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Fiscal Aggregates, Aid and Growth in Kenya: A Vector Autoregressive (VAR) Analysis

by

Daniel M'Amanja, Tim Lloyd and Oliver Morrissey

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Abstract

Theoretical predictions and empirical evidence on the impact of foreign aid and fiscal policy on growth are mixed. This paper examines the effect of fiscal variables (government expenditure and revenue) and aid on growth using annual time series data for Kenya over the period 1964 – 2002. Multivariate cointegration (VAR) and vector error correction models (VECM) are estimated to establish both the short- and long- run relationships between foreign aid, fiscal variables and growth of per capita income. Two measures of aid are used; external grants and loans, and both yield different results. Aid loans are found to have a negative impact on long run growth whilst grants have a positive one. Government spending is found to have a positive long-run influence on growth, and there is no evidence that taxes retard growth. The implication for policy is that aid to Kenya could be more effective if given in form of grants, and associated with fiscal discipline.

Outline

1. INTRODUCTION

The last few decades have witnessed intense debate on the effectiveness of fiscal policy and foreign aid in stimulating economic growth. The main focus has been on whether government activity and foreign capital inflows promote or retard economic growth. The answer, according to neoclassical growth theory, is that both factors do not affect the steady state growth rate. In contrast, new growth theories allow an important role for fiscal policy, aid and indeed all the factors that promote technological diffusion, efficiency and productivity in the growth process. This theoretical ambiguity is matched by the empirical evidence, with some studies finding a positive association between government spending and growth, and others a negative association. To the extent that government expenditure is productive it promotes growth, but it is financed by taxes that typically distort incentives, and this retards growth. It seems likely, then, that the net effect will vary from country to country.

There are a host of reasons why we observe conflicting results in the empirical literature. Studies employ different measures of government size (see Peacock and Scott, 2000), specifications and range of explanatory variables varies, the quality of data series differ and studies also employ different estimation techniques. Most empirical studies are based on cross-country analysis, which is a limitation given the *a priori* expectation that coefficients (effects of variables) will differ across countries. Where a time series approach has been used, limited effort has been made to integrate short-run and long-run dynamics (Ghali, 1998). Furthermore, there have been few individual country studies, which from a policy point of view could be more relevant.

This paper attempts to fill this gap by using historical time series data to investigate the relationship between fiscal aggregates, aid and economic growth in Kenya. We use multivariate cointegration (VAR), vector error correction model (VECM) and impulse response analysis with annual data for the period 1964 to 2002. Given the need to preserve degrees of freedom, we use total government spending and total revenue, with two measures of aid, grants and loans, entered separately. In a related paper, we decomposed revenues and expenditures and found that government capital spending, tax and non-tax revenue have significant positive effects on per capita growth, government consumption expenditure and the budget deficit impact negatively on growth (M'Amanja, 2005). Most of these fiscal variables have the same significance and sign in the long and short run.

The rest of the chapter is organized as follows. Section 2 briefly reviews the theoretical underpinnings and empirical evidence of the fiscal policy–growth relationship. Methodological issues and the theoretical model are covered in section 3 while section 4 examines data and variables. Sections 5 and 6 present empirical results and conclusions and policy implications respectively.

2. THEORY AND EMPIRICAL EVIDENCE

The general view amongst economists is that fiscal policy has an important role in stimulating investment and economic growth. Under the appropriate environment and with the right mixture of taxation and spending policies, the government can increase the quantity and productivity of aggregate investment – human and physical capital, research and technology - and thus overall economic growth [Ram (1986), Barro (1990), Barro and Sala-i-Martin (1992, 1995), Easterly and Rebelo (1993)]. Opponents of this view argue that government operations are inherently bureaucratic and inefficient and thus may retard rather than promote economic growth. Taxation creates distortions in economic decision-making, resulting in sub-optimal resource allocation and therefore stunts economic growth [Landau (1983), Levine and Renelt (1992)]. The argument is not that government spending plays no constructive role, but rather that the size of government should be kept to a minimum.

In the theoretical literature, there are two growth models that explicitly incorporate government activity (see Barro and Sala-i-Martin, 1995). The first is the growth model with productive government services in which the government buys a portion of the private output and uses it to provide public services to the same private sector. Government services are assumed to be productive public goods (implying they are non-rival and non-excludable). In this model, government influence on growth is transmitted via two channels: the negative effect of taxation on incentives and the positive effect of public services to the private sector. An alternative model relaxes the assumption of non-rivalry and assumes public services are subject to congestion (i.e. their consumption diminishes as the number of users increase), but the general treatment of the effect of government on growth is the same.

In any empirical testing of this relationship an important issue is how to measure the fiscal variables. Barro (1990) classifies government expenditure into productive and unproductive components. Productive expenditures are those that enter into the production function of the private agent while the unproductive ones are those that enter the private agent's utility function, such as consumption expenditure. Government taxation is categorized into distortionary and non-distortionary. Theoretically, productive government expenditures and non-distortionary taxation are positively associated with economic growth, unproductive government expenditures and distortionary taxation correlate negatively with economic growth. However, the empirical results are sensitive to the exact measures used [Barro (1990), Glomm and Ravikumar (1997), Nijkamp and Poot (2002)].

In a developing country like Kenya, aid is an important source of revenue and will affect the fiscal aggregates. Aid has not been incorporated into the literature on government and growth in this context. In principle, relative to taxes, aid is a non-distortionary source of revenue, and should therefore contribute to growth by financing productive government spending. McGillivray and Morrissey (2000) and Osei *et al* (2003) have argued that the role of aid in influencing the fiscal behaviour of recipient government, though important in understanding the aid-growth dynamics, has too often been ignored. Furthermore, they argue that the multiplier effect associated with increased expenditure triggered by aid inflows have been largely overlooked in the literature. Aid is incorporated into our analysis in the spirit of models of the fiscal effects of aid (see McGillivray and Morrissey, 2000), as it is a major component of fiscal policy.

3. ECONOMETRIC METHOD AND MODEL

Following Osei *et al* (2003) we employ a vector autoregressive (VAR) model. The VAR approach offers several advantages over the single equation approach associated with Engle and Granger, such as the ability to deal with several endogenous variables and cointegrating vectors, the ability to test for weak exogeneity and parameter restrictions, and to handle both I(1) and I(0) variables in one system. The VAR approach is data based and little economic theory is imposed directly (Sims, 1980). Although the structure is *atheoretical*, economic theory is often invoked to select the appropriate normalisation and to interpret the results. The VAR approach assumes all variables in the system are potentially endogenous, so each variable is explained by its own lags and lagged values of the other variables. It also assumes that there is no *a priori* direction of causality among the variables; this is particularly useful for fiscal variables which are often co-determined [Charemza and Deadman (1997), Blanchard and Perotti (1999)]. These assumptions are, however, tested.

We start by formulating a general VAR model of the relationship between fiscal aggregates, aid and economic growth. Having tested for unit roots and determined the appropriate lag length of the endogenous variables, we test for cointegration in a multivariate framework using Johansen's (1988) maximum likelihood procedure. To implement the Johansen method of determining the number of cointegrating vectors, we start by specifying a general VAR(k) of the following form.

$$\mathbf{x_t}=A(\mathbf{L})\mathbf{x_t}+\mathbf{v} \qquad (1)$$

Where $\mathbf{x_t}$ is a vector of endogenous fiscal and non-fiscal variables, A($\mathbf{L}$) is an n x n polynomial matrix in the lag operator $\mathbf{L}$ such that $\mathbf{Lx_t} = \mathbf{x_{t-1}}$**,** and $\mathbf{v_t}$ is a vector of white noise disturbance terms.

Conventionally, cointegration analysis begins by ascertaining the time series properties of the data series. Models that assume a stationary process when none exists lead to erroneous or spurious statistical inferences (Granger and Newbold, 1974). Choosing an appropriate lag length is the next step in time series modelling. Once this is established, the estimation process passes through three distinct stages: (a) determination the number of cointegrating vectors (r) as proposed by Johansen and Juselius (1990); (b) factorisation of the impact matrix $\Pi = \alpha\beta'$ in order to estimate matrices α and β; and (c) estimation and interpretation of the VAR model after cointegration is ascertained [Hamilton (1994), Johnson and DiNardo (1997)].

We establish, through identifying restrictions, any structural economic relationship explained by the long-run model. Restrictions on the *betas* (β) help determine which variables are relevant in the cointegrating vector(s) while restrictions on *alphas* (α) help determine which variables are weakly exogenous to the system. In addition to knowing the significance of variables in the cointegrating space, restrictions on β also help in the identification and thus interpretation of the structural model. We use economic theory to determine which restriction(s) to impose on each cointegrating vector [Hendry and Juselius (2001), Harris and Sollis (2003)].

We also employ impulse response analysis, which attempts to trace out the time paths of various shocks in the variables contained in the VAR. To do this, the VAR is reformulated into a vector moving average as proposed by Sims (1980). Impulse response analysis describes the chain reaction or knock-on effects arising from one standard perturbation in one innovation in the system over time on all the variables in the system assuming no other shocks hit the system thereafter (Johnston and DiNardo, 1997). Strictly, it is a cumulative error (incorporating effects of other endogenous variables), so one cannot be certain that the variable being shocked is the source of the entire impulse response. Its shortcomings notwithstanding, impulse response analysis allows us to study the dynamic behaviour of each variable in the system by determining whether or not an exogenous shock causes short run or long run changes in the variable of interest and also other variables in the VECM.

There has been some use of impulse response analysis to study fiscal behaviour in recent years. Both orthogonalised and generalised impulse responses have been used for this purpose. The latter does not depend on the way in which variables are ordered in the system but the former does. For instance, Hjelm (2001) uses generalized impulse response analysis to study how US budget deficits react to shocks in taxes, government spending and output and found government spending shocks are permanent and tend to have negative impact on the budget deficit in the long run. In the case of Germany, Hoppner (2001) uses impulse response to study the effects of fiscal response on output and finds a negative response of output to tax shocks and a positive response to government spending shocks. Blanchard and Perotti (1999) find similar results for the US. Osei *et al* (2003) adopt this approach to assess the fiscal impact of aid in Ghana. It would be interesting to conduct similar test for Kenya and examine the dynamic interactions among our variables of interest.

Vector Error Correction Model (VECM)

According to Granger's representation theorem, if there is cointegration there must exist Granger causality in at least one direction and therefore one can reformulate the VAR into a VECM in which error correction terms are included. Using the four variables of interest, i.e. per capita income (*Yp*), total government spending (*TEXP*), total tax revenue (*TAX*) and foreign aid (*AID*)[1], and following Johansen and Juselius (1990), we formulate the VECM to obtain the following system of equations.

$$\Delta Yp_t = \sum_{k=1}^{r} l_k n_{k,t-1} + \sum_{s=1}^{p} a_{1,s}\Delta Yp_{t-s} + \sum_{S=1}^{P} a_{2,s}\Delta TEXP_{t-s} + \sum_{s=1}^{p} a_{3,s}\Delta TAX_{t-s} + \sum_{s=1}^{p} a_{4,s}\Delta AID_{t-s} + z_{1,t} \quad (2a)$$

$$\Delta TEXP_t = \sum_{k=1}^{r} l_k n_{k,t-1} + \sum_{s=1}^{p} b_{1,s}\Delta Yp_{t-s} + \sum_{S=1}^{P} b_{2,s}\Delta TEXP_{t-s} + \sum_{s=1}^{p} b_{3,s}\Delta TAX_{t-s} + \sum_{s=1}^{p} b_{4,s}\Delta AID_{t-s} + z_{2,t} \quad (2b)$$

$$\Delta TXR_t = \sum_{k=1}^{r} l_k n_{k,t-1} + \sum_{s=1}^{p} d_{1,s}\Delta Yp_{t-s} + \sum_{S=1}^{P} d_{2,s}\Delta TEXP_{t-s} + \sum_{s=1}^{p} d_{3,s}\Delta TAX_{t-s} + \sum_{s=1}^{p} d_{4,s}\Delta AID_{t-s} + z_{3,t} \quad (2c)$$

$$\Delta AID_t = \sum_{k=1}^{r} l_k n_{k,t-1} + \sum_{s=1}^{p} j_{1,s}\Delta Yp_{t-s} + \sum_{S=1}^{P} j_{2,s}\Delta TEXP_{t-s} + \sum_{s=1}^{p} j_{3,s}\Delta TAX_{t-s} + \sum_{s=1}^{p} j_{4,s}\Delta AID_{t-s} + z_{4,t} \quad (2d)$$

where $n_{k,t-1}$ represents residuals from the cointegrating equations and l_k are the adjustment coefficients while r and p are respective optimal lag lengths , and z_{it} are errors assumed to be white noise.

Inasmuch as the VAR approach is considered superior to the single equation estimation procedure, it is not without problems. The approach has been criticised on grounds of data mining, sometimes leading to generation of results which, though statistically sound, are at variance or incompatible with economic theory. It is therefore necessary to always invoke

1 Here, AID is a general term used to represent either grants or loans.

economic theory for guidance on model specification, estimation, reduction and/or identification and interpretation.

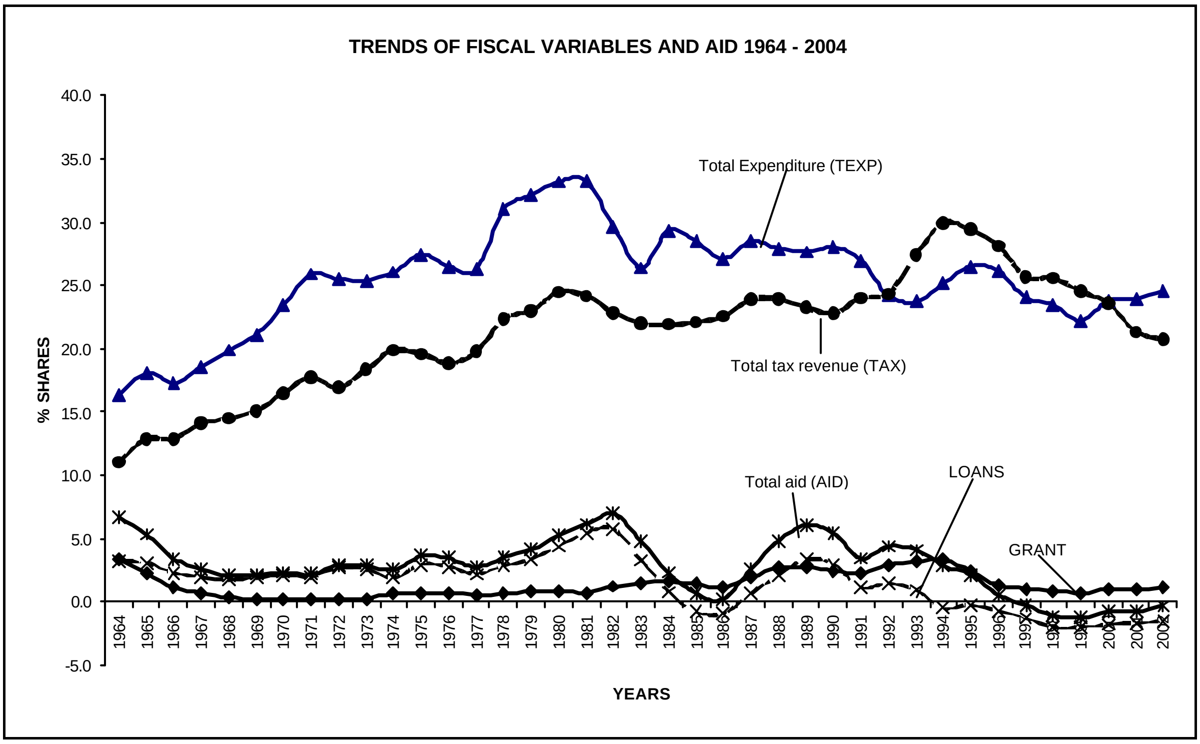
4. DATA AND VARIABLES

Data series used in this study are obtained from various publications of the *Economic Survey*, published annually by the government of Kenya. Variable definitions and raw data are presented in Tables A1 and A2 of Appendix A respectively. The four variables (i.e. Yp, TEXP, TAX and AID) in our model are in logs so that their first differences represent growth rates. Total government expenditure includes consumption (net of debt redemption) and capital expenditure, while total tax revenue includes direct and indirect tax revenue, thus excludes non-tax revenue. There are two measures of foreign aid that we use in this study: external grants (GRANT) and net external loans (LOAN). In a related study, we focused on growth effects of various fiscal variables with the implicit assumption of one endogenous dependent variable, but in this paper we consider the dynamic interactions of the fiscal system. Thus, we include total spending and tax revenues and separate aid, but omit the deficit so as not to estimate an identity.

On average, the level of total government expenditure excluding debt repayments for the period 1964 - 2002 is 25% of GDP while tax revenue (direct and indirect) accounts for 21% of GDP over the sample period. Grants and loans constitute only about 1% and 2% of GDP respectively as a period average. This is much lower than what is reported in external data sources such as OECD/DAC data set. We however stick to the Kenyan data because this is the data upon which financial and economic planning is based by the Kenyan policy makers (i.e. as revealed by the government's own budget data). Most of what is reflected in the OECD/DAC data represents commitment and not what is actually released to the recipient country. Besides, part of it goes to non-governmental organisations and therefore their figures are bound to be higher than what is reflected in official government books. **Figure 1** below shows the trend of the two fiscal and aid[2] variables for Kenya for the period 1964 – 2002.

2 AID in figure 1 is the sum of grants and net loans (GRANT + LOAN).

Figure 1: Trends in Fiscal Aggregates and Aid, 1964 – 2002



It is evident that expenditure and revenue have been moving together over the period up to the early 1990s[3]. Although the relationship appears different during the 1992-2002 period, tests revealed no evidence of structural breaks. Aid loans appear more volatile than grants. Such volatility is symptomatic of the unstable relationship between donors and the government, in which the government backtracks on agreed donor conditionalities whenever the economy peaks only to go back to donors when the economy begins to wobble. This 'cycling' with donors has characterised the Kenyan economy since the advent of structural adjustment programmes in early 1980s, and is likely to diminish the effectiveness of foreign aid.

3 The trend would have been quite different in the 1990s had debt redemption been included as part of expenditure. This period has witnessed a sharp increase in the level of stock of public debt. In fact, net foreign loans (LOAN) have been negative for most of the 1990s.

5 EMPIRICAL RESULTS

The literature of the fiscal impact of aid (e.g. McGillivray and Morrissey, 2000) demonstrates that one is essentially estimating a form of simultaneous relationship. In the traditional approach, a reduced form equation is estimated. In using the VAR approach, this reduced form representation is achieved by assuming one cointegrating vector linking the fiscal variables, using theory to guide any restrictions in interpreting the VAR (see Osei *et al.*, 2003). This approach restricts attention to the fiscal variables only; therefore one cointegrating vector is justified. Our analysis for Kenya goes a step further, in also considering the additional link to growth. This suggests the possibility of more than one cointegrating vector, as in principal one has a simultaneous equation system with one relationship between the fiscal variables, and then a relationship between the fiscal variables and growth. In a related study, M'Amanja (2005) demonstrates that not all fiscal variables impact on growth, suggesting that not all fiscal variables will be cointegrated with growth (i.e. zero restrictions will hold for some).

Economic theory is of little guidance for the precise form of the model. The empirical growth models are essentially reduced forms, often (in the Burnside and Dollar (1997) specification) including aid and a fiscal variable (typically the budget deficit and/or consumption spending) but ignoring the inter-relationship between aid and fiscal variables. Thus, we employ an empirical approach that allows and tests for the possibility of more than one cointegrating vector, and follow the cointegrating VAR methodology of Johansen and Juselius (1990) and Juselius (2002). The theoretical concerns outlined above facilitate the interpretation of more than one cointegrating vector if that is what we find, although they only provide guidance to the specification of each vector. As is well known, many variables impact on growth and we are only considering a sub-set of variables. Consequently, although our 'fiscal representation' is complete (the budget variables are all included, with an omission to avoid estimating an identity), the growth equation is incomplete (in the sense that our model does not capture all the relevant determinants of growth). This is an inevitable limitation of single country time series analysis of growth. However, our concern is not with identifying the determinants of growth, rather it is with identifying the fiscal impact of aid and how this relates to growth.

A further problem arises because aid is of different forms, specifically grants and loans, and these need not have identical effects on fiscal behaviour. Specifically, grants have no implications in terms of future repayment, whilst one could expect that governments would be willing to accept any grants offered (and adjust the budget accordingly), whereas they would be less willing to accept all loans offered (until they know the money is needed). This presents problems for estimation: although we have a relatively long data series by developing country standards, it is a short series by the standards of estimating a VAR system. Degrees of freedom constraints require us to keep the number of fiscal variables included to a minimum. As previously mentioned, we will run the VAR with both types of aid, and one with total aid (grants plus loans), where the latter will be treated as a special case of the former. If indeed, statistical tests reveal that the two have different effects on growth, then it is erroneous, as has been the case in much of the existing literature, to use either grants or loans to proxy for total foreign aid. Conversely, if the two have similar growth effects, then adding them up into an aggregate variable is well-founded.

Econometric issues in respect of time series properties of the data series, choice lag length as well as cointegration and related analysis are covered in Appendix B. Test results summarised in Table B1 of Appendix B provides evidence that all the variables used in this study are integrated of order one, i.e. I(1), implying that each data series is I(1) in levels and I(0) in first differences. Having established this, we then conducted tests for selection of appropriate lag length, and settled for two lags. This was then followed by the determination of cointegration amongst the variables. Following the preceding discussion, we estimated two variants of the VAR model: one in which both forms of aid were aggregated into a single variable and another in which the two were entered separately. The objective, as stated earlier, was to investigate whether or not grants and loans have differential effects on growth.

We started by estimating a disaggregated model with the two aid measures entered separately. Results were then used to test for the grants-loans equality. The null of same growth effects was rejected by the likelihood ratio (LR) test[4], implying that it is erroneous to aggregate the two to proxy for foreign aid. To demonstrate that ignoring such tests can produce misleading

4 LR test of restrictions: $\chi^2(1) = 4.7165[0.0299]^*$

estimates, we estimated an aggregate model in which grants and loans were aggregated and results corroborated with our hypothesis that estimated coefficients are quite different (see Appendix B3 for details). Consequently, we estimated a model in which grants and loans were entered separately. Cointegration test was then conducted using the Johansen's trace and max test statistics (Table B2). From theory, and following our previous discussion, we expect two long-run relations describing the output and the fiscal relations respectively. Besides economic theory, the possibility of two cointegrating relationships was supported by interpreting the tests and also by using other criteria such as plots of possible cointegrating vectors and the number of significant columns of the estimated adjustment coefficients of the estimated model (Hendry and Juselius, 2001). We therefore settled for two cointegrating vectors for subsequent analyses.

Identification of Long Run Model

The Johansen's reduced rank procedure enables us to establish the number of unique cointegrating vectors spanning the cointegrating space. We must therefore impose appropriate restrictions and normalisations on the bs to be able to unearth and interpret the underlying economic or structural model [Johansen (1995), Hendry and Juselius (2001)]. Accordingly, with two cointegrating vectors, we need to impose two restrictions and two normalisations so as to exactly identify the long run model. Once this is done, test of over-identifying restrictions can then be conducted.

Although in general taxes are believed to distort incentives (returns on factor incomes) and thus discourage investment and growth, Milesi-Ferretti and Roubini (1995) have argued that in a situation where the government is free to borrow and lend, taxes may have zero long run effect on growth. In such a case, the government effect on long-run growth is through expenditure, and taxes have no or marginal impact. For the growth relation in the first cointegrating vector, we therefore normalise on output and put a zero restriction on tax revenue. For the fiscal relation represented by the second cointegrating vector, we may exclude output as our interest is to investigate the relationship between aid, taxes and expenditure. In this case, normalisation is on aid and a zero restriction is imposed on output.

The results are reported in **Table 1** below.

Table 1: Long Run Model with Grants (and corresponding α s)

Variable	Vector1 (β1)	Vector2 ((β2)	α1	α2
Yp	1.0000	0.0000	**-0.3434**	6.0227
TEXP	-0.3945	-3.9763	0.1996	-0.0174
TAX	0.0000	2.2883	0.3625	-0.0243
GRANT	-0.0207	0.0361	3.4369	-0.5911
LOAN	0.0981	1.0000	-0.8151	**-0.3688**

Note: *α1 corresponds with vector 1 and the bolded coefficient represents the error correction term for this vector. Similarly, α2 corresponds to vector 2 and its error correction term is shown in bold (-0.3688).*

These results show that both vectors are error correcting (both have negative and significant error correction terms), confirming that they are cointegrating vectors. Normalisation and imposition of restrictions must be done in a way that makes both economic and statistical sense (Juselius, 2002). When over-identifying restrictions were imposed and tested, results either failed to make economic sense or were statistically rejected by the likelihood ratio test. We therefore adopted the just-identified model for further analysis. This outcome was also validated by the variable exclusion test as shown in **Table 2** below.

Table 2: Exclusion test on β s

H_0: Coefficient is zero ($\beta_i = 0$)				
Variable	**Output Vector**		**Fiscal Vector**	
	χ^2(1)	**P-Value**	**χ^2(1)**	**P-Value**
Output (Yp)	-----	-----	-----	-----
Expenditure (TEXP)	3.2178	[0.0728]	8.7308	[0.0031]
Revenue (TAX)	-----	-----	6.3044	[0.0428]
Foreign aid(GRANT)	0.9708	[0.3245]	0.0818	[0.7749]
Foreign aid(LOAN)	2.6950	[0.1007]	-----	-----

Note*: Figures in square brackets are p-values that indicate the level at which the null hypothesis that* β_i *are zero can be rejected. Both expenditure and foreign loans appear important (at 10% significant level) in the first cointegrating vector whilst expenditure and tax revenue are significant in the second cointegrating relation.*

The exclusion tests strongly reject the null of non-significance of variables except that of aid grants which appeared insignificant in both the output and fiscal vectors. This contradicts results observed when significance of the aid grants coefficient is tested using the *t*-test which suggests the coefficient is significant in the output vector. In contrast, exclusion tests as well as *t*-test statistics indicate that expenditure, tax revenue and foreign loans are significant in the cointegrating relations. Given the theoretical importance of our variables in explaining growth, we include all the four variables in the long run relationships. The two long run relations can be summarised in the following equations (*t*-statistics are in parentheses).

Output relation

$$Yp=0.39TEXP+0.02GRANT-0.10LOAN \quad (3)$$

(6.15) (2.19) (-6.40)

Fiscal relation

$$LOAN=3.98TEXP-2.29TAX-0.04GRANT \quad (4)$$

(7.92) (-5.95) (-0.45)

Aid loans exhibit a strong negative correlation with output in the long run, although expenditure and aid grants have significant positive effects (equation 3). As we conjecture that the government seeks aid loans in the face of a fiscal deficit, this is consistent with observing a negative effect of deficits on long-run income. Equation (4) supports the conjecture as expenditure has a positive effect on loans while tax revenue has a negative effect. Furthermore, the coefficient on *TEXP* is much higher than that on *TAX*, implying that the responsiveness of loans to spending is greater than the responsiveness to tax revenue. Aid grants have a negative but insignificant relationship with aid loans.

One consistent result is the positive sign of the coefficient on government spending, implying that government spending contributes to growth in the long run. No distinction is made between investment and recurrent expenditure. However, as the former is a far lower share of spending than the latter, the presumption must be that recurrent spending contributes to per capita output (and, at least, does not retard growth). It is also worth noting that tests justify excluding tax from the long-run output model, implying that taxes have no negative impact on per capita income.

The results for aid are less clear, as they depend on the measure used. Grants appear beneficial, as they have a positive effect on income (output). As grants do not generate future interest payments, they are not associated with increased spending. The weak significance of grants may be reflecting their low value throughout the study period. The effect of aid loans is more of a concern. The results suggest that loans substitute for domestic tax effort to finance a fiscal deficit, and are therefore negatively associated with output. There exists an inverse relationship between aid loans and aid grants. The results indicate that if donors increase grants to Kenya, loans could decline. The overall effect is that aid in Kenya fosters more aid dependence. This supports the finding of Remmer (2004) who, using a sample of 120 low and medium income countries for the period 1970 – 1999, found a positive relationship between aid and government spending and a negative one between government revenue and aid.

Impulse Response Analysis of the Long Run Model

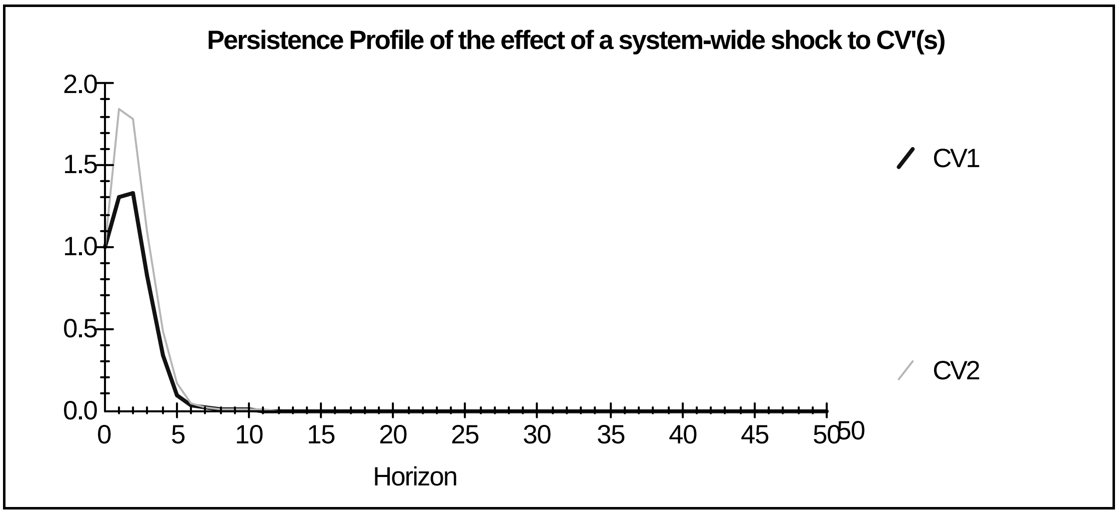
To measure the effect of one standard error shock to the j^{th} equation at time t on expected values of $\mathbf{x}$ at time $t+1$, we employ the generalised impulse response function (which is invariant to the ordering of variables in the VAR). This takes full account of historical patterns of the correlation of shocks (Pesaran and Pesaran, 1998). Another advantage of the generalised response function is that it handles a system of endogenous variables whereby they have contemporaneous effects on each other (Hjelm, 2001). Our main interest here is to determine how the economy reacts to various shocks in the variables. For example, due to the recent change of government in Kenya[5], donors have pledged unprecedented amounts of financial resources for various development activities in the economy. It would be interesting to investigate how such a huge

5 In the general elections of December 2002, the political party that had been in power since independence was defeated by a coalition of opposition parties. This generated high hopes and expectations of better fiscal management both domestically and internationally (especially among donors).

injection of external funding (aid) might impact on long run growth. We base our impulse response analysis on the definition of aid as net external loans (as this was consistently significant).

In the following section, we analyse the effect of shocks on the cointegrating vectors starting with the system-wide shocks and later with shocks in specific variables. Persistence profiles of the two cointegrating vectors arising from economy-wide shocks are illustrated in **Figure 2**[6] below.

Figure 2: Effect of system-wide shocks to cointegrating vectors

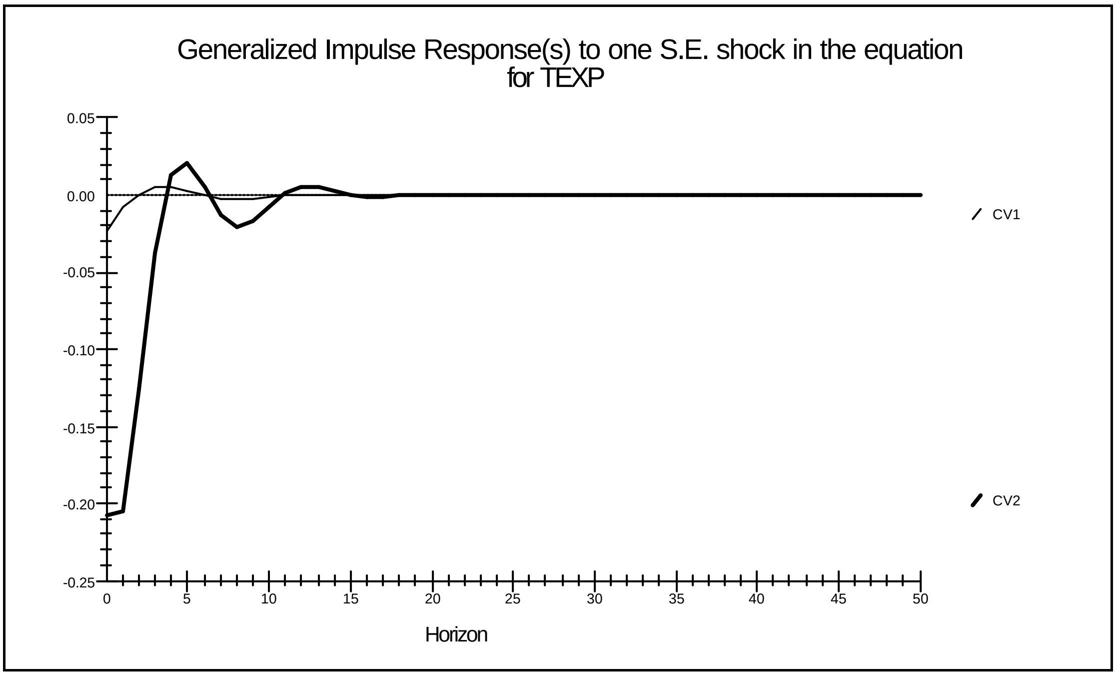


As can be seen from these profiles, the two cointegrating vectors converge to their long run equilibria within ten years. For both vectors, the impact or immediate response to the system-wide shocks is unity and positive. However, the output-expenditure relation (CV1) converges slightly faster than the fiscal relation (CV2). There is a bit of overshooting on the fiscal vector reflected by a large jump in the first three years of the shock. Thus a system-wide shock to the economy seems not to persist into the long run.

Effects of Variable/Equation specific shocks on cointegrating vectors

Figures 3 and 4 show the nature of responses of the two cointegrating vectors to shocks in the equation for government expenditure and foreign loans.

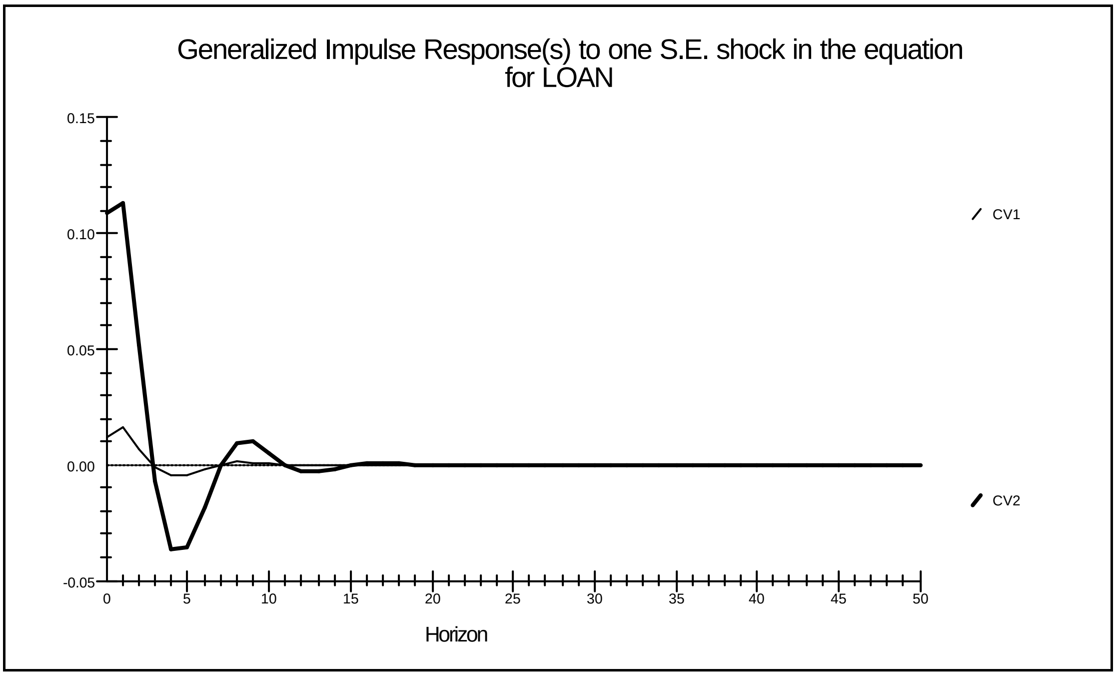
Figure 3: Effects of Government expenditure



When the shock emanates from government expenditure, the two vectors take less than 15 years to revert to their long run equilibria. We note that expenditure has a positive impact on output until it levels off after 10 years. Although both vectors start below their long run equilibriums on impact, their response to an expenditure shock is positive but dies out within 7 years for the output vector and about 15 years for the fiscal vector.

6 Impulse response functions are generated by Microfit econometric software version 4.0.

Figure 4: Effects of Aid Loans Shocks on the Cointegrating vectors



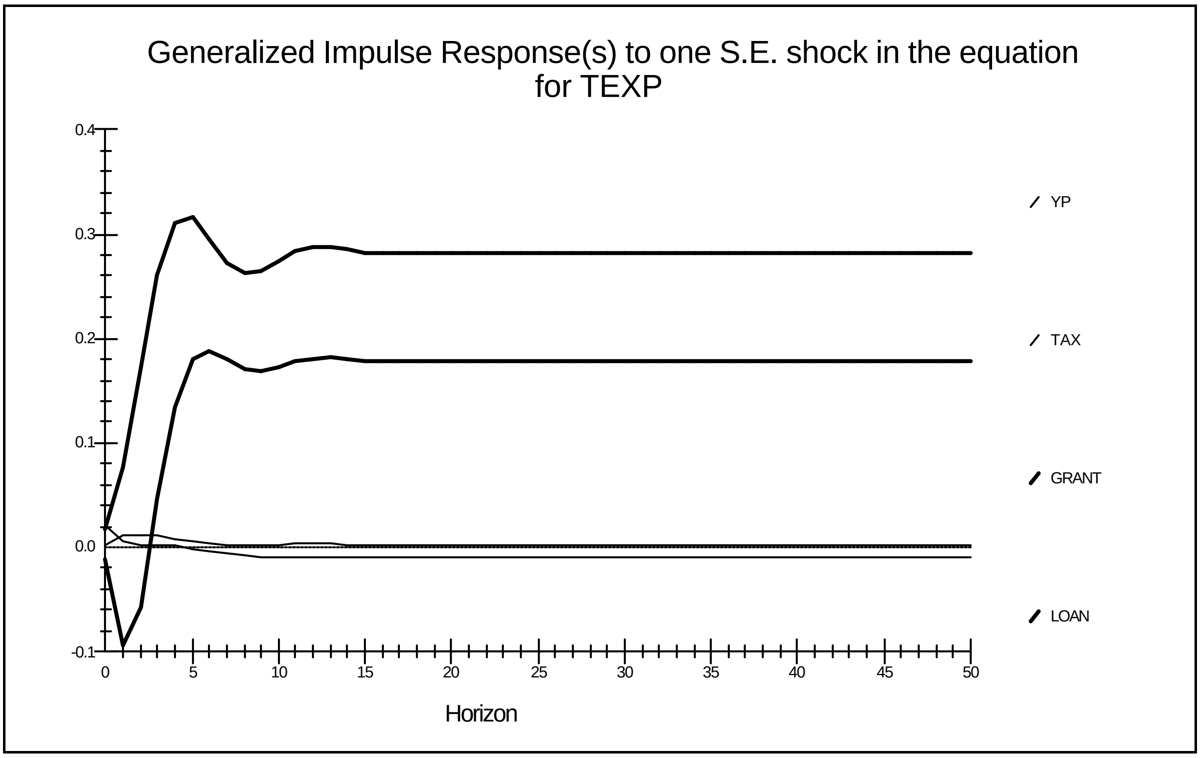
If there is a one standard error shock in loans, the effect on the output vector dies out after seven years, while the effect on the fiscal vector dissipates after 15 years. Within the first two years, the shock on aid loans has a positive impact on both vectors. As can be seen in Figure 4 above, an aid shock has a higher impact on the fiscal vector, so it takes longer to get back to equilibrium. The same picture emerges when external grants are shocked (see figure B4.1: Appendix B4).

From the above impulse responses of the cointegrating vectors to either system-wide or specific variable shocks, it is evident that their time paths converge to the long run equilibrium in a space of at most 20 years. Although the nature of this convergence is procyclical in some cases, there is no testimony of explosive responses. These findings suggest that our estimated model is stable (which confirms the earlier diagnostic tests). However, these responses, as discussed earlier, should be interpreted with caution because the shocks could be cumulative and not necessarily from the shocked variable(s).

Effects of a Shock in an Equation on Variables

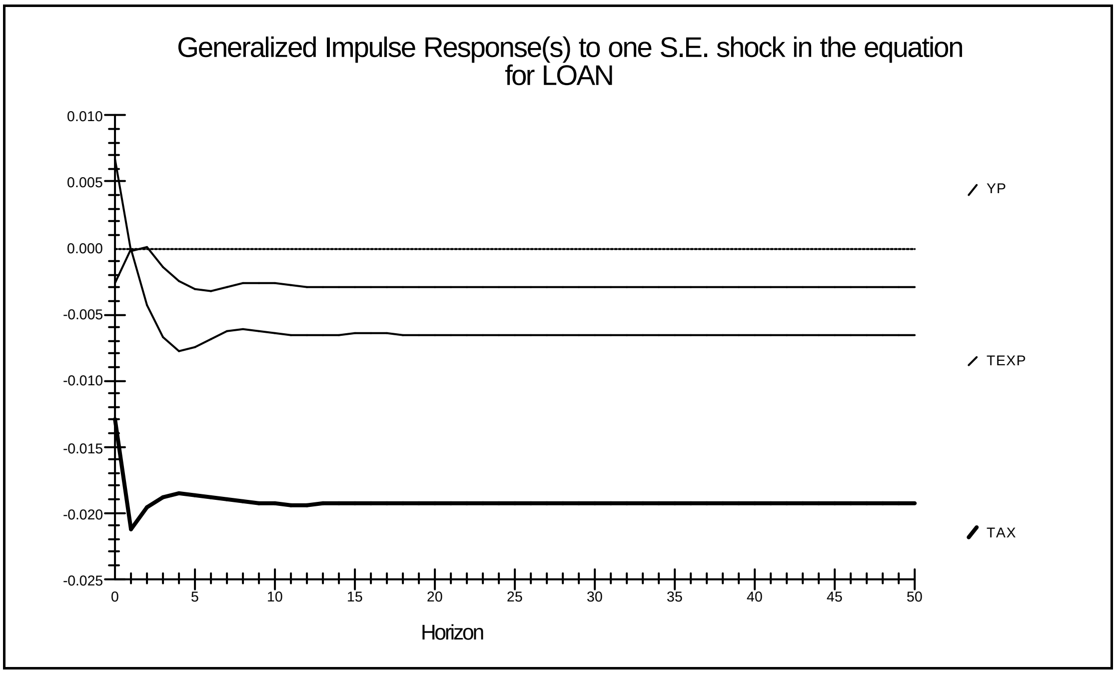
Figures 5 and 6 below describe the nature of responses of variables to shocks in expenditure and external loans respectively. In figure 5, focus is on the upper two graphs which represent responses of loans and grants in that order.

Figure 5: Effects of expenditure shock on other variables



The major effect of a shock to expenditure is on aid loans, which rises considerably and remains at higher equilibrium level thereafter. This illustrates the underlying relationship whereby aid loans are required to meet expenditure shocks. It appears a shock in the expenditure equation triggers explosive responses on itself and the aid variables but very little effect on tax revenue and output. If we take the difference between spending and tax revenue responses as representing budget deficits, then an expenditure shock creates persistent deficits both in the short- and long-run. This also underscores the fact that in view of Kenya's narrow tax base, tax revenues cannot respond adequately to match an expenditure shock, hence recourse to external borrowing by the government.

Figure 6: Effect of a shock in Aid Loans on selected Variables



A shock to aid loans seems to have a permanent negative effect on the fiscal variables and per capita income. The responses of all the variables except expenditure have negative impact response. After the initial positive response, expenditure falls to zero within a year and then stabilises below its long run equilibrium after 10 years. Thus assuming the shock to the economy are solely caused by disturbances in aid loans, then our results suggest that an expected increase in aid loans leads to increased expenditure initially before falling thereafter. The immediate impact of a shock in aid loans to tax revenue is negative and remains so throughout the simulation period, but with some volatility within the first 10 years before stabilising thereafter. The finding is consistent with earlier results that aid loans reduce tax effort. Analogously, the effect of a one standard error shock in aid loans on per capita income has a negative initial effect and remains below zero for the entire period. Comparatively, shocks in aid loans have higher impact on expenditure and tax revenue than on income – a fact confirmed by the magnitudes of estimated coefficients found in the long run model discussed earlier.

We may therefore conclude that the impulse response analysis of shocks in aid loans on fiscal variables is in tandem with earlier finding in which loans substitute for tax effort while encouraging expenditure. There is a rise in output in the first 3 years of the shock in aid loans but falls thereafter. In contrast, shocks in aid grants have an overall positive effect on per capita output (see figure b4.2: Appendix B4). The response of tax revenue to a shock in grants is higher than that of expenditure implying that it generates a budget surplus, confirming the fact that grants are associated with increased tax effort and reduced expenditure – both of which are important for growth. The simulation illustrates that while aid loans have negative effect on growth, a positive one is observed in the case of aid grants. One implication is that if donors are to increase aid to Kenya under the new democratically elected government, Kenya would derive greater benefit from grants than from loans (assuming the historic relationships modelled here represent what would happen).

Vector Error Correction Model (VECM)

To capture the short run dynamics of the model, a VECM was formulated based on the identified long run relationships. Error correction terms, $ECT1_{t-1}$ and $ECT2_{t-1}$, from the two cointegrating relations are included to capture the speed of adjustment to a disturbance in the long run equilibrium in respective vectors. The presence of cointegrating relationships in the long run model implies that all terms in the VECM are stationary and therefore conventional *t*-statistics can be used to evaluate the model. Results of the over-parameterised short run model are given in Appendix B5 while those of the parsimonious short run model are summarised in **Table 3** below.

Table 3: Parsimonious Short Run Model

Variable	Equation 1 (DYp)	Equation 2 (DTEXP)	Equation 3 (DTAX)	Equation 4 (DGRANT)	Equation 5 (DLOAN)
CONSTANT	-1.54 **(-4.76)**	-0.002 (-0.19)	0.002 (0.22)	-14.53 **(-3.24)**	-1.82 **(6.08)**
DYpt-1	--- ---	0.72 **(1.90)**	0.74 **(2.52)**	--- ---	2.25 **(2.38)**
DTEXPt-1	--- ---	--- ---	-0.38 **(-2.85)**	-3.15 **(-3.80)**	-1.21 **(-2.32)**
DTAXt-1	0.14 **(2.57)**	0.28 (1.65)	0.53 **(3.36)**	3.05 **(3.27)**	2.78 **(4.39)**
DGRANTt-1	-0.03 **(-3.18)**	--- ---	--- ---	--- ---	--- ---
DLOANTt-1	0.03 **(2.65)**	--- ---	--- ---	0.48 **(2.76)**	0.51 **(4.78)**
ECM1t-1	-0.36 **(-4.78)**	--- ---	--- ---	2.95 **(2.78)**	--- ---
ECM2t-1	0.02 **(2.60)**	--- ---	--- ---	-0.62 **(-5.39)**	-0.39 **(-5.95)**

** t-statistics are in brackets.*

Multivariate diagnostics

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Log-Likelihood 507.78

Vector Portmanteau(5) 131.91

Vector EGE-AR test: F(50, 85) = 0.8363 [0.7513]

Vector Normality test Chi^2(10) = 8.3400 [0.5957]

Vector hetero test F(210,29) = 0.4383 [1.0000]

--

Although in the parsimonious model the likelihood ratio test did not reject further reduction, we could not continue the reduction process because most of the coefficients were significant. Therefore results contained in Table 3 above are used for interpreting the short run model.

The only factors that seem to matter for output in the short run are lagged values of tax revenue, foreign grants, loans and the disequilibrium from the two cointegrating vectors. Tax revenue and external loans have, in the short run, beneficial effects on growth, but past grants have a negative one, which is surprising because one would expect grants to have a beneficial effect on growth in the short run as well as in the long run. Grants do not require any future repayment and therefore should serve as non-distortionary way of financing expenditure and thus resulting in a positive relationship with output. The negative effect of grants on growth in the short run could be reflecting the adverse effects of donor conditionalities which require the government to meet 'counterpart' spending to match given grants. However, owing to budgetary constraints facing most government in the developing countries, such requirement may lead to domestic borrowing, which in turn triggers some adverse knock-on effects in the economy. On the other hand, results for tax revenue tally with results we found in a related study where it was positive both in the long- and short- run (M'Amanja, 2005). While external grants possess a negative sign in the short run, external loans appear to have the opposite sign, implying that loans are beneficial to growth in the short run. The error correction term possesses the appropriate sign and is significant.

In the expenditure equation, only income and to a lesser extent tax revenue appear to matter for short run growth of expenditure, both of which have positive association with expenditure. According to our results, a 10% change in income and tax revenue led to 0.72% and 0.28% rise in growth rate of expenditure respectively. The tax and spend hypothesis seem to hold here. In the short-run, increases in tax revenue permit increased spending. The result is consistent with our interpretation of the long-run: it is when tax revenue is insufficient to fund expenditure that aid is required.

The results for the tax equation are not easily interpreted for expenditure. Contrary to expectation, expenditure has a negative correlation with growth of tax revenue. It could be the case that it is only current expenditure that has a positive association with growth of current tax revenue, and not past expenditure. Changes in income and tax revenue, as expected, have positive correlation with growth of current tax revenue. In the equation for grants, results reveal that changes in expenditure have inverse relation with growth of current aid grants, meaning that donors reduce funding with increased government spending. Conversely, changes in tax revenue have a positive association with growth of current grant, which reinforces the observation that grants in Kenya are associated with increased tax effort. There is also a positive relationship between loans and grants reflecting the possibility that aid is given in 'packages' comprising grants and loans.

In the equation for loans, we found that growth of lagged income, expenditure, tax revenue and loans are all significant determinants of growth of loans in the short run. The positive relationship between income and loans can be interpreted to mean that in the short run, growth permits taking new loans. Similarly, if tax revenue is rising the ability to service loans is stronger. The negative coefficient on lagged spending suggests cyclical behaviour: loans are taken to meet a deficit, then subsequently loans are lower (thus, when expenditure increases the deficit requires a loan and subsequently new loans are lower). The positive coefficient on lagged loans suggests that loans are disbursed over more than one year (as also suggested in the impulse response analysis). The error correction term from the fiscal relation possesses the right sign and is significant, implying cointegration and also justifies our choice of loans for normalisation.

6 CONCLUSIONS AND IMPLICATIONS

We have employed time series econometric techniques to investigate the relationships between fiscal aggregates, aid and growth in Kenya. Government spending appears to have significant beneficial effects on growth in Kenya. Tax revenue has no significant direct influence on growth, but may have an indirect effect through government expenditure. The effect of aid depends on whether one considers grants or loans. Grants appear to have a positive effect on growth in the long run. However, loans appear to substitute for taxes and finance fiscal deficits, and therefore have a negative effect on growth in the long run.

We draw three implications. First, noting that the measure used did not distinguish between capital and recurrent expenditure, the evidence suggests that government spending in its totality has contributed to per capita income and growth in Kenya. It cannot be presumed that this is an effect of government investment only, as recurrent spending (such as on wages or social sectors) can also contribute to income (see Kweka and Morrissey, 2000, for Tanzania). A policy recommendation is that there is need to re-examine the composition of government expenditure with a view to assessing the contribution of its components to efficiency and re-directing it to growth promoting activities. Second, there is no evidence that the distortions associated with domestic taxes have retarded growth; tax revenue did not appear to influence income directly in the long run.

Third, there are implications for aid. In Kenya, it appears that expenditure and tax revenues are in effect beyond the direct control of government, so aid is the instrument they adjust to meet fiscal deficits. The results suggest that the government takes out aid loans when there is a deficit to finance, and consequently aid loans are negatively associated with growth. Aid grants, on the other hand, are positively associated with growth; although the grants may also be used to fund a deficit, they incur no future repayment obligations and therefore do not retard long run income. In general, aid has been used largely as a borrowing instrument to substitute for tax effort. This undermines the effectiveness of aid in promoting growth. Aid to Kenya could be more effective if given in the form of grants, and associated with fiscal discipline.

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APPENDIX A: VARIABLE DEFINITIONS AND RAW DATA

Table A1: Variable definitions/descriptions

VARIABLE	DESCRIPTION	REMARKS/EXPECTED SIGN ON GROWTH
(1) Non-fiscal		
NY	Nominal GDP at factor cost as reported in various publications of the *Economic Survey* (Government of Kenya)	All variables are expressed as ratios of NY
Y	Real Gross Domestic Product (GDP) in constant 1982 prices[7].	The splicing converted data into continuous series in constant 1982 prices.
Yp	Real per capita GDP at factor cost expressed in constant 1982 prices.	Real GDP divided by total population. Where applicable, used as dependent variable to proxy for real output growth.
GRANT	Nominal receipts from abroad in form of grants expressed as shares in nominal GDP (NY)	Positive or negative depending on its usage by the government and on existence of other supporting policies.
LOAN	Net external loans to the government (inflows minus outflows).	Positive or negative depending on other factors.
(2) Fiscal		
TEXP	Total government expenditure (net of debt redemption) = recurrent expenditure ***plus*** development/capital expenditure	Can be positive or negative depending on its composition. Positive if spending on productive activities negative otherwise.
TAX	Total tax revenue includes direct & indirect tax revenue	Positive or negative, but mainly negative.

Note:- *All these variables except AENR were expressed as shares in GDP and then their logs taken.*

7 Real GDP series for 1964-1972 were in constant 1964 prices whilst the series for 1972 – 2002 were in constant 1982 prices. To splice the two series we had to calculate ratios for an overlapping year and multiply them by these ratios to generate continuous series expressed in one base year (constant 1982 prices).

Table A2: Raw Data in percentage shares of GDP

YEAR	TEXP	TAX	GRANT	LOAN
1964	16.4	11.0	3.4	3.3
1965	18.1	12.8	2.3	3.1
1966	17.3	12.9	1.1	2.3
1967	18.6	14.1	0.7	2.0
1968	19.9	14.5	0.3	1.7
1969	21.1	15.1	0.3	1.9
1970	23.4	16.5	0.2	2.1
1971	25.9	17.7	0.2	2.0
1972	25.5	16.9	0.2	2.7
1973	25.3	18.3	0.3	2.6
1974	26.1	19.9	0.7	1.9
1975	27.4	19.6	0.7	2.9
1976	26.5	18.8	0.7	2.8
1977	26.2	19.8	0.6	2.2
1978	31.0	22.3	0.6	2.9
1979	32.1	23.0	0.8	3.3
1980	33.2	24.4	0.8	4.4
1981	33.2	24.2	0.7	5.4
1982	29.6	22.8	1.2	5.8
1983	26.4	22.0	1.5	3.3
1984	29.3	21.9	1.6	0.8
1985	28.5	22.1	1.4	-0.8
1986	27.1	22.6	1.1	-0.9
1987	28.5	23.9	2.0	0.6
1988	27.9	23.9	2.7	2.1
1989	27.6	23.2	2.7	3.4
1990	28.0	22.8	2.5	2.9
1991	27.0	24.0	2.3	1.1
1992	24.2	24.3	2.9	1.4
1993	23.7	27.4	3.2	0.9
1994	25.2	29.9	3.3	-0.5
1995	26.5	29.4	2.4	-0.3
1996	26.1	28.1	1.3	-0.8
1997	24.0	25.6	1.0	-1.3
1998	23.4	25.6	0.9	-2.0
1999	22.2	24.5	0.7	-2.0
2000	23.8	23.6	1.0	-1.8
2001	23.9	21.3	0.9	-1.7
2002	24.6	20.7	1.2	-1.5
AVERAGE	25.5	21.3	1.3	1.5

APPENDIX B: UNIT ROOTS, LAG LENGTH AND COINTEGRATION TESTS

Appendix B1: Unit Roots and choice of Lag Length

When dealing with macroeconomic time series data, as we do here, the first step in cointegration analysis is to determine the order of integration or non-stationarity properties of the series. If a vector $\mathbf{y_t}$ is integrated of order d (i.e. $\mathbf{y_t}$, $\sim I(d))$, then the variables in $\mathbf{y_t}$ need to be differenced d times to induce stationarity. In this study, we employed the widely used Dickey-Fuller (DF) or its augmented version, the Augmented Dickey-Fuller (ADF) test which takes the following form.

$$Dy_t = a + bT + gy_{t-1} + \sum_{i=1}^{p} di\, Dy_{t-i} + e_t$$

(B1)

Where α is an intercept term, β and γ are coefficients of time trend and level of lagged dependent variable respectively, while e_t are white noise residuals; p is the number of lags required to produce residuals that are statistically white noise by correcting for any autocorrelation. Test statistics for non-stationary series do not follow conventional t-distribution, thus the relevant critical values are obtained from Dickey-Fuller tables (1981) and MacKinnon tables (1991). Under the ADF test, the null hypothesis is that the true values of the coefficients are zero (unit roots) which would be rejected if computed t-ratios are larger than their critical values.

In addition to testing for unit roots, it is appropriate to also test whether the data generating process (DGP) is characterized by non-stationarity with or without a drift and/or a linear deterministic and/or stochastic trend. To do this, a general ADF equation given in (Equation B1) above is estimated and the significance of their coefficients tested. The critical values for these tests are also non-standard. They include the non-standard F-statistics denoted by ϕ_i. To test the joint hypotheses of unit roots and time trend, the null hypothesis is H_0: $\beta = \gamma = 0$ (i.e. ϕ_3 – test) against the alternative of time trend and non-stationarity. If $\gamma = 1$, $\alpha \neq 0$ and $\beta = 0$, then $\mathbf{y_t}$ is integrated of order one and is a random walk with a drift. However, if $\alpha = \beta \neq 0$ and $\gamma = 1$, then $\mathbf{y_t}$ is integrated of order one and is a random walk with a drift and deterministic time trend.

If $\phi_{3\ (calculated)} < \phi_{3\ (critical)}$, we reject the null and conclude that $\mathbf{y_t}$ has a time trend. The other joint test is that of the significance or otherwise of the constant term, time trend, and non-stationarity. That is, H_0: $\alpha = \beta = \gamma = 0$ (i.e. ϕ_2 – test). If $\phi_{2\ (calculated)} < \phi_{2\ (critical)}$, then the null is rejected meaning that $\mathbf{y_t}$ has a non-zero drift term (Harris, 1995).

The choice of appropriate lag length is an important aspect in time series cointegration analysis. The length should be long enough to yield white noise residuals and short enough to preserve degrees of freedom. In our case, we started by estimating a model with 5 lags and then sequentially reduced them by examining the significance of different lags using the joint *F*-test statistic. In each round, the highest insignificant lag was dropped until a significant lag was reached. In our case, this occurred with a lag length of two. We therefore estimated a VAR model with two lags. **Table B1** below reports results of the ADF test statistics for unit roots and deterministic tests.

Table B1: DF/ADF tests for unit roots and time trend (Levels and first differences)

ADF Model: $DYt = a + bT + gY_{t-1} + \sum_{i=1}^{p} d_i \Delta Y_{t-i}$							
VARIABLE IN LEVELS						**FIRST DIFFERENCES**	
	Ho: γ=0	Ho:$\beta=\gamma=0$ (ϕ_3-test	Ho:$\beta=\alpha=\gamma=0$ (ϕ_2-test)	Lag length	Inference	H_0: γ=0	Inference
$\mathbf{Y_{Pt}}$	-2.08 (-3.53)	5.289 (6.73)	4.607 (5.13)	0	I(1)	-5.383**	I(0)
$\mathbf{TEXP_t}$	2.21 (-3.53)	4.870 (6.73)	3.658 (5.13)	0	I(1)	-5.260	I(0)
$\mathbf{TAX_t}$	-1.06 (3.53)	5.003 (6.73)	3.337 (5.13)	0	1(1)	-4.647**	I(0)
$\mathbf{GRANT_t}$	-3.12 (3.53)	5.003 (6.73)	3.337 (5.13)	1	I(1)	-3.658**	I(0)
$\mathbf{LOAN_t}$	-3.08 (-3.53)	4.776 (6.73)	3.302 (5.13)	1	I(1)	-3.757@**	I(0)

Note: *Unit roots test statistics are generated from PcGive version 10.1. Critical values for ADF-test are simulated from MacKinnon (1991) tables and their values at 5% significance level are given in parentheses. Simulation of the critical values are based on the formula* $C(p) = f_{¥} + f_1 T^{-1} + f_2 T^{-2}$ *given in Harris (1995: 158). The simulated critical values for the* f_i *tests at 1% and 10% significance levels are –4.22 and 3.20 respectively. In the above table, ** indicate significance at 5% significance level.*

Appendix B2: Cointegration Test for the Disaggregated Model

A disaggregated model with two lags was estimated and tested for cointegration using Johansen's maximum likelihood test. **Table B2** below presents results of the cointegration tests based on the trace and max test statistics.

Table B2: Test Statistics for Cointegrating rank for the Disaggregate Model

Rank	**Null**	**Alt.**	λ_{Trace} **[Prob]**	λ_{Trace} **(T-nm)**	**Null**	**Alt.**	λ_{Max} **[Prob]**	λ_{Max} **(T-nm)**
0	r=0	r≥1	86.67[0.001]**	63.24[0.149]	r=0	r=1	38.15[0.011]*	27.84[0.228]
1	r≤1	r≥2	48.52[0.042]*	35.40[0.432]	r≤1	r=2	24.14[0.131]	17.61[0.539]
2	r≤2	r≥3	24.38[0.191]*	17.79[0.591]	r≤2	r=3	13.06[0.461]	9.53[0.787]
3	r≤3	r≥4	11.32[0.196]	8.26[0.446]	r≤3	r=4	7.46[0.445]	5.45[0.688]
4	r≤4	r=5	3.85[0.050]*	2.81[0.094]	r≤4	r=5	3.85[0.050]*	2.81[0.094]

Results of the trace and max tests are conflicting (both adjusted for small sample size and the unadjusted). The trace unadjusted test indicates at least two cointegrating vectors, but the max test at least one cointegrating vector. Consequently, there is need to evoke other criteria for determining the number of cointegrating vectors. A visual inspection of the plots of corresponding cointegrating vectors (presented in figures B1.1 – B1.4 below) reveal a clearly stationary relation for the output vector, two borderline cases for the expenditure and aid vectors, and a clearly non-stationary vector for tax revenue). As pointed out at the beginning of section 5, economic theory allows possibility of two long run relations describing the output-expenditure equilibrium and the fiscal relation. This theoretical expectation largely agrees with the outcome of the trace test and plots of cointegrating vectors. Consequently, we assume two cointegrating relationships for subsequent analysis.

Figure B1: Graphical representations of cointegrating betas (b s)

Figure B1.1 *Output Relationship*

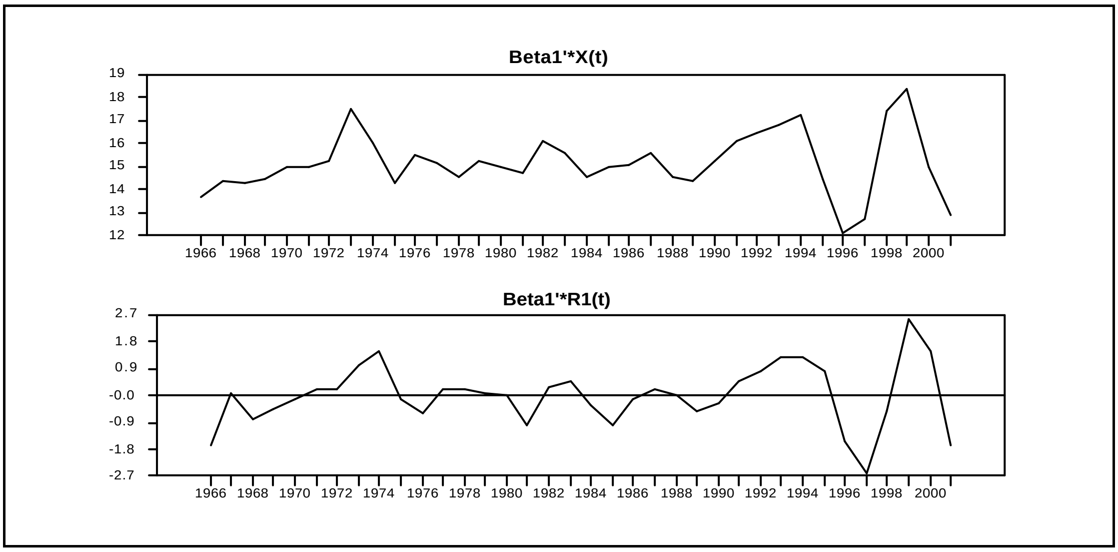


Figure B1.2 **Expenditure Relationship**

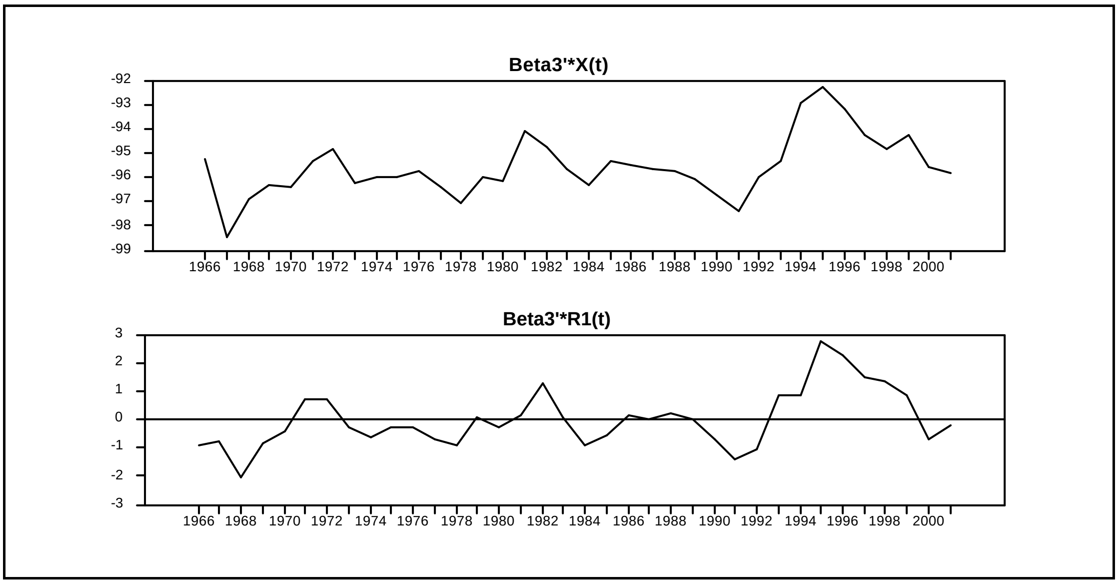


Figure B1.3 **Tax revenue Relationship**

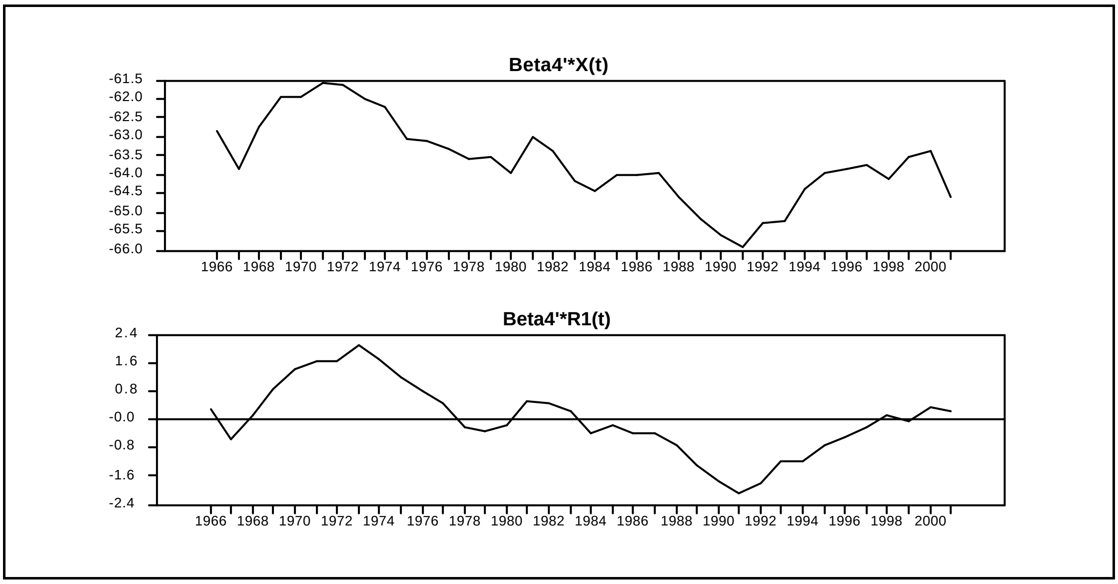
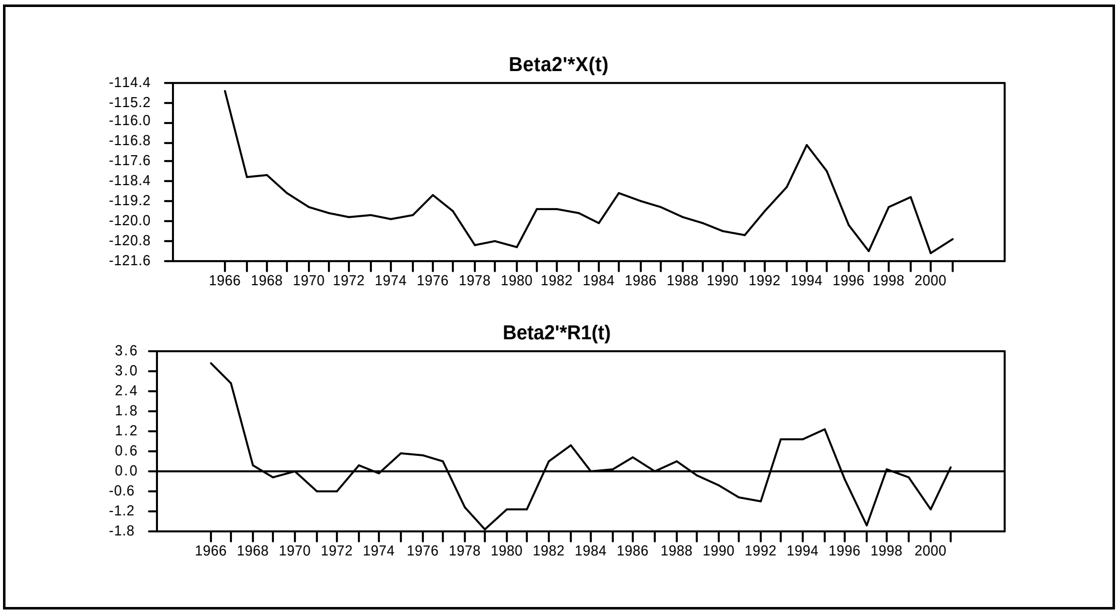


Figure B1.4 **Foreign Aid (loans)**



***Note**: For each set of plots, we consider the second which nets out short run dynamics. From the above graphs, the set representing the tax revenue relationship is clearly non-stationary (not cointegrated). The output graph appears stationary while the remaining two are borderline cases. As theory suggests two possible long run relationships, we take two as the rank of the P matrix i.e. we have two cointegrating vectors.*

Appendix B3: Aggregate Model

An aggregate model was estimated that included both grants and loans as one variable (which we called AID). The objective was to show that aggregating the two leads to misleading parameter estimates, especially when the two variables are moving in direction directions. Cointegration results are reported in the Table C1 below.

Table B3: Cointegration tests of the Aggregate model

rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	92.83 [0.000]**	46.01 [0.000]**	61.88 [0.001]**	30.67 [0.016]*
1	46.82 [0.000]**	33.73 [0.000]**	31.21 [0.034]*	22.48 [0.030]*
2	13.09 [0.112]	10.08 [0.211]	8.73 [0.398]	6.72 [0.531]
3	3.02 [0.082]	3.02 [0.082]	2.01 [0.156]	2.01 [0.156]

As with the disaggregated model, we chose two cointegrating vectors and normalised on output in the first cointegrating vector and foreign aid in the second vector. Results of the just-identified model are summarised in the following two equations (*t*-statistics are in parentheses).

Output relation

$$Yp = \underset{(5.88)}{0.65}TEXP - \underset{(-29.83)}{0.42}AID \qquad (B2)$$

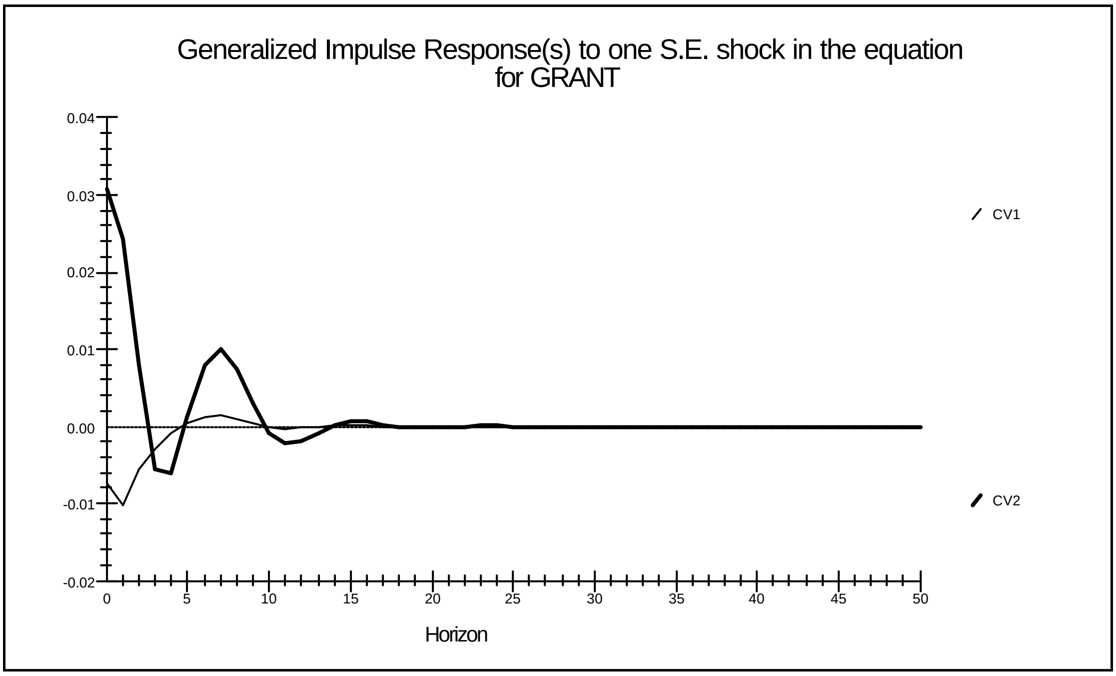
Fiscal relation

$$AID = \underset{(-6.34)}{-1.59}TEXP - \underset{(-13.50)}{0.06}TAX \qquad (B3)$$

Comparing coefficient estimates of the aggregate model (Equations B2 and B3) with those of the disaggregate model (Equations 3 and 4), it clear that these two sets of coefficients are quite different. In particular, the aid coefficient in the aggregate model is -0.42 whilst in the disaggregate model grants have a positive coefficient of 0.02 and loans a negative one of magnitude 0.1 for the output relation. These results underscore the importance of carefully testing the equality of different components of foreign aid before aggregating them into one variable, otherwise statistical results would be spurious.

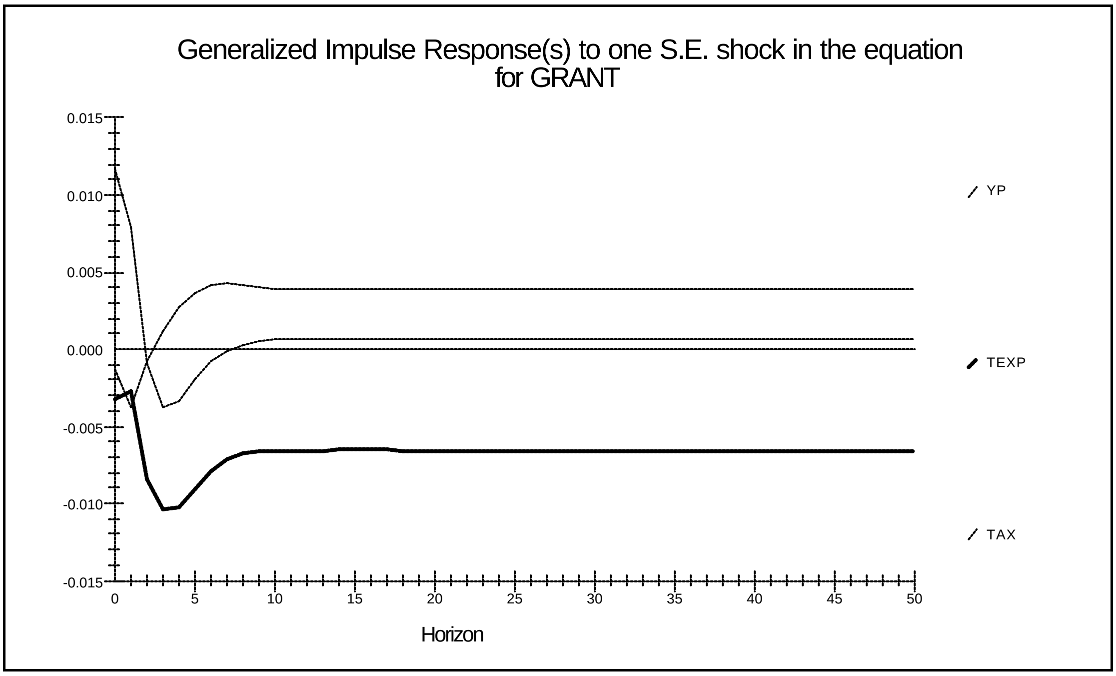
Appendix B4: Impulse Responses

Figure B4.1: Effect of a shock in external grants on the cointegration relations



Note: *Effect of shocks in grants on the two vectors dissipates after 15 years.*

Figure B4.2: Effect of a shock in External grants on the other variables



Note: *The response of output to shock in aid grants is much higher than that of loans implying that on net basis, foreign aid to Kenya is beneficial to economic growth.*

Appendix B5: Over-Parameterised Short Run Model

Variable	Equation 1 (DYp)	Equation 2 (DTEXP)	Equation 3 (DTAX)	Equation 4 (DGRANT)	Equation 5 (DLOAN)
CONSTANT	1.47 **(4.06)**	-0.87 (-0.66)	-1.54 (-1.53)	-16.28 **(-3.31)**	1.49 (0.46)
DYpt-1	0.06 (0.47)	0.69 (1.47)	0.40 (1.12)	-1.58 (-0.91)	2.42 **(2.13)**
DTEXPt-1	0.05 (0.73)	-0.04 (-0.18)	-0.40 **(-2.17)**	-2.67 **(-3.00)**	-1.54 **(-2.65)**
DTAXt-1	0.11 (1.41)	0.37 (1.36)	0.65 **(3.14)**	2.66 **(2.62)**	2.68 **(4.04)**
DGRANTt-1	-0.02 **(-2.28)**	-0.004 (-0.12)	-0.03 (-1.13)	0.14 (0.94)	-0.06 (-0.60)
DLOANTt-1	0.03 **(1.94)**	-0.004 (-0.07)	0.01 (0.19	0.41 **(2.13)**	0.57 **(4.52)**
ECM1t-1	-0.34 **(-4.01)**	0.20 (0.64)	0.36 (1.52)	3.44 **(2.95)**	-0.82 (-1.07)
ECM2t-1	0.02 **(2.42)**	-0.02 (-0.51)	-0.02 (-0.93)	-0.59 **(-4.59)**	-0.37 **(-4.42)**

* *t-statistics are in brackets.*

Multivariate diagnostics

Log-Likelihood 513.65
Vector Portmanteau(5) 124.71
Vector EGE-AR test: F(50, 71) = 1.008 [0.4825]
Vector Normality test Chi^2(10) = 10.2810 [0.4162]
Vector hetero test F(210,29) = 0.3065 [1.0000]

Note: *Although diagnostics do not reveal any specification problems, we note several non-significant coefficients which may be dropped without throwing away useful information.*

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