and the inflation rate low. Just how low will be investigated in the next section. While the initial empirical findings are consistent with the international literature, the theoretical considerations above should imply caution in their interpretation. Imposing linearity on a structure that is potentially fundamentally non-linear may generate biased parameter estimates.

[21] Note that these are not standardized coefficients, thus the size of the coefficients has little meaning. For the standard deviations of the variables the reader is referred to Table A1 in the Appendix.
[22] See Tables A.2.1.1, A.2.1.2 and A.2.1.3 in the appendix for the short-run dynamics.

Table 3. Per capita GDP, Investment rate, math and science degrees, white enrollment rates and (1) government consumption spending, (2) inflation, (3) both policy variables

	Null hypothesis r=0	***Null hypothesis r=1***
Govcgdp		
Maximal Eigenvalue	*35.8604 **	*17.4039*
Trace Statistic	*73.1044 **	*37.2440*
Inflation		
Maximal Eigenvalue	*27.3112*	*16.998*
Trace Statistic	*66.4339 **	*39.1227*
Both Policy		
Maximal Eigenvalue	*44.8624 **	*19.1083*
Trace Statistic	*102.2988 **	*57.4364*

* denotes significance

Table 4. Investigation of the direct impact of policy on per capita GDP

Dependent variable LNPCGDP	*(1)*	*(2)*	*(3)*
INVR	*2.0839 **	*1.6616 **	*2.141 **
PDEGRPOP	*3602.9 **	*5752.8 **	*5909.8 **
WENROL	*2.0361 **	*0.46966 **	*0.91536 **
GOVCGDP	*-3.3267 **	*-*	*- 1.9977 **
INFLAT	*-*	*-2.5305 **	*- 1.8240 **
VAR	*3*	*3*	*3*
ECM (p-value)	*-.1485 (.003)**	*-.1576 (.003)**	*-.2116 (.001)**

*denotes significance

6.2.2 Non-linear "Reduced" Direct Impact

In order to obtain more information regarding policy optimality we proceed by introducing the possibility of the existence of non-linearities, as suggested earlier, with respect to the two policy variables considered in this study.

Table 5. Per capita GDP, Investment rate, math and science degrees, white enrollment rates and (1) government consumption spending and an indicator term (2) inflation and an indicator term

	Null hypothesis r=0	***Null hypothesis r=1***
Govcgdp		
Maximal Eigenvalue	*48.1636 **	*25.2271*
Trace Statistic	*111.3806 **	*63.2170*
Inflation		
Maximal Eigenvalue	*34.6341 **	*31.5561*
Trace Statistic	*88.9910 **	*54.3569*

*denotes significance

Table 6. Investigation of non-linearities

Dependent variable LNPCGDP	*(4)*	*(5)*
INVR	*0.64052*	*1.3735 **
PDEGRPOP	*3941.8**	*5134.1 **
WENROL	*0.33985*	*0.47848 **
GOVCGDP	*-13.6277* #*	-
IG6	*10.6452**	-
INFLAT	-	*-8.1789 #*
II2	-	*5.1056*
VAR	*2*	*2*
ECM (p-value)	*-.05856 (.033) **	*-.1138(.005) **

*denotes significance

# denotes joint significance of the policy variable with its indicator term.

Table 7. An Examination of the Threshold Levels

GOVCGDP	***6%***	***7%***	***8%***	***9%***	***10%***	***11%***	***12%***
Linear term	*-13.63**	*-12.49**	*-11.29**	*-9.484**	*-7.796**	*-6.594**	*-2.474*
Threshold	*10.645**	*10.001**	*9.139 **	*7.662**	*6.234**	*5.248**	*-0.364*
Inflation	***1%***	***2%***	***3%***	***4%***	***5%***	***6%***	
Linear term	*1.095*	*-8.179*	*-7.465**	*-11.76**	*-9.358**	*-4.721**	
Threshold	*-5.760*	*5.1056*	*1.5409*	*4.5546*	*3.1451**	*-0.0944*	

*denotes significance

Table 5 reports the results of the cointegrating vector analysis. There is one cointegrating vector in the data implying the imposition of one just-identifying restriction through normalization on per capita GDP. Table 6 reports the results of the estimation of the threshold effects with government consumption expenditure at 6% and inflation at 2%.

As is the case in Model 1 we see that the coefficients on the investment term as well as those on the human capital terms continue to confirm the findings in the literature.[23] For both estimations the combined total effects of the policy variable and the indicator variable on output are negative thereby suggesting that these levels of government consumption spending and inflation have already breached the postulated threshold.

Once again the size of the ECM coefficients implies a slow adjustment process back to equilibrium following a shock to the system. As in the case for the direct linear effect, the model is likely to be under-specified, providing a possible explanation for the size of the ECM coefficients.

Table 6 should be read in conjunction with Table 7, which reports the coefficients on government consumption spending for a number of ratios of government consumption spending to GDP. Due to the low number of observations it is not possible to investigate ratios of government consumption spending to GDP lower than 6%. Table 7 suggests that if a threshold level exists it is to be found at a ratio lower than 6%. From 6% onwards we see that the combined effect of the government consumption spending coefficient and the indicator variable is negative.[24] At larger ratios we see that both the variable and its indicator have a negative impact on GDP. Recall that we are investigating only government consumption expenditure and not government expenditure in its entirety which accounts for the low ratio. Table 7 thus suggests that the optimal ratio of government consumption spending to GDP for South Africa over the sample period to have been below 6%.

[23] These coefficients are not standardized.
[24] The combined effect is found by adding the coefficients of government spending and the indicator term.

We can extend the analysis to the inflation rate. The results for inflation suggest that even an inflation rate of 1% may have breached the threshold. Beyond 5% both the variable and the indicator variable are negative implying an unambiguous negative impact of inflation. For growth purposes, therefore, even the SARB's target range of 3-6% for inflation may well be too high.

Once again, the error correction specification suggests an initial increase in the growth rate from an acceleration of government consumption expenditure and inflation as the economy moves to the new steady state. This again suggests a non-linear movement of the economy to the new steady state beginning with an increase in the growth rate of output, followed by a decline as the steady state is reached.

We have so far replicated the findings in the literature of the negative impact of high government consumption expenditure and a high inflation rate. We have also shown the possibility of the existence of a non-linearity in the data beyond which any further increases in either government consumption expenditure or the inflation rate will lead to a decline in output. The optimal levels of government consumption spending and the inflation rate are low.

The implication is that there exists a limited scope for demand-side stimulus to long-run growth.

6.2.3 Indirect Non-linear Impact

We now turn to an examination of the third model from Section 4. Recall the possible impact of policy on investment as well as its direct effects on output. In addition it was noted that uncertainty has a vital role to play with respect to investment.

Table 8 shows the existence of two cointegrating vectors in the data once we include the additional variables, notably instability and the user cost of capital. We thus investigate an output equation as well as an investment equation.

Table 9 reports the results of an estimation investigating the possibility of an indirect non-linear relationship between government consumption and GDP via government consumption's effects on investment at a ratio of government spending to GDP of 12%. As in the case of Models 1 and 2 all the coefficients have the expected signs.[25] Investment in physical capital continues to have a positive effect on GDP, as does investment in human capital for both human capital variables. In addition, white pupil enrollment rates have a positive effect on the investment rate. As noted in Section 3.4, instability has a negative impact on the investment rate in South Africa, as does the user cost of capital. Due to the stationarity of the capacity utilisation variable it has been omitted from the long-run analysis but appears in first difference form in the short-run dynamics in Tables A.2.3.1 and A.2.3.2 in the appendix.

[25] Again, these are not standardized coefficients.

In both the cointegrating vectors the combined effect of government consumption spending and the indicator variable is negative, confirming the hypothesis of an indirect impact of government consumption spending on GDP. The ECMs again have small coefficients suggesting that the speed of adjustment to equilibrium is slow.

Standardising the coefficients of the estimations in Table 9 shows that a one standard deviation increase in government consumption spending leads to a 1.019 standard deviation decrease in per capita GDP. A one standard deviation increase in the indicator variable leads to a 0.1826 standard deviation decrease in per capita GDP.

Table 10 reports the impact of government consumption expenditure and the indicator term for ratios of 12% and 14%. The results show that the threshold level of government consumption expenditure appears to have been reached at a lower ratio of government consumption expenditure to GDP than 12%. At 12% the total impact of government consumption spending is already negative. Further, the impact of government consumption spending on investment is negative at both 12% and 14% implying that government consumption expenditure crowds-out private investment at these ratios. If there is a threshold below which increases in government consumption expenditure lead to increases in investment, this appears to be reached before 12%. Unfortunately limitations in the data, specifically the limited availability of the user cost of capital data prevent us from examining ratios lower than 12%.

We can once again analyse the growth rate of output from the error correction specification. The dynamics of the output equation suggest, as before, that an acceleration of government consumption expenditure leads to an initial increase in the growth rate. The dynamics of the investment equation suggest though, that an acceleration of government consumption expenditure leads to a decline in the rate of change of investment. It is thus only in the movement of the economy to a new output steady state that we see the initial positive impact of government consumption expenditure.

Tables 9 and 10 are significant in that they confirm the findings of the international literature in terms of the direct impact of government consumption expenditure on output. They also suggest that there is an indirect impact of policy on output via its impact on investment as suggested in Section 3.4 and further do not discount the possibility of the existence of a non-linearity. The evidence provided in Tables 9 and 10 shows that estimations involving only the linear incidence of the variable as well as single relationship studies of policy on output may be mis-specified in that they fail to capture the indirect impacts of policy on stability and investment.

Table 8 Per capita GDP, Investment rate, math and science degrees, white enrollment rates, instability, user cost of capital, government spending

	Null Hypothesis r=0	Null Hypothesis r=1	Null Hypothesis r=2
Maximal Eigenvalue	*51.8038**	*36.8754*	*28.8565*
Trace Statistic	*151.9547**	*100.1509**	*63.2755*

*denotes significance

Table 9 Cointegrating vector analysis

Dependent Variable	Per capita GDP	Investment
LNPCGDP	-	-
INVR	0.30887	-
PDEGRPOP	5308	-
WENROL	-	0.73353
LNINST	-	-0.012567
COSTCAP	-	-0.00120
GOVCGDP	-7.1024	-0.96057
IG12	0.74341	0.16480
VAR	2	2
ECM (p-value)	-.03102(0.03)*	-.415 (0.00)*

Table 10. Threshold effects

Threshold Level		
On Output	**12%**	**14%**
Level	-7.1024	-5.8036
Threshold	0.74341	-0.50069
On Investment		
Level	-0.96057	-5.2054*
Threshold	0.16480	0.55036*

7. Conclusion

Growth Theory accepts a role for policy in influencing the growth rate of an economy. This paper provides an investigation of the impacts of two policy variables on economic growth in South Africa over the 1935-1992 period - government consumption expenditure and the inflation rate. The theoretical discussion shows the possibility of an optimal level of government spending, beyond which we begin to see decreases in the growth rate of output. In addition policy may have an indirect effect on output via its effects on the investment rate.

Johansen estimation techniques replicate the international cross-sectional experience that rising levels of government consumption expenditure and inflation lead to declines in output when examining their direct effect. This is seen not only in the examination of a linear direct impact as found in Model 1 but also in Models 2 and 3 where allowance was made for the existence of non-linearities and an indirect impact of policy on GDP via investment.

Further, Models 2 and 3 find evidence in favour of non-linearity in the policy variables, suggesting that there may, indeed, be an optimal ratio of government spending and an optimal inflation rate beyond which we begin to see decreases in per capita output. Model 3 suggests that such a non-linearity may also be present via indirect effects on output through the effects of policy on investment. Due to the low number of observations the search for the precise optimal point is constrained.

While the impact of government policy on steady state output appears to be negative, or subject to an optimal level of government consumption expenditure or inflation at very low levels, we have seen that in terms of the short-run dynamics, the impact of government consumption expenditure and inflation may be positive on growth. What is significant about this finding is that it may come to account for any ambiguity in the international findings. But equally, we should note that the lowering of the long-run steady state solution means that any positive impact of government consumption expenditure or inflation on growth must be understood to be strictly transitory, and hence non-sustainable.

A larger data set is required in order to confirm the above findings. However the results are sufficient to conclude that studies that are concerned merely with the direct linear effects of policy on GDP may be mis-specified and are ignoring potential feed-through effects from other variables as well as the potential existence of non-linearities. Conclusions drawn from such studies need to be interpreted with care.

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Appendix

A.1. Standard Deviations

Table A.1 Standard Deviations of the Variables

Variables	1935-1992	1947-1992
LNPCGDP	.28851	.20163
INVR	.068836	.032686
PDEGRPOP	.3734E-4	.3198E-4
WENROL	.055440	.035560
GOVCGDP	.039748	.026944
IG12	.074906	.066341
INFLAT	.049100	.049576
II2	.053314	-
LNINST	-	1.9395
COSTCAP	-	10.9703

A.2.Error Correction Equations

A.2.1Error Correction Equations for the "Reduced" direct linear impact (Model I)

Table A.2.1.1 ECM for government consumption expenditure

ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(3)

Dependent variable is dLNPCGDP

58 observations used for estimation from 1935 to 1992

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	1.1186	.35858	3.1196[.003]
dLNPCGDP1	.34137	.13916	2.4531[.018]
dINVR1	.085693	.16743	.51182[.611]
dPDEGRPOP1	46.8253	541.7478	.086434[.931]
dWENROL1	-.56065	.54695	-1.0251[.311]
dGOVCGDP1	.063664	.51501	.12362[.902]
dLNPCGDP2	-.074546	.13846	-.53841[.593]
dINVR2	.0058615	.14394	.040723[.968]
dPDEGRPOP2	493.4407	516.5009	.95535[.344]
dWENROL2	-.050757	.57519	-.088243[.930]
dGOVCGDP2	1.0727	.51178	2.0961[.042]
ecm1(-1)	-.14854	.047574	-3.1224[.003]

Table A.2.1.2 ECM for the inflation rate

ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(3)

Dependent variable is dLNPCGDP

58 observations used for estimation from 1935 to 1992

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	1.3220	.42222	3.1311[.003]
dLNPCGDP1	.26399	.14767	1.7877[.080]
dINVR1	-.088615	.16718	-.53006[.599]
dPDEGRPOP1	-510.9780	653.7087	-.78166[.438]
dWENROL1	-.45374	.54386	-.83430[.408]
dINFLAT1	.093510	.21383	.43732[.664]
dLNPCGDP2	-.021613	.14727	-.14676[.884]
dINVR2	-.10390	.15060	-.68990[.494]
dPDEGRPOP2	-25.4421	585.1613	-.043479[.966]
dWENROL2	-.016848	.56303	-.029924[.976]
dINFLAT2	.17449	.17146	1.0177[.314]
ecm1(-1)	-.15759	.050300	-3.1330[.003]

Table A.2.1.3 ECM for government consumption expenditure and inflation

ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(3)

Dependent variable is dLNPCGDP

58 observations used for estimation from 1935 to 1992

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	1.7205	.49442	3.4798[.001]
dLNPCGDP1	.24905	.14529	1.7142[.094]
dINVR1	-.038897	.16216	-.23986[.812]
dPDEGRPOP1	-811.7412	688.4779	-1.1790[.245]
dWENROL1	-.86933	.56676	-1.5339[.132]
dGOVCGDP1	.39213	.56284	.69670[.490]
dINFLAT1	.12352	.21281	.58042[.565]
dLNPCGDP2	-.089497	.15636	-.57239[.570]
dINVR2	-.11439	.14749	-.77555[.442]
dPDEGRPOP2	-167.4317	610.2266	-.27438[.785]
dWENROL2	-.22430	.59327	-.37807[.707]
dGOVCGDP2	1.2299	.50843	2.4191[.020]
dINFLAT2	.056591	.17406	.32513[.747]
ecm1(-1)	-.21161	.060741	-3.4838[.001]

A.2.2 Error Correction Equation for the "Reduced" direct non-linear Impact (Model II)

Table A.2.2.1 ECM for government consumption expenditure

ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(2)

Dependent variable is dLNPCGDP

58 observations used for estimation from 1935 to 1992

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	.54229	.24138	2.2466[.029]
dLNPCGDP1	.39705	.13291	2.9874[.004]
dINVR1	.017546	.17700	.099132[.921]
dPDEGRPOP1	29.2995	482.2389	.060757[.952]
dWENROL1	-.061575	.48601	-.12670[.900]
dGOVCGDP1	.31076	.65103	.47734[.635]
dIG61	.65191	.47951	1.3595[.180]
ecm1(-1)	-.058566	.026696	-2.1938[.033]
D1	-.012365	.0080839	-1.5296[.133]

Table A.2.2.2 ECM Inflation non-linearity

ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(2)

Dependent variable is dLNPCGDP

58 observations used for estimation from 1935 to 1992

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	.97932	.32697	2.9951[.004]
dLNPCGDP1	.14884	.13944	1.0674[.291]
dINVR1	.074306	.16101	.46149[.646]
dPDEGRPOP1	-442.9031	512.1233	-.86484[.391]
dWENROL1	-.45145	.50750	-.88955[.378]
dINFLAT1	.58075	.28804	2.0162[.049]
dII21	-.52169	.26650	-1.9576[.056]
ecm1(-1)	-.11380	.038586	-2.9494[.005]
D1	-.0032003	.0091117	-.35122[.727]

A.2.3 Error Correction Equations for the Indirect Non-linear Impact (Model III)

Table A.2.3.1 ECM Vector 1

```
ECM for variable LNPCGDP estimated by OLS based on cointegrating VAR(2)
*******************************************************************************
 Dependent variable is dLNPCGDP
 45 observations used for estimation from 1948 to 1992
*******************************************************************************
 Regressor               Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                   .30313            .13218              2.2934[.029]
 dLNPCGDP1                   .61291            .11590              5.2881[.000]
 dINVR1                     .012146           .050935              .23845[.813]
 dPDEGRPOP1                -72.9108          119.1587             -.61188[.545]
 dWENROL1                   -.15697            .14026             -1.1191[.272]
 dLNINST1                  .6265E-3          .4530E-3              1.3830[.177]
 dCOSTCAP1                -.2074E-3          .1479E-3             -1.4018[.171]
 dGOVCGDP1                   .26878            .18198              1.4770[.150]
 dIG121                   -.0061780           .016636             -.37136[.713]
 ecm1(-1)                  -.031017           .013673             -2.2685[.030]
 ecm2(-1)                  -.055586           .041436             -1.3415[.190]
 D1                       -.0021831          .0036397             -.59980[.553]
 DCU                         1.0464           .046206             22.6471[.000]
 DCU(-1)                    -.60237            .13894             -4.3356[.000]
*******************************************************************************
```

Table A.2.3.2 ECM Vector 2

```
ECM for variable INVR estimated by OLS based on cointegrating VAR(2)
*******************************************************************************
 Dependent variable is dINVR
 45 observations used for estimation from 1948 to 1992
*******************************************************************************
 Regressor               Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                  .065128            .33298              .19559[.846]
 dLNPCGDP1                  -.38481            .29199             -1.3179[.197]
 dINVR1                      .32441            .12832              2.5282[.017]
 dPDEGRPOP1               -105.9113          300.1885             -.35282[.727]
 dWENROL1                    .12894            .35335              .36490[.718]
 dLNINST1                  .0017173          .0011412              1.5048[.143]
 dCOSTCAP1                 .0010963          .3727E-3              2.9415[.006]
 dGOVCGDP1                  -.49066            .45844             -1.0703[.293]
 dIG121                    -.017218           .041911             -.41082[.684]
 ecm1(-1)                  -.010370           .034445             -.30106[.765]
 ecm2(-1)                   -.41470            .10439             -3.9727[.000]
 D1                        .0080771          .0091691              .88090[.385]
 DCU                         .27402            .11640              2.3540[.025]
 DCU(-1)                     .60452            .35002              1.7271[.094]
*******************************************************************************
```