AID, FISCAL POLICY AND MACROECONOMY OF UGANDA: A Cointegrated Vector Autoregressive (CVAR) Approach

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The views expressed, as well as any remaining errors, are those of the author and do not necessarily represent those of the acknowledged persons or institutions.

CHAPTER ONE

1.1 Introduction

The effect of aid on economic performance in aid-dependent countries is an issue that has attracted considerable attention. The dominant strands in the literature focus on cross-country studies of the effect of aid on growth, or more recently on welfare or poverty. Another, smaller, strand of the literature has focused on the effects of aid of fiscal behaviour, as most aid spent in a country goes through or may influence the government, typically with country studies, and more recently, the International Monetary Fund (IMF) initiated work on short- and medium term effect of aid with important insights regarding absorption and spending not analysed in more classical fiscal response literature. I combine elements of the literature on the effect of aid of fiscal behaviour and of the effect of aid on growth as my interest is in the effect of aid in Uganda, a major sub-Saharan African (SSA) aid recipient over the past few decades. My primary focus is on the fiscal effects of aid, but also considers how, given this, aid affect growth (in private consumption).

Uganda is an interesting case study for assessing the effectiveness of aid as for over twenty years significant aid inflows have supported government spending in an environment of low tax revenue. The restoration of political stability in a country known for large scale violence when the Museveni regime was established in 1986, with a commitment to economic reform programmes and the resolve to alleviate poverty, renewed donor enthusiasm in Uganda and has been associated with large increases in aid inflows (Brownbridge and Tumusiime-Mutebile, 2007; Atingi-Ego, 2005; Collier and Reinikka, 2001). The aid-Gross Domestic Product (GDP) share, which was about 1 per cent in 1980 rose significantly to about 5 per cent in 1986 reaching a peak of about 19 per cent in 1992, and averaged about 11 per cent between 1990 and 2006 (Egesa, 2011; Mugume, 2008). In terms of the budget, total donor support (both direct budget support and project aid) has averaged 43 per cent of the national budget over the 2003/4-2008/9 period (Macroeconomic Policy department, Ministry of Finance Planning and Economic Development (MoFPED) in Background to the Budget, 2008/9).

As is often the case in most empirical aid studies, an important issue (but often ignored) in the context of a developing country like Uganda is which GDP measure is most reliable as this is crucial for measuring the macroeconomic impact of aid. The most commonly used GDP measure in the aid-growth literature is typically from World Development Indicators (WDI) or Penn World Tables (PWT) (being considered the most reliable or the easiest to obtain). However, disparities in GDP from alternative sources are common and in practice one has different estimates of the level, change and growth of GDP for the same country over the same period. This is of a particular concern especially in developing countries (without exception) where the informal and subsistence sectors are a large share of the economy (Jerven, 2010) and where not all transactions in the formal sector are recorded (MacGaffey, 1991), and the quality of data is still very poor and measurement perceptions of macroeconomic aggregates are varied and weak (Mukherjee, White and Wuyts, 1998). We will address the issue of which if any GDP measure is most reliable for Uganda and it is from this that the fiscal data will be derived and private consumption will be taken as a preferred measure of growth in the rest of the thesis. The study employs a powerful and scientifically strict CVAR model (that facilitates learning about complex empirical reality), and is executed using *CATS in RATS, version 2* and E-views 7.2.

The rest of chapter one is structured to incorporate a discussion on the economic effect of aid in Section 1.2 and an outline of the structure of the thesis in Section 1.3.

1.2 The Economic Effects of Aid

The underlying economic rationale for aid to developing countries can be traced back to the two-gap model of Chenery and Strout (1966). In the model, investment is the cornerstone of growth. This requires domestic savings and, atleast initially, imported capital goods. Low income countries are constrained by two gaps: insufficient domestic savings to provide the resources needed to finance the level of investment required to achieve their target growth rates and insufficient foreign exchange earnings (as they are unlikely to have sufficient export earnings) to finance capital imports. As these savings and foreign exchange gaps constrain growth, capital flows (of which aid is one form) are an important source of development finance (Franco-Rodriguez *et al.*, 1998; McGillivray and Morrissey, 2000) as they relax the savings and foreign exchange constraints. Bacha (1990) added the '*fiscal-gap*' to allow for how aid relates to the effects of fiscal and monetary policies on investment (e.g. aid financed public investment may affect private investment).

Aid is premised on different development constraints, so aid can be expected to have heterogeneous effects. In principle, if we recognise in common with McGillivray (1994), Franco-Rodriguez *et al.* (1998) and McGillivray and Morrissey (2001) that most of the aid that is spent in the country is given primarily to the government, then, any associated effect on the economy is likely to be mediated by the public sector fiscal behaviour (i.e. the effect on government spending, tax revenue and borrowing).

Fiscal response models (FRMs) (see McGillivray and Morrissey, 2000, 2004) offer important insights into how donors could expect recipient governments to respond to aid receipts. Aid packages come with strong pressures to spend (O'Connell *et al.*, 2008), so aid inflows are expected to be associated with an increase in government spending (aid additionality). It may also affect taxation either because aid influences tax effort or because reforms linked to aid conditionality affects tax rates or the tax base (Morrissey 2012; Greenaway and Morrissey, 1993). Aid is also expected to be associated with lower domestic borrowing (Adam and O'Connell, 1999; Azam and Laffont, 2003) because donor conditionality often requires the aid recipient to reduce the budget deficit (McGillivray and Morrissey, 2000).

It is clear, from the FRMs that aid is likely to be associated with public sector fiscal behaviour. Although aid is not an argument in the standard growth models, theory suggests that fiscal policy has an important role in stimulating investment and economic growth (Ram, 1986; Barro, 1990, Barro and Sala-i-Martin, 1992, 1995; Easterly and Rebelo, 1993). Public sector growth models feature channels that explicitly incorporate government activities. In particular, some expenditures are productive although the taxes required to finance them may create distortions (Barro and Sala-i-Martin, 1995; Levine and Renelt, 1992; Landau, 1983). In theory, productive government spending financed by non-distortionary taxation is growth promoting, but unproductive spending (often interpreted as consumption spending) and distortionary taxes are growth retarding (Barro, 1990). As a source of revenue, aid does not have the price distorting effects of taxes so it would be expected to contribute to increased growth if used to finance productive expenditure (Hansen and Tarp, 2001; Lensink and Morrissey, 2000). Furthermore, government spending on public goods and services is expected to be more than it would have been in the absence of aid (Morrissey, 2012; O'Connell *et al.*, 2008; McGillivray and Morrissey, 2001b). This may have positive effects on the private sector and hence promote growth (Mosley, Hudson and Verschoor, 2004; Lin, 1994).

In the literature, aid effectiveness has typically been judged in terms of its effect on economic growth usually in cross-country econometric studies. Surveys and discussions of the literature on the growth effect of aid are provided in Hansen and Tarp (2000, 2001), McGillivray *et al*. (2005), Roodman (2007) and many others, but significant disagreement remains. Meta-analysis does not resolve the impasse: While Doucouliagos and Paldam (2008, 2009, 2010) argue that the 'collective evidence' suggests that aid is not effective, Mekasha and Tarp (2013) use similar methods to show a positive effect of aid on growth. Recent studies of aid effectiveness have been based on some variant of neo-classical or endogenous growth models of Lucas (1988), Romer (1986) and Arrow (1962). They base their empirical analysis on a general equilibrium growth model, try to address the endogeneity of aid, deal with non-linear effects of aid and assess the impact of aid on growth controlling for other variables, especially indicators of economic policy and the institutional environment in the aid recipient countries (McGillivray *et al.*, 2005; Lloyd *et al.*, 2001).

Studies at the centre of the debate on effectiveness of aid takes place in the shadow of the controversial Burnside and Dollar (1997; 2000, B-D hereafter) research. This study has provoked and mobilized a relatively large and still growing empirical literature. These are critical of the validity of the B-D empirical results and its crucial policy implications. Critics argue that the study offered a simple analysis, showing that aid has a positive impact on growth, but this outcome is contingent on ''good'' fiscal, monetary and trade policies being in place. Moreover, perhaps because its implications are intuitively plausible, the research received prominence in the World Bank (1998) landmark publication, *Assessing Aid: What Works, What Doesn't and Why*.

The strongest attacks on the robustness of the B-D result are probably Easterly *et al.* (2004) and Roodman (2004). The former study retains the methodology, model specification and country coverage of the B-D study, but extends the sample from 1970-93 to 1970-97, and include previously excluded observations. This extension of the data set by four more periods results in the B-D result disappearing (although it is replicated in the 1970-93 period). This casts doubts to the conclusion that aid is effective in countries with good policies. Like Easterly *et al*. (2004), Roodman (2004) extends the sample and in addition, subjects the B-D framework to a battery of additional tests but finds little empirical support for the aid-policy link. However, there appears to be four studies to-date (Collier and Dehn, 2001; Collier and Hoeffler, 2002; and Collier and Dollar, 2002; 2004) that corroborate the B-D (1997, 2000) conclusion. In a related study, Burnside and Dollar (2004b) shift the focus from 'good' policy to institutions and investigate whether institutional quality[1] enhances the effectiveness of aid. They estimate a growth model similar to their earlier specification and find that aid in itself is not significantly related to growth, but the interactive term is, suggesting that institutional quality matter for aid effectiveness.

This notwithstanding, a large number of papers directly attack the B-D results on varied grounds but importantly, inappropriate econometric methodology and specification of the empirical model, problematic definition of the 'policy' variable, endogeneity issues etc. (McGillivray *et al.* 2005: 7-10). Hansen and Tarp (2001), Dalgaard and Hansen (2001), Lensink and White (2001), Guillaumont and Chauvet (2001), Easterly (2003), Ram (2004), Roodman (2007), among others have analysed the aid-growth relationship using different empirical approaches and an interaction term between aid and policy as suggested by B-D. None of these studies finds the interactive term to be statistically significant. Dalgaard and Hansen (2001), for instance, find that aid stimulates growth irrespective of the policy environment and that the B-D result crucially depends on the fact that they deleted five observations from the data set. Studies that include aid squared term in the specification (see Table A2 in McGillivray *et al*., 2005: 21) find support for diminishing returns to aid (due to limited absorptive[2] capacity of countries to take up large inflows of aid and problems of the Dutch disease effect) - the threshold of aid to GDP varying between 15 to 45 per cent (Feeny, 2003). In a related analysis, Dalgaard *et al*. (2004) add a climate-related variable (fraction of a country's land located in the tropics) interacted with aid to the B-D growth model specification. They find that the policy index interacted with aid is

[1] Institutional quality in the study is based on data set constructed by Kaufman *et al.* (1999)
[2] Absorption is the widening of current account deficit (excluding aid) due to more aid (Foster and Killick, 2006:3)

insignificant, but aid has a strong positive impact on growth of countries outside the tropical regions although the impact decreases for countries in the tropics.

Gomanee *et al*. (2005) test the hypothesis that aid contributes to aggregate welfare measured by infant mortality and the Human Development Index (HDI) using data for 104 recipient countries, and for sub-samples of low-income and middle income countries. They find robust evidence that aid is associated with improved values of the welfare indicators, and that this effect is greater for low-income countries. They also interestingly find that aid increases welfare either directly or through the effect on growth but no evidence that aid operates through public spending. Antipin and Mavrotas (2006) use three different data sets (including the one used in the B-D paper) and Bayesian instrumental variable to test the robustness of the central finding relating to the aid and policy interaction coefficient. They find (in their own words) that the problematic interaction term of aid and policy is not statistically significant even with the heteroskedastic-consistent estimator, and most importantly, its marginal effect on real per capita GDP growth is substantially smaller than in the B-D (2000) paper.

Overall, there are no signs of the aid effectiveness debate dissipating. Evidence from cross-country regressions is inconclusive and puzzling. It is inconclusive in the sense that different stories have been told, each proposing a variable on which aid effectiveness depends. Some studies find that aid does contribute to growth, whilst others find either a negative relationship or even no relationship at all, or that the impact of aid is conditional only on policy, institutional quality, amount of aid, or environment etc. It is puzzling in the sense that most of these studies use data from the exact same publicly available data bases, i.e. aid data from the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development (OECD) and macro data from WDI and the PWT (Juselius *et al.*, 2011), so that the opposing views on aid effectiveness may seem difficult to rationalize. Commentators have attributed opposing views to the use of different proxies and context in which aid effectiveness is evaluated. Juselius *et al.* (2011) adds nuance, stressing that the contrasting conclusions are due the use of differences in econometric models and methods, exogeneity/endogeneity assumptions and choices of data transformations (logs, ratios, levels, growth rates etc). To mention in passing, they demonstrate that while data transformations are frequently used (despite the ease with which it can be done), it may significantly influence the results (*ibid:* 5-6). However, it is also fair to observe that the distinct conclusions found in the aid-effectiveness literature are perhaps unavoidable. A variety of econometric specifications and approaches are used, and results appear sensitive to specification, sample, outliers and how endogeneity is addressed. The core problem is that different econometric specifications are associated with different technical complications and limitations (Juselius *et al.*, 2011; Roodman, 2008; Durlauf *et al.*, 2005). Further investigation may therefore be warranted.

Some studies, mostly country-specific but a few cross-country (most of these are rather old and limited) have investigated the effect of aid on the budget behaviour of recipient governments, i.e. the effect on spending and taxation. These are reviewed and discussed in McGillivray and Morrissey (2001a, 2004) and Morrissey (2012). But '…*there is relatively little evidence on the effects of aid on the level and evolution of government spending*' (Morrissey 2012: 1) and the evidence on tax effort is mixed. Although we cannot generalize on how aid affects government fiscal behaviour in recipient countries, it clearly does (and the effects may differ by country). Thus, overt concern with the growth effect of aid in the literature may distract attention from understanding how aid affects the economy through the broader fiscal dimension, and at the same time, concerns with the fiscal effect of aid does not reflect on the fact that aid itself is not independent of the level of income (or growth) in the aid recipient. Moreover, the focus in the IMF inspired studies on the short- and medium term effects of aid, i.e. absorption and spending (see Berg *et al.*, 2010, 2007; Portillo *et al.*, 2010; Hussein *et al.*, 2009; Foster and Killick, 2006) has not been analysed in more classical fiscal response models. Morrissey *et al*. (2007) address one aspect of this in which they investigate the impact of aid on growth within a fiscal framework in Kenya. They find that grants were associated with increased spending and that government spending had a positive effect on growth. Loans, on the other hand had a negative association with growth. Also, Gomanee *et al.* (2005b), investigate the impact of aid on growth via government spending and show that aid financed investment spending contributes to growth in SSA.

Most empirical studies are based on cross-country analysis, but like aid (in purpose and probably effect), countries are heterogeneous and country specific factors may constrain or promote aid effectiveness. As Doucouliagos and Paldam (2008) argue, aid-growth results are associated with regional differences, and this could be of a serious concern when it comes to country-level differences. Thus, one major limitation of focussing on cross-country regressions is that country-specific questions regarding aid are omitted (Clist, 2010). Indeed, Riddell (2007), cited in Juselius *et al.* (2011) argues that country-based evidence provides the only reliable backdrop against which to judge aid effectiveness. This thesis engages with more specific fiscal hypotheses on Uganda with the ultimate aim of assessing aid effectiveness within the broader context of the economy.

1.3 Structure of the Thesis

As the source chosen for GDP may affect inferences on growth and economic performance for African countries (Jerven, 2010) and this being essential to assess how aid may have related to growth, **Chapter two** of the thesis examines alternative sources of national income to construct a consistent GDP series for Uganda using data on GDP in current, constant and PPP prices from WDI, UBOS and PWT6.3 over the period 1970-2008 for GDP and 1982-2008 for GDP PPP. The Chapter investigates the extent of discrepancy in GDP estimates, and derives year on year percentage GDP growth rates, including percentage and average growth rate discrepancies. A particular focus is on sub-periods when there are notable divergences between GDP from alternative sources.

The **third chapter** traces the evolution of the methods used in analyzing the fiscal effects of aid. It begins with a brief review of fungibility studies, then proceeds to the fiscal response models, which are now being estimated within a vector autoregressive (VAR) framework, and then the short- and medium term macroeconomic effect of aid. The chapter gives a broad view of the gaps in the fiscal effects literature and lays out our contribution. It discusses the theoretical foundation of the cointegrated Vector Autoregressive (CVAR) model that we employ in the study, and the data, measurement and sources. It also includes trend analyses of aid, fiscal aggregates and other macroeconomic variables, presents statistical data description and finally demonstrates that the series are unit-root nonstationary.

The **fourth chapter** investigates the impact of aid on fiscal behaviour in Uganda, i.e. effects on public spending, tax revenue and borrowing. It begins from a view point that most of the aid that is spent in the country goes to or through the government or finances services that would otherwise be a demand on the budget (Morrissey, 2012), so effectiveness of aid depends on public sector fiscal behaviour (McGillivray, 1994; Franco-

Rodriguez *et al.*, 1998; McGillivray and Morrissey, 2001). The chapter provides a coherent econometric method in which assumptions about effectiveness and endogeneity/exogeneity of aid are tested, i.e. allowing the data to speak freely (Hoover *et al.*, 2008). It estimates the magnitude of the effect of aid on spending, and formulates and tests specific fiscal hypotheses on the link between aid and domestic fiscal variables.

The **fifth chapter** considers the impact of aid, fiscal variables and exports on growth of private consumption to address the growth response to aid in Uganda. Private consumption is chosen as a dependent variable to circumvent the difficulty in fiscal aggregates and exports, and implicitly aid, being accounting elements of GDP, and to allow a focus on the effects on the private sector. Aid may not increase private consumption directly, but may do so through effects on government behaviour (assuming some elements of this are significant in private consumption growth, such as public investment and public sector wages).

The **sixth chapter** provides a brief conclusion drawing together the research findings, addressing some limitations and outlining directions for future work.

CHAPTER TWO

ASSESSING GROWTH PERFORMANCE DURING INSTABILITY AND ADJUSTMENT IN UGANDA: A CONTEST BETWEEN DATA SOURCES AND DATA TYPE

2.1 Introduction

The issue of whether national income is correctly measured and whether any element of mis-measurement is consistent through time and space (i.e. whether the measure is reliable and valid) in alternative sources of GDP for SSA countries has been raised in Jerven (2010).There is an element of under coverage in all national accounts, but this is a significant issue in African countries where the informal and subsistence sectors are a much larger share of the economy. Even more, in the formal sector, not all types of economic transactions are often recorded due to the effect of the state's lack of capacity of record keeping and the small scale and informality of these transactions (MacGaffey, 1991 cited in Jerven, 2010). This is reinforced by International agencies requesting national statistics offices to provide data on aggregates but then using different statistical methods to assemble these into continuous GDP series. For example, they use different statistical methods to bridge years when no official statistical data were published and over different base years. The combined effect of the poor quality of data and the fact that measurement perceptions of macroeconomic aggregates are varied and weak (Mukherjee, White and Wuyts, 1998) implies that the source chosen for GDP may affect inferences on growth and economic performance for African countries (Jerven, 2010).

In the case of Uganda for almost three decades the focus of macroeconomic policy has been to accelerate the realization of the national vision of ***economic and social prosperity for everybody*** (Background to the budget, *various issues*). The income measure that has been extensively used to measure this unobservable (latent) variable is GDP defined as the total market value of all final goods and services produced in a given year. There are various statistical approaches to calculating GDP but the most common methods are the income, expenditure and output or value added approaches. Using these different approaches with different data sources raises the likelihood that GDP estimates can considerably vary. This is an example of the problem of measurement error in economic statistics. For example, an anonymous *Wall Street Journal* article of November 22, 1983 reports that the Federal Reserve had estimated US personal savings in the second quarter of 1983 at an annual rate of $209.3 billion and the Commerce department, for the same period, estimated personal savings of only $92.3 billion (annualized). This shows that even for the US there can be large differences in estimates of macroeconomic aggregates, and hence trusting any source at face value could be unwise.

Discrepancies in measuring macroeconomic aggregates in general and GDP estimates in particular are likely to be even greater in poorest developing countries like Uganda. The country severely fell apart in the 1970s. In the bottom billion, Collier implores how there could be no usable data in such countries during such periods (Collier, 2007:9). Thereafter, the country underwent a comprehensive change in economic structure from the mid-1980s, where in particular, liberalization may have in general temporarily worsened the accounting and record-keeping problem as comprehensive data were no longer available from state agencies.[3] Deriving GDP estimates from different data and sources, and even within the same data source, reveals measurement errors or discrepancies in the series. In such circumstances, one will have different estimates of the level, change and growth of GDP for the same country over the same period.

This chapter uses the available Ugandan time series for GDP and GDP in Purchasing Power Parity (PPP) from WDI, Uganda Bureau of Statistics (UBOS) and PWT6.3[4] to investigate the extent of discrepancy in GDP estimates, on the basis of which we derive consistent and stable series that ‘‘best’’ reflect Uganda’s economic welfare. Specifically, the paper investigates variations in GDP (including at source level) and the GDP PPP measures due to variations in compilation methods, the piecing together of shorter series in the construction of long time series, the nominal exchange rate, the PPP exchange rate, the GDP deflator, size of the revisions and smoothing of data. The choice of these data sources, as summarized in Table (1.1), reflects data availability. The chapter contributes to the existing economic growth literature by undertaking an in-depth analysis of alternative GDP sources for Uganda with the aim of deriving the most reliable series for Uganda.

[3] See Jerven (2010: 287) for a general discussion with reference to Kenya, Tanzania, Botwana and Zambia
[4] Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.3, Centre for International Comparisons of Production, Income and Prices at the University of Pennsylvania, August 2009.

While the chapter is inspired by a similar comparison in Jerven (2010) where the author focusses on comparison of annual growth rates, here the focus is on both levels and growth rates, thus making a valuable contribution for studies of long-run growth. In this respect, the current study differs from most previous studies involving Uganda that have used only one source of GDP data, typically WDI or PWT as these have been considered the most reliable (or the easiest to obtain). Although one major study of Ugandan growth appears to use data from alternative sources, unlike here they are not explicit about any differences (Kasekende and Atingi-Ego, 2008).

The rest of the chapter is structured as follows. Section 2.2 explores GDP construction, especially the role of exchange rates, while issues relating to real GDP, real GDP per capita and GDP PPP per capita are discussed in Section 2.3. Analysis of growth rates, including a brief discussion on the particular period when series diverge is presented in Section 2.4 and the time series characterization of Uganda's real GDP is discussed in Section 2.5. Section 2.6 concludes the chapter.

Table 1.1: Uganda's GDP Data Description and Data Sources as used in this Thesis

Series	Source	Series length	Series Description	Measure	Notes: Adopted from source
GDP	Uganda Bureau of Statistics, UBOS	1970-2008	Aggregate, sector value added and expenditure disaggregates Aggregate	In current Local and USD prices In constant Local and USD prices (1990=100)	Dollar figures for GDP are converted from domestic currencies using end of year official exchange rate. Data are in current and 1990 constant UGX and USD prices respectively.
GDP deflator			UGX GDP deflator (1990=100) USD GDP deflator (1990=100)	Index	GDP implicit price deflator is the ratio of local and USD current prices to local and USD constant 1990 prices
Exchange rate			End of year (Official)	Index	Quantity of local currency (UGX) to 1 USD
Population				Millions	
GDP	World Development Indicators, WDI	1960-2008	Aggregate, sector value added and expenditure disaggregates Aggregate	In current Local and USD prices In constant USD prices (2000=100)	Dollar figures for GDP are converted from domestic currencies using end of year market exchange rate. Data are in current and 2000 constant USD prices.
GDP deflator		1970-2008	USD GDP deflator (2005=100)	Index	GDP implicit price deflator is the ratio of local and USD current prices to local and USD constant 2005 prices
Exchange rate		1960-2008	End of year (Market)	Index	Quantity of local currency (UGX) to 1 USD
GDP, PPP per capita		1982-2008	GDP, PPP per capita GDP, PPP per capita	In current UDD prices In constant USD prices (2005=100).	GDP per capita based on PPP. PPP GDP is GDP converted to international dollars using PPP rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. Data are respectively in current and 2005 constant USD prices.
PPP exchange rate			End of year	Index	Exchange rate between two currencies that equates the two relevant national price levels if expressed in a common currency at that rate
Population		1960-2008		Millions	
CGDP, PPP	PWT6.3	1960-2007	GDP, PPP per capita	In constant USD prices (1996=100)	The variable CGDP is used, and is real GDP per capita obtained from an aggregate using price parities & LCU expenditures for consumption, investment & government of Aug 2001 *vintage*.

Sources: World Bank national accounts data and OECD National Accounts data files (2009); World Bank, International Comparison Program database; Uganda Bureau of Statistics: National Accounts Estimates of main Aggregates & Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.3centre for International Comparisons of Production, Income and Prices at the University of Pennsylvania, August 2009.

2.2 GDP Construction and Exchange Rates

The primary sources for GDP are WDI and UBOS although time coverage differs, 1960-2008 (WDI) and 1970-2008 (UBOS) [Although the World Bank must have obtained national accounts to construct the series for the 1960s, we found no record of earlier data in UBOS]. Each source reports GDP in current market prices, expressed in billions of local currency units (LCU or Ugandan Shillings, UGX) and United States Dollars (USD), in aggregate and disaggregated by expenditure and sector value added components. The WDI GDP estimates (reported in year 2009) are in constant 2000 USD while UBOS estimates (reported in year 2009) are in constant 1990 USD. Appendix A presents the sector disaggregation of GDP and shows that both sources derive aggregate GDP using the expenditure method. Here we focus on how the choice of exchange rate affects the derived series in USD.

Current Price dollar value GDP

This section builds from the current price GDP series in LCU, the UGX series discussed in Appendix A, to assess differences in how WDI and UBOS convert this to a USD series. The choice of which nominal exchange rate (UGX: USD) to use may matter; for example, there is likely to be a difference between the end of year and average year exchange rates, and there may be different end of year exchange rates (for example, prior to 1992, Uganda had no single market-determined exchange rate). In principle, the exchange rate adjusts to differences in price changes (inflation) between Uganda and the US, that is, GDP in USD deflates GDP in UGX by the excess of Ugandan over US inflation (assumed to proxy world inflation).

In practice, however, the nominal exchange rate will not adjust fully to inflation differences, most obviously because it is augmented by the global exchange rate realignment with other trading partners notably Europe (the Euro and Pound Sterling) and there are policy reasons why Uganda may wish to limit changes in the exchange rate (a case in point is where an appreciation in the shilling against the US dollar, - the dominant currency in Uganda's foreign transactions, potentially undermines the competitiveness of its exports). This is especially important prior to the late 1980s when Uganda operated an official exchange rate (set by the government rather than the market); exchange rate liberalization began from 1989 but was not completed until 1992. This is discussed in more detail below but the principle concern is that it is not evident how to identify the appropriate exchange rate prior to the early 1990s.

The nominal exchange rate (e) is the relative price of the currency of two trading countries (Mankiw, 2007; Blanchard, 2009). The real exchange rate (RER) on the other hand relates to the relative prices of tradeables (P_T , importables and exportables) and non-tradeables (P_N) (Mankiw, 2007; Blanchard, 2009); as this reflects relative incentives it is often interpreted as a measure of a country's competitiveness. Given the nominal exchange rate e (UGX per dollar) and domestic prices of non-tradeables and tradeables, the real exchange rate is:

$$\text{RER} = \frac{P_N}{P_T} = \frac{P_N}{eP_T^w} \tag{1.1}$$

where RER is the real exchange rate, $e = LCU : USD$, P_N is domestic price of non-tradeables and P_T^w is the world price of tradeables (in USD). Given the difficulty of measuring the non-tradeables, an alternative definition of the RER is derived from the purchasing power parity (PPP) approach (Atingi-Ego and Kaggwa Sebudde, 2004). The PPP relationship links national price levels and the nominal exchange rate (Enders, 2010) to international PPP prices. Using the PPP approach, RER is defined as the nominal exchange rate (e) corrected for the ratio of foreign price level (P^f) to the domestic price level (P^d):

$$RER = e\left(P^f \big/ P^d\right) \tag{1.2}$$

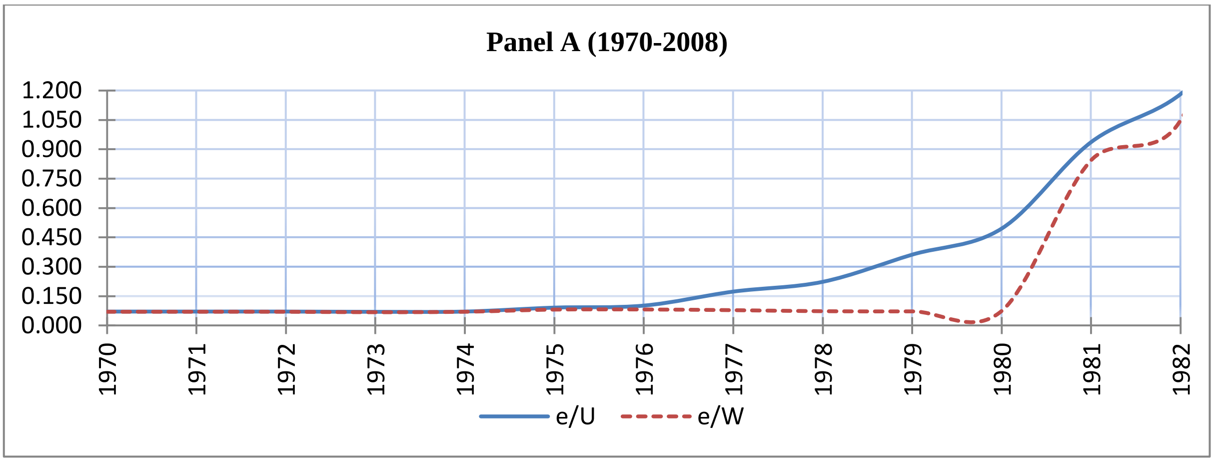
In (1.2), it is clear that if inflation (ΔP) for f and d differs, e can adjust to maintain RER. This approach avoids the difficulty of measuring P_N by concentrating on relative rates of inflation. However, to the extent that the inflation measure excludes P_N , this is incomplete (and this RER may not really capture competitiveness).

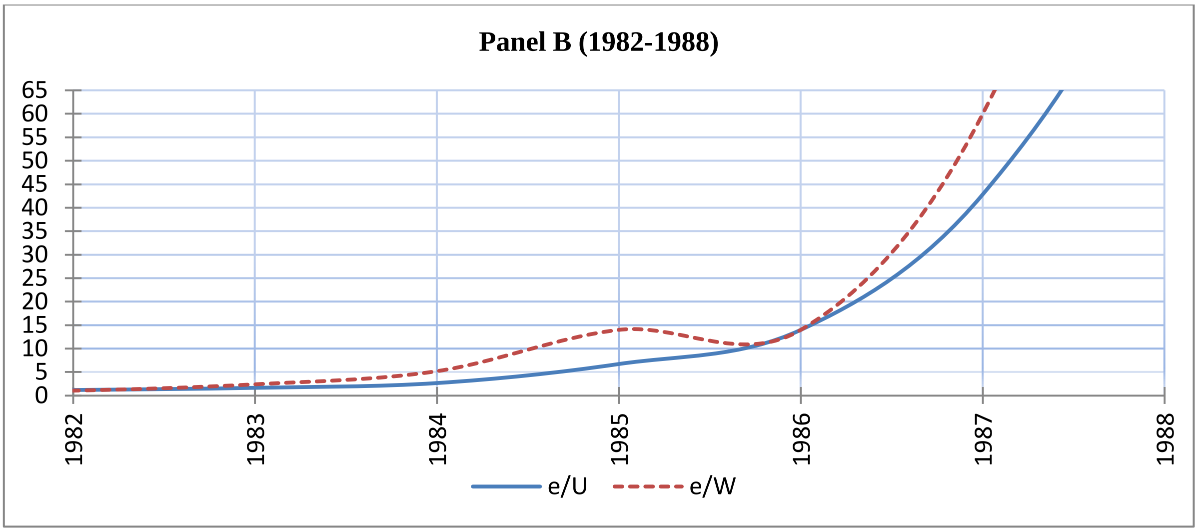
Here inflation is measured by the annual growth rate of the GDP implicit deflator (World Bank national accounts data and OECD National Accounts data files, 2009) and not the conventional percentage change in the CPI, which tends to over-state inflation (see Mankiw, 2007). Moreover, although CPI and the GDP deflator move together most of the time, the two indices differ (see Blanchard, 2009). Assuming that e adjusts to maintain RER when relative prices change, we use the nominal exchange rate index. Data on end of year nominal exchange rates are obtained from the World Bank and OECD National Accounts data files (2009) for WDI and National Accounts Estimates of main Aggregates for UBOS.

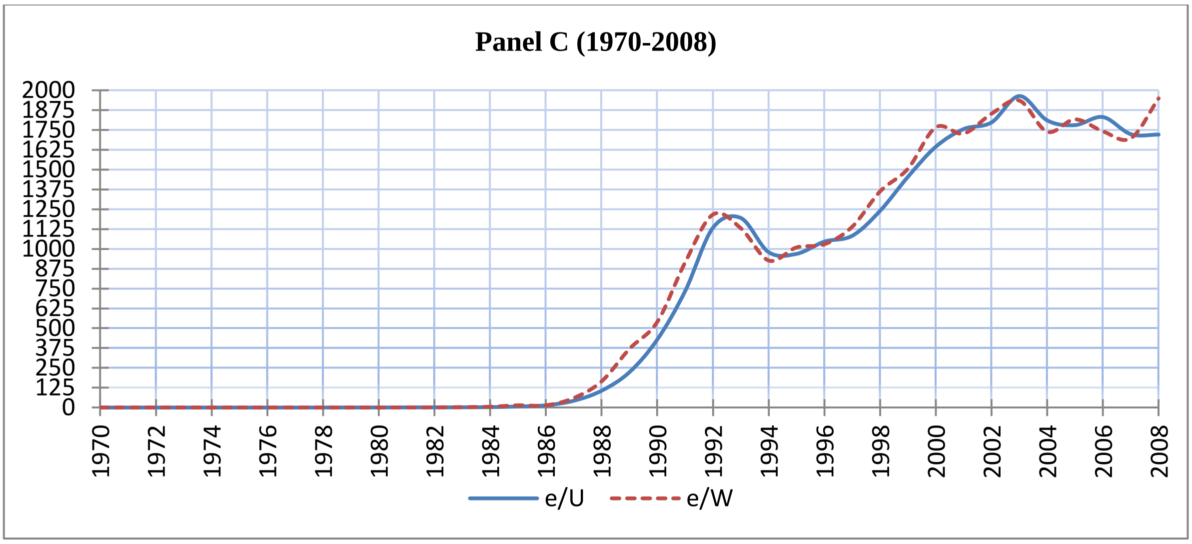
Figure (1.1) provides a plot of the respective source end of year nominal exchange rate. Given the large changes in scale, panels A, B and C are presented for sample periods 1970-1982 (when there was an official and overvalued exchange rate), 1983-1987 (a transition to a market exchange rate) and 1970-2008 (entire sample period) respectively.

The figure reflects the distortions in Uganda's exchange rate market for the greater part of the sample period. The 1970s was characterized by a series of exchange rate regimes. For example, in the period prior to 1974, plots in panel A show a unified exchange rate of UGX 0.07143 per USD. Over the period 1975-1981, the Ugandan monetary authorities maintained an overvalued exchange rate, accounting for the huge variation from WDI as panel A portrays.

Figure 1.1: Nominal Exchange Rate (LCU per USD) Index







Notes: On the vertical axis is Official exchange rate (LCU per US$, end of Period), e is nominal exchange rate and U and W respectively are UBOS and WDI representations

Sources: UBOS National Accounts Estimates of main Aggregates and World Bank and OECD National Accounts data files (2009)

A flexible exchange rate regime with a two-window system was introduced in August 1982.[5] By 1984, after a series of devaluations, the gap between the two institutions' exchange rate not only narrowed, but switched position with the UBOS exchange rate exhibiting appreciation pressures. While the UBOS exchange rate remained below that of WDI, the massive series deviation between 1984 and the last quarter of 1985 (see panel B) could be a result of the deep economic crisis that engulfed the economy in 1984 (Baffoe, 2000).

[5] Under the dual exchange rate system, Window I was the official exchange rate while the auction or the underground foreign exchange market operated under window II. The exchange rate for the two windows moved closer to each other following a significant devaluation to over UGX 270/US$1 in 1984

The nearly unified exchange rate in 1986 could be attributed to Uganda's domestic monetary authority's intervention. The period in question corresponds to a series of exchange rate events, including reductions of the exchange rate misalignment[6] effective 1986, legalisation of foreign exchange market and adoption of a fully-fledged flexible exchange rate regime in 1992 (Kasekende and Atingi – Ego 1995; Loxley, 1989).

While a similar trend movement in the two nominal exchange rates can be inferred from the figure panels, the two series are inconsistent. Even if none of the series is consistently biased upwards, UBOS series appears relatively over valued on average. These inconsistencies could reflect in part differences in the weighting of high rates of inflation. It is possible that the high inflation rates may not have been fully reflected in one of the exchange rate series. Mugume (2008) attributes the over valuation in the UBOS rate to Bank of Uganda's intervention, through its sales of foreign exchange (an intervention that can give rise to exchange rate misalignment) to keep the exchange rate close to its market clearing level while ensuring appreciation at least since the early 1990s. Mugume's assertion corroborates the overvaluation that the plots in Figure (1.1) seem to reveal, especially effective 1992. Therefore, whereas both sources use exchange rate as of end of period, WDI's rate could be the true market clearing exchange rate while that of UBOS is a managed float. These nominal exchange rate differences will affect dollar value GDP estimates.

Inserting the appropriate values in (1.3) using UGX GDP (aggregate) data in Figure (A3 (of Appendix A)) and the respective source end of year nominal exchange rate in Figure (1.1), a series of GDP measured in billions of current price USD is generated.

$$\text{Current price USD GDP} = \frac{\text{current price GDP(UGX)}}{\text{nominal exchange rate}} \tag{1.3}$$

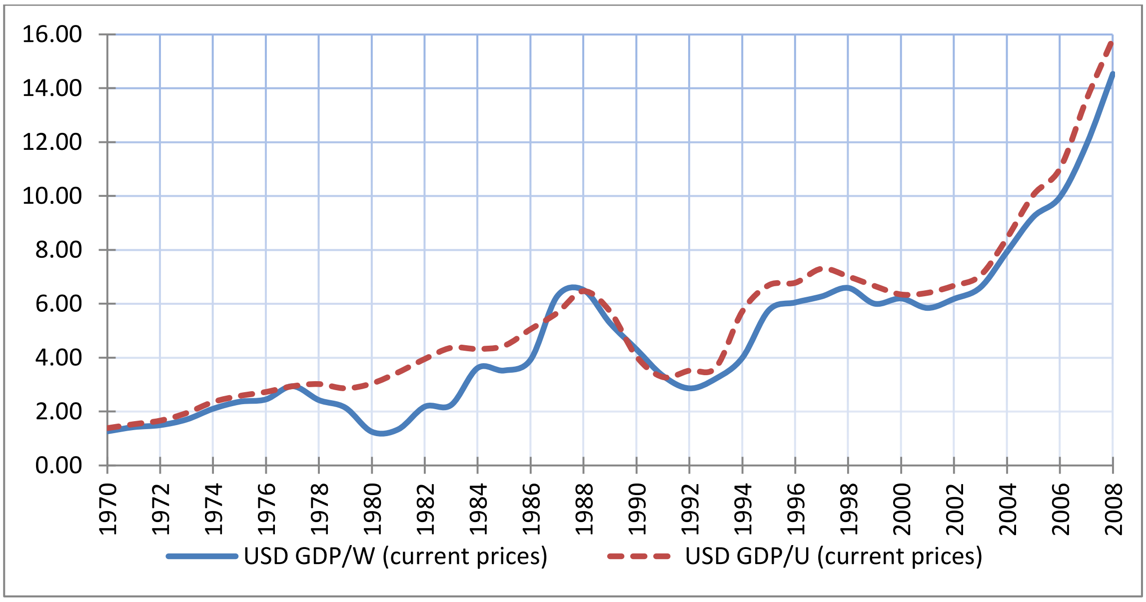
The resulting current price dollar value GDP is plotted in Figure (1.2), and this raises a number of striking points. First, regardless of the source, the series shows an upward trend in Uganda's USD GDP at current prices over time. Secondly, the series move together (except for 1978-88), although UBOS series is slightly higher from 1992. As these are

[6] This specifically involved a massive devaluation from UGX 1,400 to UGX 6,000 per 1USD.

based on the USD implicit price deflator, the discrepancies could be due to incomplete adjustment or differences in the retrospective revisions in the data.

The fixed-base Laspeyres procedure requires several heterogeneous shorter series to be pieced together, arguably to ensure that the price structure reflected in the index [7] construction remains representative (Fuente, 2009). Thus, the base year is updated and the national accounts data is linked at regular intervals, usually after every five years. This five year window period has, however, been reached at different points in time. WDI GDP series' most recent update is in 2005 after the base year was moved from 2000 while UBOS series most recent update is 2002 after the base year was moved from 1997/98. Young (1989) shows that each time GDP base year is moved forward, GDP drops sharply. This and the fact that WDI base year has always preceded that of UBOS may in effect explain the inconsistencies.

Figure 1.2: USD GDP (current price U.S dollars), 1970-2008



Notes: On the vertical axis is GDP in billions of USD current prices; U & W are respectively UBOS and WDI representation

Sources: UBOS National Accounts Estimates of main Aggregates, World Bank national accounts data and OECD National Accounts data files (2009) and Author's own calculations

[7] This is because over time relative prices and volumes of goods and services change; some products disappear from the market place and new products appear (Brueton, 1999).

The discrepancy during the period 1977-1986 corresponds to economic shocks. The economy suffered deep economic crisis as a result of political turmoil, social disorder and pervasive state intervention (Shaw et *al.*, 2007) and external large petroleum price rises (Jerven, 2010; Niringiye, 2009). The series discrepancy over this period may partly be a result of the differences in the magnitude of the revisions in the data in an effort to carry certain definitional changes back in time. It may be the case that actual changes made in one of the series may have been very small with no substantial changes made in the key components of GDP.

2.3 Real UGX GDP and Real GDP per capita

Real UGX GDP

The recovery and subsequent use of real GDP series draws from a well founded argument in economic growth literature. Nominal GDP, estimated as the sum value of all produced goods and services at current prices suffers from inherent weaknesses, as an increase from one year to the next could be a result of an increase in prices, an increase in the volume of goods and services produced or some combination of these two.

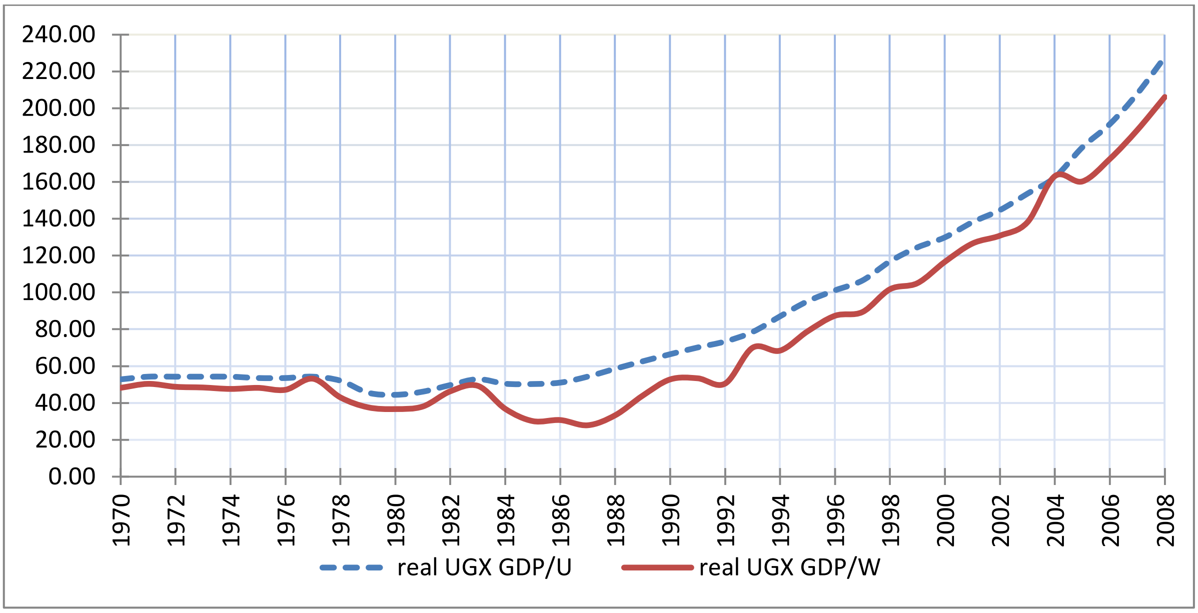
Real GDP, that is, GDP estimated in constant prices, removes the impact of price fluctuations. In real terms, changes in GDP only reflect changes in the volume of goods and services produced, that is, it attributes year on year changes in GDP to changes in output quantities, holding prices constant. When analyzing economic growth one wants to use changes in real GDP (in aggregate or per capita). As noted in the previous section, GDP in USD adjusts for Uganda – US inflation differences via nominal exchange rate, e. Importantly, one should not then deflate this series with a Ugandan deflator to derive a real series but could use a US deflator to allow for US inflation (which however is again not possible as the US deflator is augmented by the global deflator realignment with other trading partners particularly Europe). To circumvent this problem, we use the UGX implicit price deflator to derive and compare real UGX GDP series, i.e. we compare real GDP in LCU across WDI and UBOS. Subsequently, we convert the USD GDP and the real UGX GDP into indices which are then finally compared. While one may argue that this is similar to the comparison of growth rates, it is better because it shows when levels converge and diverge.

The real UGX GDP is recovered from the nominal UGX GDP (given in Figure (A3 of Appendix A)) using the UGX implicit price GDP deflator in 2005 constant prices (given in Appendix Table A2: Selected UBOS data set).[8] This recovery employs the relationship in (1.4).

$$\text{Real UGX GDP}\,(2005=100) = \frac{\text{Nominal UGX GDP}}{\text{UGX implicit price GDP deflator}\,(2005=100)} \tag{1.4}$$

The resulting real UGX GDP series is provided in Figure (1.3).

Figure 1.3: Real UGX GDP (2005=100), 1970-2008



Notes: On the vertical axis is real UGX GDP in billions of constant 2005 prices; U, W are respectively UBOS and WDI representations

Sources: World Bank national accounts data and OECD National Accounts data files (2009), UBOS National Accounts Estimates of main Aggregates and Author's own calculations

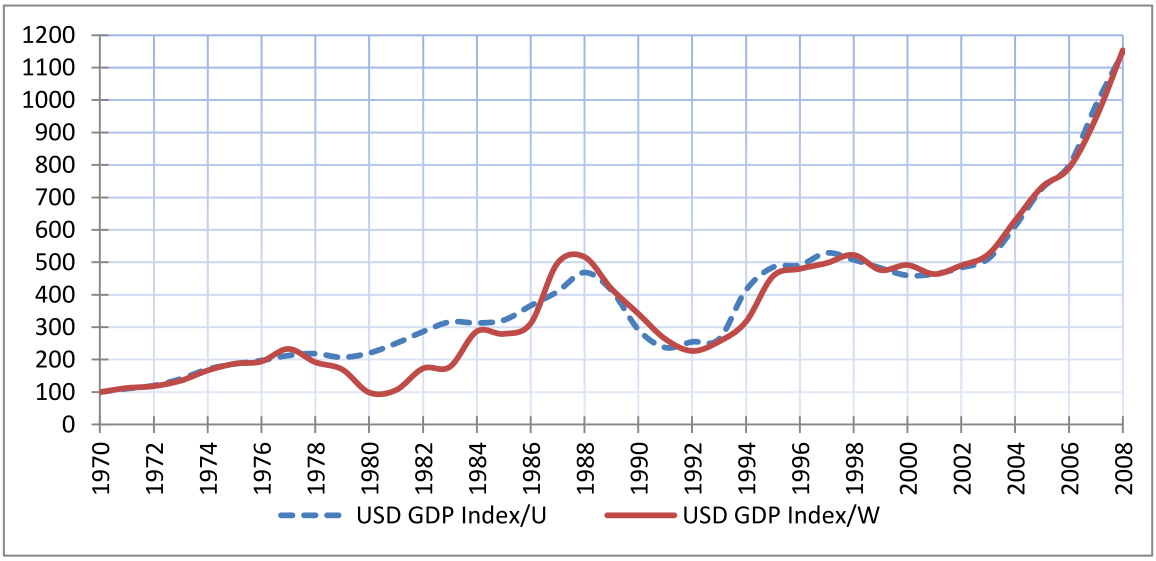
Although these are similar, they are inconsistent (real UGX GDP/U is consistently higher than real UGX GDP/W) and only converge at three data points (1977, 1983 and 2004). The similarity is because alternative sources use a similar fixed-base Laspeyres index splicing/linking technique to construct continuous time series. The inconsistence in the two series is because of differences in regularity of the time intervals at which alternative

[8] Detailed **Appendix Tables** are available with the author on request

sources pieced together several heterogeneous shorter series. Commentaries with WDI show that the series was linked by butt splicing in 1972 while 1979, 1986, and 2002 corresponds to a break in analytical comparability data or change of magnitude. It is also shown that multiple time series versions were linked by ratio splicing using the first annual overlap in 1991 and 2004. No such commentaries about the series linking points are available with UBOS except for one point, 2004 when multiple time series versions were linked by ratio splicing (as in WDI). So, it appears 2004 corresponds to a common point in time at which alternative sources linked multiple time series versions by ratio splicing using the first annual overlap, and so may be the convergence in 1977 and in 1983. Overall, in the figure, UBOS series is smoother while WDI series displays some variability from year to year.

Because we wish to establish when levels in USD GDP (in current prices) and real UGX GDP series converge and diverge as a way of comparing the two series, these are converted into indices by setting the index for the first year of each series (i.e. 1970) to 100 and calculating evolution against this base. The resulting USD GDP and real UGX GDP indices are respectively shown in Figures (1.4) and (1.5).

Figure 1.4: USD GDP Index (1970=100)

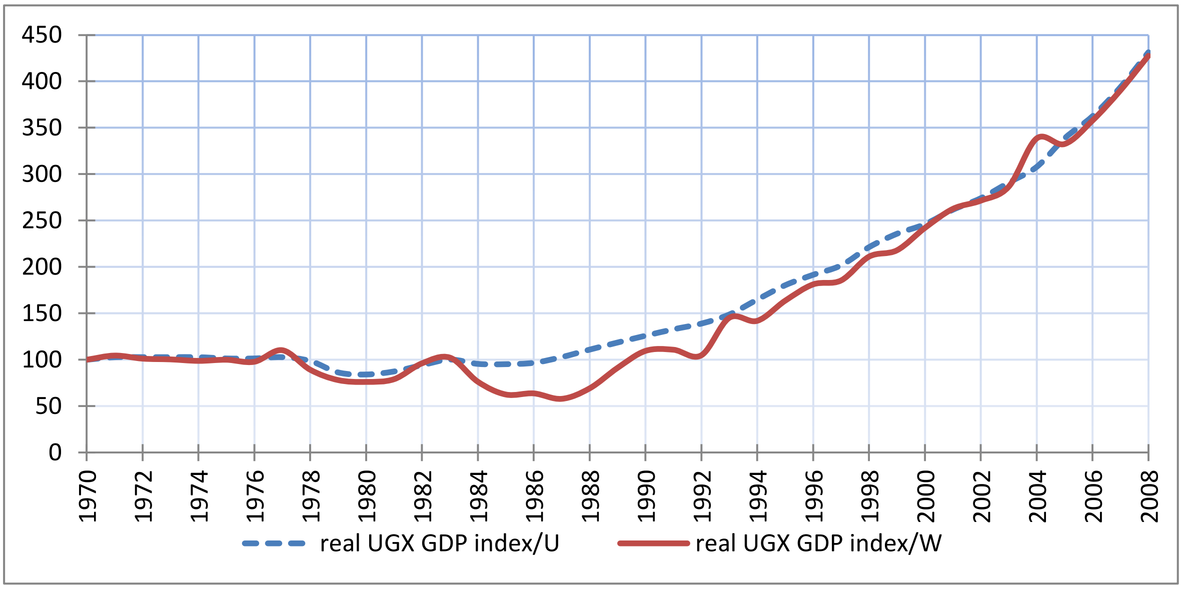


Notes: On the vertical axis is USD GDP (in current price) indices; U, W represents respectively UBOS and WDI.

Sources: UBOS National Accounts Estimates of main Aggregates, World Bank national accounts data and OECD National Accounts data files (2009) and Author’s own calculations

From figure (1.4), we observe many points at which the series converge, occurring especially during the early to mid-1970s and from about 2002 onwards. The levels however also diverge, with a big disparity occurring over the period 1978-1984. Both indices show variability and the plots do not point to any index being consistently above or below the other. Nonetheless, they are quite similar except for the one period noted above as characterized by political and economic instability.

Figure 1.5: Real UGX GDP Index (1970=100)



Notes: On the vertical axis is real UGX GDP indices; U, W represent UBOS and WDI respectively.

Sources: World Bank national accounts data and OECD National Accounts data files (2009), UBOS National Accounts Estimates of main Aggregates and Author's own calculations

From the indices in Figure (1.5), levels diverge most over the period 1983-1992. For the rest of the period, any divergence is minimal. The UBOS index is smoother but both exhibit a similar pattern of evolution.

Real GDP per capita

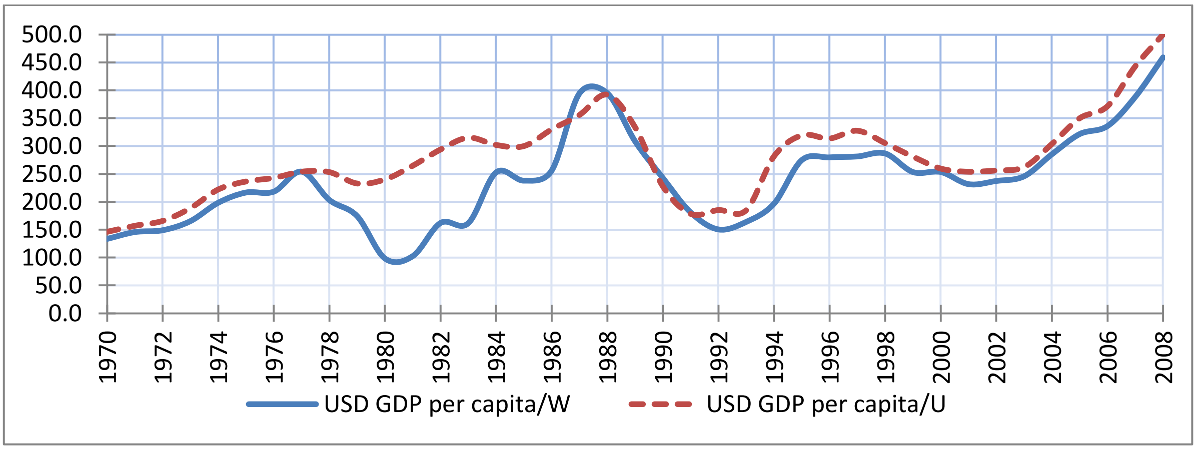
As noted above, real GDP measures economic welfare at the aggregate level. Real GDP per capita distributes this economic welfare and measures the average welfare of a person, and is given as the ratio of real GDP to the population. Using USD GDP series in Figure (1.2), real UGX GDP in Figure (1.3) and population data in Appendix Tables (A1 and A2)[9], real GDP per capita is recovered from (1.5) as:

$$\text{Real GDP per capita} = \frac{\text{Real GDP}}{\text{Population}} \qquad (1.5)$$

Using equation (1.5) we derived real GDP per capita series, denoting this respectively as USDy and UGXy in USD and LCU. USD GDP per capita series is plotted and compared in Figure (1.6) while the real UGX GDP per capita series is given in Figure (1.7).

Correspondingly, USD GDP per capita (Figure (1.6)) and USD GDP (Figure (1.2)), and real UGX GDP per capita (Figure (1.7)) and real UGX GDP (Figure (1.3)) plots are similar in levels, but differ in scale (due to the population factor, measured in millions). Hence, the two measures of growth (aggregate and per capita) yield growth rates that may differ depending on the rate of population growth.

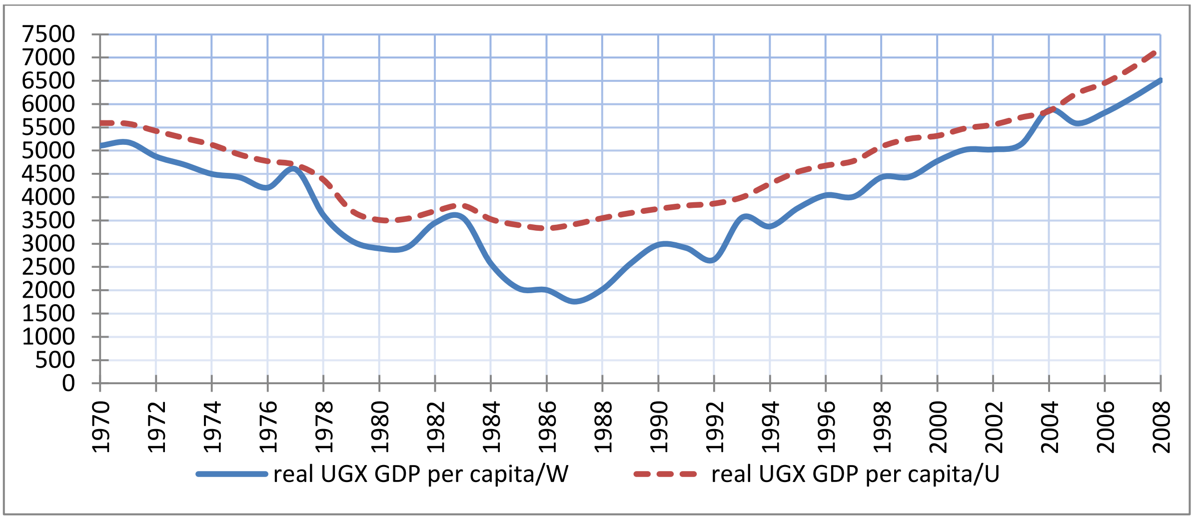
Figure 1.6: USD GDP per capita (current prices)



Notes: On the vertical axis is USD GDP per capita (in current prices); U, W represent respectively UBOS and WDI.

[9] For both UBOS and WDI, population is the same and is measured in millions.

Figure 1.7: Real UGX GDP per capita (2005=100)

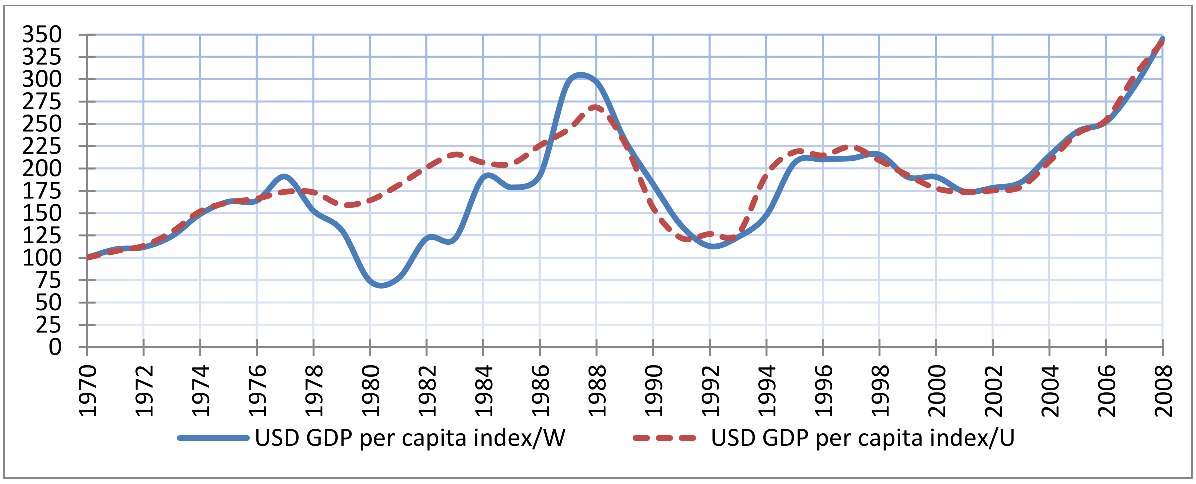


Notes: On the vertical axis is real UGX GDP per capita; U & W are respectively UBOS and WDI representation

Sources: UBOS National Accounts Estimates of main Aggregates, World Bank national accounts data and OECD National Accounts data files (2009) and Author's own calculations

We then converted the USD GDP per capita (series in Figure (1.6)) and real UGX GDP per capita (series in Figure (1.7)) into indices to reveal when levels converge and diverge. USD GDP per capita indices are plotted and compared in Figure (1.8) while the comparison of real UGX GDP per capita indices is drawn from Figure (1.9).

Figure 1.8: USD GDP per capita Index (1970=100)

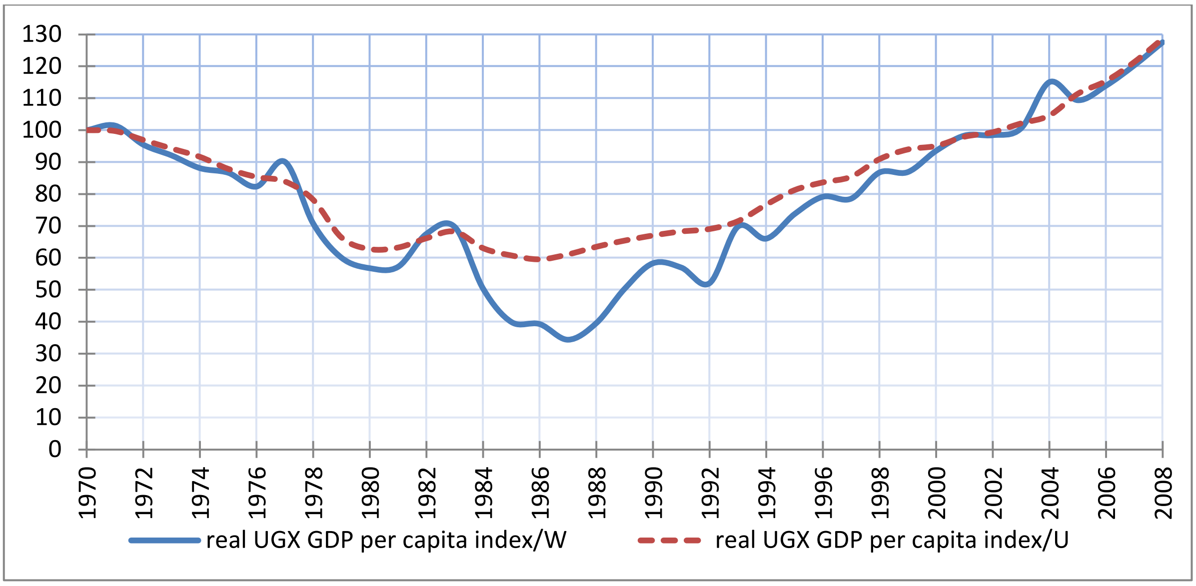


Notes: On the vertical axis is USD GDP per capita (in current price) indices; U, W represent UBOS and WDI respectively.

Sources: UBOS National Accounts Estimates of main Aggregates, World Bank national accounts data and OECD National Accounts data files (2009) and Author's own calculations

Again, the corresponding index plots, i.e. Figure (1.8) and Figure (1.4) [respectively USD GDP per capita and USD GDP indices], and Figure (1.9) and Figure (1.5) [respectively real UGX GDP per capita and real UGX GDP indices] are similar in levels, but differ in scales due to the population factor. So, as before, the same comment as to when levels converge and diverge applies.

Figure 1.9: Real UGX GDP per capita Index (1970=100)



Notes: On the vertical axis is real UGX GDP per capita indices; U, W represent UBOS and WDI respectively

Sources: UBOS National Accounts Estimates of main Aggregates, World Bank national accounts data and OECD National Accounts data files (2009) and Author's own calculations

It has emerged from this section that while real UGX GDP or USD GDP may have been used to gauge Uganda's economic prosperity (be it at aggregate or per capita level), the two measures differ depending on whether the series is derived from the implicit price deflator (inflation in Uganda) or the nominal exchange rate (inflation differential). In particular, basing on the GDP indices, USD GDP measures show similar and significant variability, with no series being consistently above or below the other. On the other hand, GDP measures derived from the LCU implicit price deflator are similar, but differ in stability depending on the data source. The WDI series is relatively volatile while that of UBOS is smooth. As the two series are similar especially at the beginning and end of the sample period, the real UGX GDP series (aggregate or per capita) is henceforth used to derive year on year percentage growth rates, including percentage and absolute average growth rate discrepancies. Based on this, we investigate if differences in underlying UBOS and WDI series yield significant discrepancies in the growth estimates in Section 2.4.

Real GDP PPP per capita

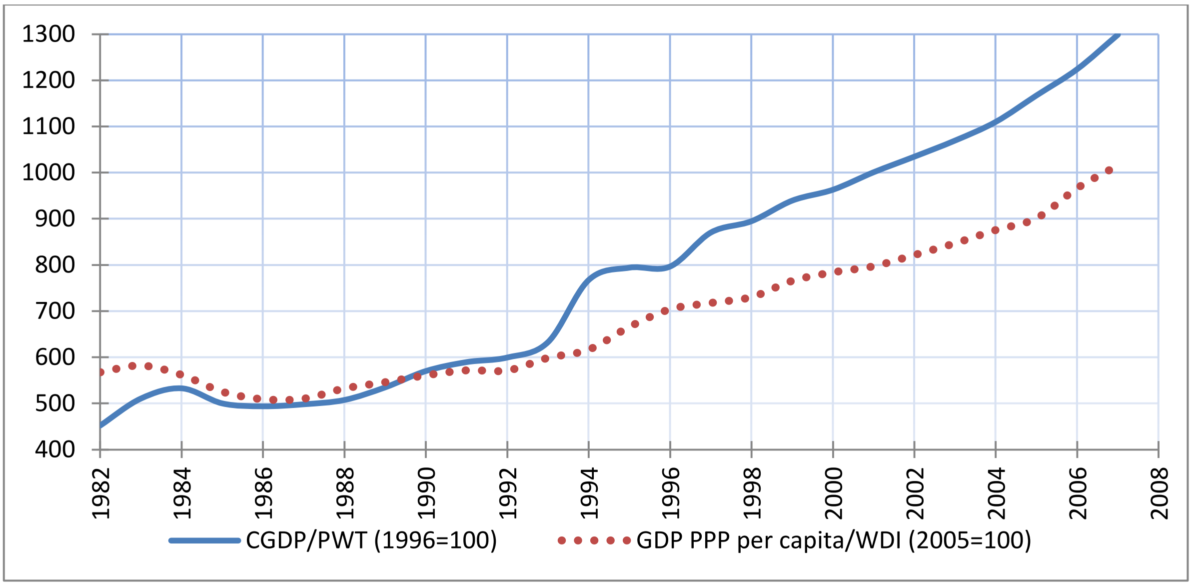
We also explored Uganda's real GDP PPP per capita using two measures, PWT6.3 and WDI as UBOS neither constructs GDP PPP nor GDP PPP per capita. In the PWT, cross-country income data compilation is subject to data quality and countries are given grades based on the ability to construct good PPP measures and a country's capacity to produce reliable national income accounts and domestic price indices. Grades A, B, C and D indicate a margin of error of 10%, 20%, 30% and 40% respectively. For the 43 SSA countries in the PWTs, 17 get a D (including Uganda) and 26 get a C (Deaton and Heston, 2008).

PWT6.3 gives real gross domestic product per capita series in unit 1USD as CGDP while in WDI, it is given as GDP PPP per capita. Moreover, the GDP PPP per capita series in both cases is expressed in constant international dollars but over different base years. That is, 1996 constant prices for the PWT6.3 series as in PWT6.1 and 2005 constant prices for the WDI's series. The series comparison covers the period 1982-2008 (as this is the period over which the series is available in alternative sources), and is respectively denoted CGDP/PWT and GDP PPP per capita/WDI for PWT and WDI sources in Figure (1.10). As can be noted, the series are not only inconsistent, but are not directly comparable given the fact that they are based on different base years (Young, 1989; Romer, 1987).

More specifically, the difference between PWT6.3 and WDI series arise from variations in the PPP compilation methods with the underlying source. While it is documented that prior to 2000, WDI used the PWT (Summers and Heston, 1991) as the main source of PPP, the source has since updated its series using the PPP data from the latest International Comparison Program (ICP) round for 2005. The ICP round for 2005 introduced other improvements in the data and estimation methods for the PPP (World Bank, 2008a, b). The PWT6.3 does not include the ICP round for 2005 data but this will be incorporated in PWT7.0 version, which, at the time of compilation, was in preparation (Deaton and Heston, 2008). It is therefore expected that there could be methodological differences between the

PWT6.3 and the WDI PPP (Shaohua and Ravallion, 2008; World Bank, 2008a, b and Ackland *et al.*, 2006).

Figure 1.10: Real GDP PPP per capita (1982-2008)



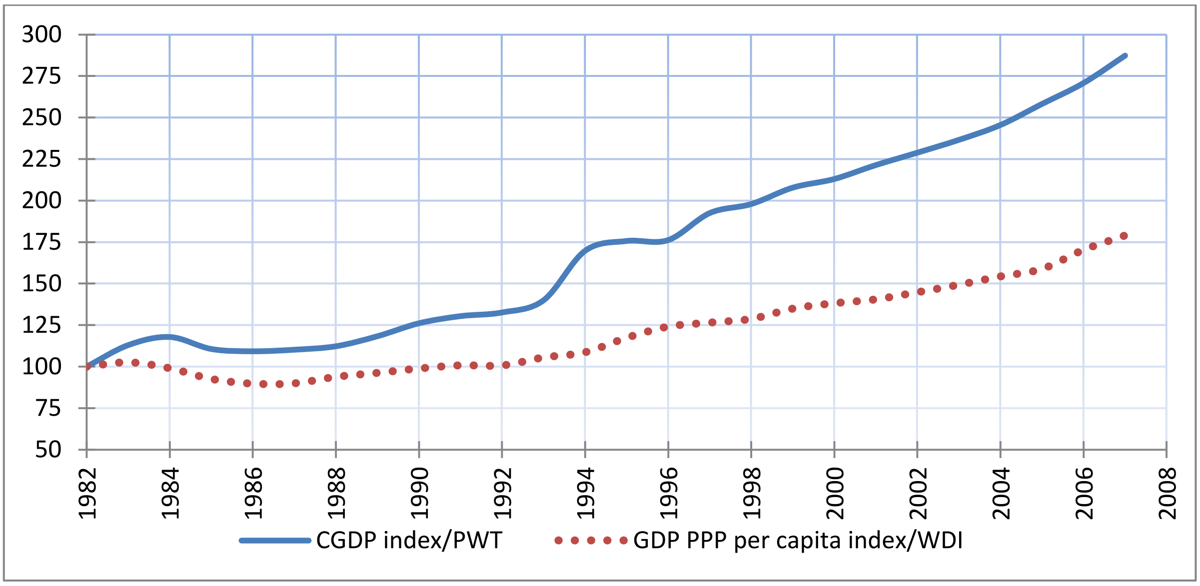
Notes: On the vertical axis is GDP PPP per capita (in USD)

Sources: World Bank, International Comparison Program database Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.3, Centre for International Comparisons of Production, Income and prices at the University of Pennsylvania, August 2009

Johnson *et al*. (2009) illustrate the degree of measurement error intrinsic to the PWT methodology, pending adjustment notwithstanding and argue that PWT suffers from problems of variability and valuation. To illustrate this, they compare version 6.1 of the PWT (released in 2002) with version 6.2 (released in 2006). For example, they calculate the ten worst growth performers in Africa based on the PWT6.1 data and similarly based on the PWT6.2 data. Only five countries were on both lists, and so, they conclude that there is considerable variability in the level and growth of PPP-adjusted GDP estimates and in the estimates of the PPPs across alternative versions of the PWT. They also demonstrate that for years other than the benchmark year, GDP growth and level estimates from the PWT are not at PPP prices. Because these shortcomings are intrinsic to the PWT methodology, there is little basis for knowing whether version 7.0 of the PWT will supersede all previous versions (*ibid*: 25, emphasis mine) and as such produce GDP PPP per capita series that are consistent with those of WDI.

This notwithstanding, we facilitate comparison by converting the real GDP PPP per capita series into indices. This we do, by setting the index for the first year of each (i.e. 1982) to 100. Against this base, we calculate evolution and make a comparison to reveal when levels converge and diverge. The resulting indices are given in Figure (1.11).

Figure 1.11: Real GDP PPP per capita Index (1982=100)



Notes: On the vertical axis is GDP PPP per capita index (1982=100)

Sources: World Bank, International Comparison Program database Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.3, Centre for International Comparisons of Production, Income and prices at the University of Pennsylvania, August 2009 and Author's own computations

The indices in the figure are different and do not converge. This is particularly surprising because, the two series are supposed to relate to exactly the same latent variable using the same indicator, i.e. GDP PPP per capita. CGDP/PWT is consistently biased upwards with some volatility at least up to mid-1990s while GDP PPP/WDI is smoother. This implies that WDI series would yield growth rates that are relatively more stable than the PWT6.3 series.

This suggests that any assessment of Uganda's economic performance over the period would most likely yield conflicting results depending on the GDP PPP data used as the two measures differ in level and diverge. As opposed to PWT, WDI measures are smoother and appear to be better measured using the ICP round of 2005. In this regard, WDI GDP PPP series would be selected for further analysis. However, as GDP PPP data is suitable for cross country studies where one requires internationally comparable measures, we do not pursue this measure as our analysis is based on a single country, Uganda.

2.4 Analysis of Annual GDP growth rates

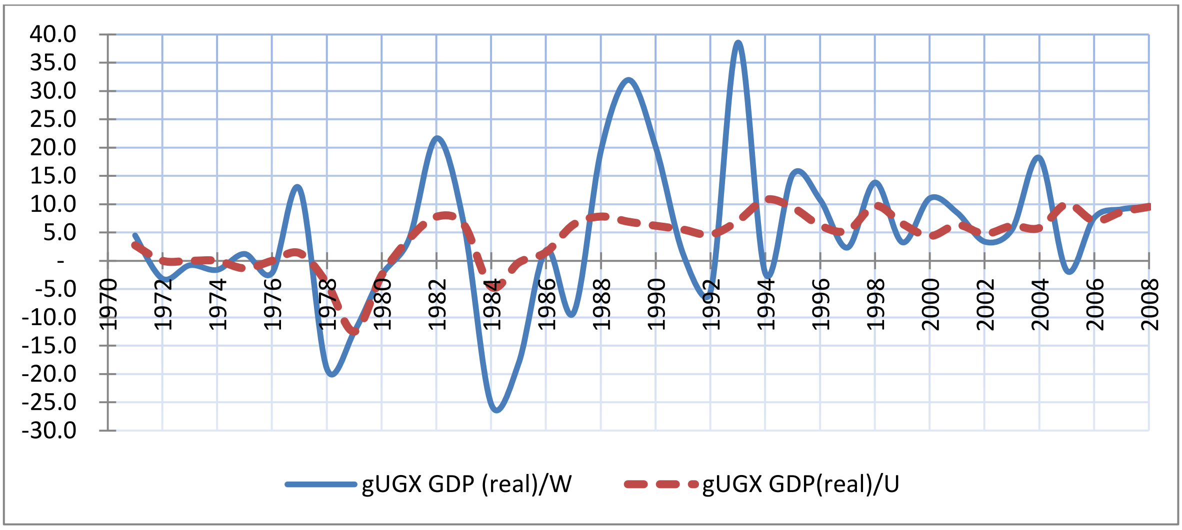
This section derives year on year percentage growth rates to identify any large specific annual or periodic growth rate discrepancies in the underlying UBOS and WDI real UGX GDP series. The fact that these series differ in level implies that each may yield different findings when used in analysing macroeconomic relationships. So, a question as to which series could be better arises naturally. This section investigates if the level differences in the series yield significant discrepancies in the annual growth rate estimates by computing the absolute average percentage discrepancy. The year on year percentage change in real GDP growth rate of a series of T annual observations, say $Y_1, Y_2, ..., Y_T$ is derived as

$$g = \left(\frac{Y_t - Y_{t-1}}{Y_{t-1}} \right) * 100 \qquad (1.6)$$

where, g, is the year on year percentage change in real GDP, t and $t-1$ designates the current and the previous years' real GDP. We calibrate year on year real UGX GDP growth rate using real UGX GDP data as in Figure (1.3). A similar calibration can be made using real UGX GDP per capita data as in Figure (1.7). The two calibrated growth rates would differ as the latter incorporates the rate of population growth, but this is simply a population scaling effect. Focusing on economy-wide growth, the percentage growth rates derived using aggregate real GDP data as in Figure (1.3) are plotted in Figure (1.12). Based on the data in this figure, we derived the percentage growth rate discrepancies, i.e. the difference between WDI and UBOS estimated percentage growth rates in each period. This is presented in Figure (1.13). In addition, we also compute and report the absolute average percentage discrepancy. This is obtained as a ratio of summation of each period average percentage discrepancy over the sample period to total sample size. The magnitude of this could inform whether the discrepancies in the growth estimates would alter inferences on economic performance response to structural shocks or reforms, holding other considerations constant.

The year on year percentage growth rates derived from the UBOS series is not only relatively stable, but also positive since the mid-1980s. On the contrary, the percentage growth rate derived from the WDI series is very volatile, characterized by positive and negative spikes, which lasts until the mid-1990s. This notwithstanding, neither series yields growth rate estimates that are consistently above or below the other. Importantly, both series produce growth rate estimates that evolve over time with a similar pattern, albeit differing in magnitude, a variation that we estimate at 3.6 percentage points per year (i.e. the average absolute percentage discrepancy)

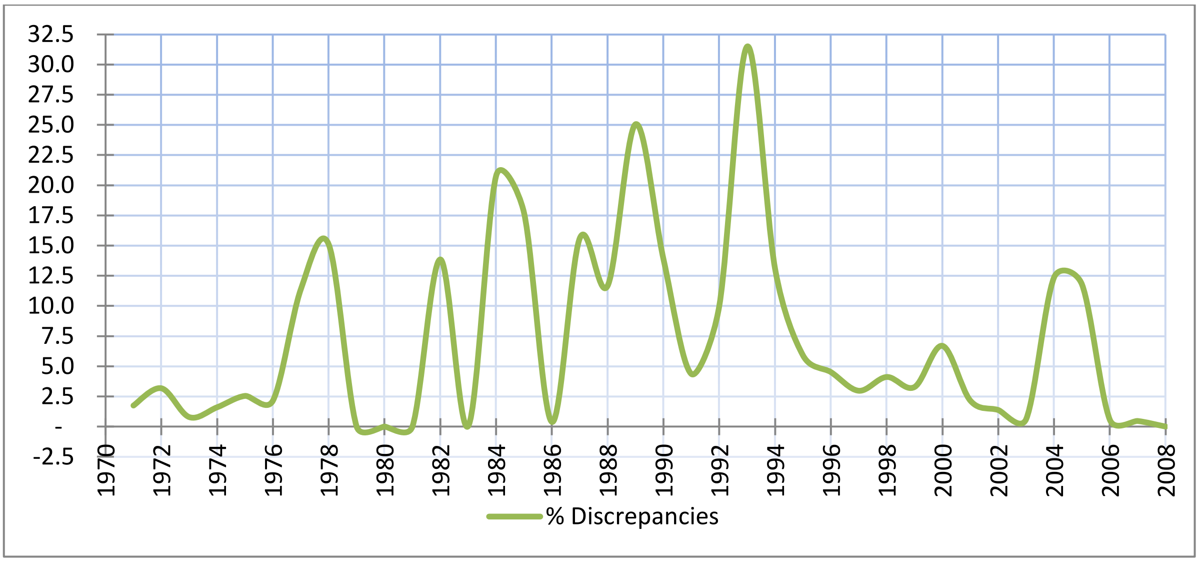
Figure 1.12: Real UGX GDP Percentage Growth Rate



Notes: On the vertical axis is real UGS GDP percentage growth rates; U, W represent UBOS and WDI respectively

Sources: World Bank national accounts data and OECD National Accounts data files (2009), UBOS National Accounts Estimates of main Aggregates and Author's own calculations

Figure 1.13: Real UGX GDP Percentage Growth Rate Discrepancies



Notes: On the vertical axis is real UGX GDP percentage growth rate discrepancies; U, W represent UBOS and WDI respectively.

Sources: As in figure 1.12.

While this per year average absolute percentage discrepancy is reasonably large, the two series have patterns that are consistent and similar (albeit with one far more volatile). Essentially, WDI is suggesting considerable variability in growth compared to UBOS. This could capture 'true' economic instability during a period of change, but may also reflect weak underlying statistics, and is likely to have study implications especially when assessing growth performance before and after structural adjustment. An important question remains regarding the direction of measurement bias, i.e. whether it is due to economic instability or weak underlying statistics. As noted in Jerven (2010: 287), there is hardly any usable data during periods when a country severely falls apart due to instability, and in addition, change in economic structure with liberalization temporarily worsened the accounting and record-keeping problem as comprehensive data were no longer available from state agencies.

2.5 Statistical characterization of real UGX GDP

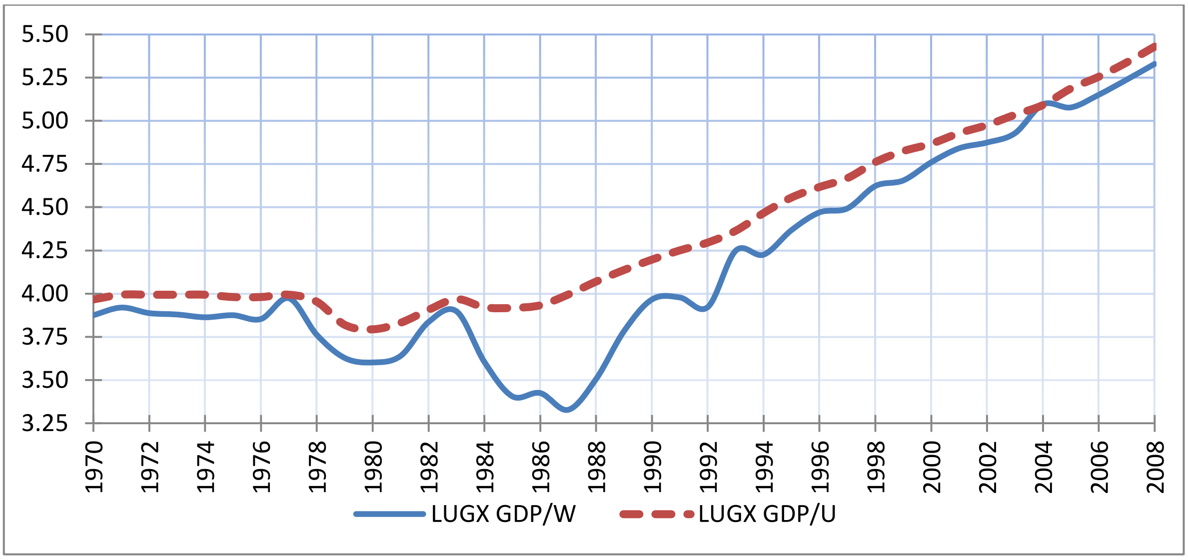
It is noticeable from the above level data discussion that although the series are similar, they are inconsistent. However, long discussions of series consistency seem immaterial once we characterize the data using statistics. An econometric way to assess if either series may yield similar inferences is to test whether these series are cointegrated. Cointegration implies that the series represent a common long-run equilibrium, i.e. although they may diverge at times the equilibrium is restored after some period. There may be a persistent difference between the series, but if they are in equilibrium in the long run one can infer that either captures the performance of GDP in the ‘long-run’ (short-run dynamics may differ). In the next section, we conduct time series characterization, including testing for cointegration between the two indicators (i.e. real UGX GDP/U and real UGX GDP/W) for the same latent variable.

The order of Integration and Cointegration

It has been well-documented in time series modelling literature that most economic time series are commonly characterized by strong trend components, that is, a deterministic and/or stochastic trend or some combination of the two. Many of these are said to contain a unit root (non-stationary), that is, the variables in question may have a time variant mean and/or non-constant variance. This means working with such series in their levels while analyzing economic relationships may give a high likelihood of results that are economically misleading, a symptom that Granger and Newbold (1974) call spurious regression. This is often characterised by significant *t*-ratios and a high explanatory power, even though the regressors are economically unrelated to the variable being explained. Moreover, no inference can be deduced from such results since the least-square estimates are not consistent and the customary tests of statistical inference, namely the ‘‘F’’ and ‘‘t’’ ratio test statistics do not have the limiting distributions (Enders, 2010).

Because nonstationarity arises quite naturally in the context of macroeconomic time series, we undertake several important steps to investigate the presence of and point to appropriate econometric procedures of correcting for the trend-like behaviour in the real UGX GDP series. The first step involves pre-testing each series to determine its order of integration, since by definition cointegration requires that the variables are integrated of the same order. We begin with the graphical expositions of the log level and the first difference of the log of real UGX GDP/U and real UGX GDP/W. These are respectively presented in Figures (1.14) and (1.15). This is because, while the log level real UGX GDP could show the trend like behaviour over time (i.e. non-stationary), transforming the trending series in its first difference could make the processes stationary.

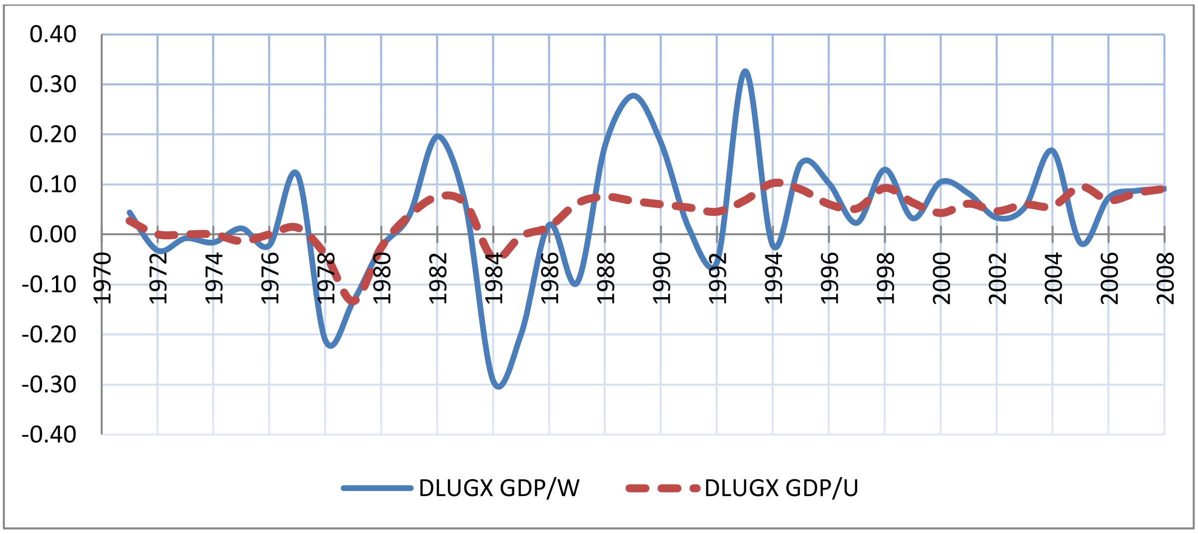
Figure 1.14: Log of real UGX GDP



Notes: On the vertical axis is the log of real UGX GDP/U and real UGX GDP/W

Source: Author's computations using real UGX GDP data in Figure (1.3).

Figure 1.15: First Differences of the Log of real UGX GDP



Notes: On the vertical axis are the first differences of the log of real UGX GDP/U and real UGX GDP/W

Source: Author's Computations using the log of real UGX GDP data in Figure (1.15).

Clearly, the series in Figure (1.14) exhibit trend like behaviour over time (i.e. are trending), while those in Figure (1.15) meander in a fashion characteristic of stationary process.

Finally, we determined the order of integration or non-stationarity properties of the series. In theory, a vector $\mathbf{z}_t$ is said to be integrated of order d (i.e. $z_t \sim I(d)$) if variables in $\mathbf{z}_t$ can be differenced d times to induce stationarity. We employed the commonly used Augmented Dickey Fuller (ADF) unit root test (Dickey and Fuller, 1979) which takes the following specification:

$$\Delta z_t = c_0 + c_2 t + \gamma z_{t-1} + \sum_{i=1}^{\rho} \delta_i \Delta z_{t-i} + \varepsilon_t \tag{1.7}$$

Where, c_0 is the intercept term, c_2 and γ are coefficients of time trend and level of lagged dependent variable respectively, Δ is the first difference operator and ε_t are white noise residuals. ρ is the lag-length introduced to account for autocorrelation and is chosen using the minimum of the information criteria: Akaike Information criterion [AIC], Schwarz Bayesian criterion [SC] or the Hannan-Quinn Criterion [HQ].

To evaluate whether the sequence { $\mathbf{z}_t$ } contains a unit root, we estimated (1.7) and tested the significance of the parameter of interest, i.e. γ. If $\gamma = 0$, the sequence { $\mathbf{z}_t$ } contains a unit root or is otherwise stationary. In the equation, the null hypothesis that $\gamma = 0$ is rejected if the *t*-statistic is less than the critical value reported by Dickey and Fuller (DF) (1981), as this is a lower tailed test. Furthermore, mindful of the fact that critical values of the *t*-statistic do depend on whether an intercept (c_0) and/or time trend (t) is included in the regression equation and on the sample size (Enders 2010: 206), the τ_τ - statistic, scaled by the 5 per cent critical value is used for $n = 50$ usable observations. Critical values for the τ_τ - statistic are obtained from Table A in Enders (2010: 488).

Based on the same equation, we also evaluate whether the data generating process (DGP) is characterized by non-stationarity with or without a linear deterministic trend and a drift, and non-stationarity with or without a linear deterministic trend. This involves testing joint hypotheses on the coefficients of interest, i.e. γ, c_0 and c_2. However, under non-stationarity, the computed ADF- test statistic does not follow a standard *t*-distribution, but rather a dickey Fuller (DF) distribution and so the critical values for these joint tests are also non-standard. They follow the non-standard *F*-statistics denoted by ϕ_2 and ϕ_3 statistics which are constructed in exactly the same way as ordinary *F*-tests (adopted from Enders, 2010: 207), i.e.

$$\phi_i = \frac{[SSR(restricted) - SSR(unrestricted)]/r}{SSR(unrestricted)/(T-K)} \tag{1.8}$$

Where *SSR (restricted)* and *SSR (unrestricted)* are the sums of the squared residuals from the restricted and unrestricted models, *r* is the number of restrictions, *T* is the number of usable observations and *k* is the number of parameters estimated in the restricted model.

The joint hypothesis $c_0 = c_2 = \gamma = 0$, i.e. the significance or otherwise of a constant term, time trend and non-stationarity is tested using the ϕ_2-statistic. The null hypothesis is then that the data are generated by the restricted model and the alternative hypothesis is that the data are generated by the unrestricted model. Thus, if ϕ_2 (calculated) is smaller than ϕ_2 (critical) (reported by Dickey and Fuller for $n = 50$ usable observations scaled by the 5 per cent critical values), we accept the restricted model. Similarly, the joint hypothesis $\gamma = c_2 = 0$, i.e. the sequence { $\mathbf{z}_t$ } contains a unit root and no linear deterministic trend is tested using the ϕ_3-statistic, and is evaluated on exactly the same grounds as the ϕ_2-statistic. That is, the restricted model is accepted if ϕ_3 (calculated) is smaller than ϕ_3 (critical) (reported by Dickey and Fuller for $n = 50$ usable observations scaled by the 5 per cent critical values). Critical values for the ϕ_i - statistics are obtained from Table B in Enders (2010: 489).

Test results reported in Table 1.2 indicate that the series are $I(1)$ in levels but no time trend or drift. However, ADF unit root test is known to have (very) low power if the series has undergone a (permanent) regime shift during the period under consideration (Harris and Sollis, 2005: 57) or if there are outliers in regression residuals. Specifically, Figure (1.14) shows a slight but detectable change in behaviour of Uganda's economic performance. The period up to early 1980s is characterized with low and declining growth probably due to political and economic instability of the 1970s and early 1980s, the second oil price shock and the breakdown of the East African Community (EAC) (Collier and Reinikka, 2001; Baffoe, 2000; Kasekende and Atingi-Ego, 1999; Jamal, 1988; Niringiye, 2009; Jerven, 2010) during the late 1970s. The economy improved from the mid-1980's with political stability under the Museveni regime and successful implementation of the Structural Adjustment Programs (SAPs).

Such economic behaviour needs to be included in the deterministic part of the model (Opoku-Afari *et al*, 2004), and is likely to bias estimates and result in invalid inference if ignored (Juselius, 2003). In addition, Perron (1989: 1371), Hendry and Neale (1991) and Campos *et al.* (1996) argue that in the presence of structural breaks, the various Dickey-Fuller test statistics are biased towards the non-rejection of a unit root, when in reality the series could simply be trend-stationary but characterized by a structural break, which the test would fail to take into account. It is unfortunate however that the series at hand is too short to enable us reliably conduct unit root tests that allow for breaks in trend. Moreover, a Chow test for structural breaks has not been performed as imposing a break point in a small sample (like ours) may render the test less informative.[10]

Table 1.2: The Augmented Dickey-Fuller (ADF) Unit root test

	ADF test in Level					ADF test in First difference	
Macro variable	$H_0: \gamma = 0$	$H_0: c_0 = \gamma = c_2 = 0$ (ϕ_2 - test)	$H_0: \gamma = c_2 = 0$ (ϕ_3 - test)	**Lag-length**	**Inference**	$H_0: \gamma = 0$	**Inference**
GDP/U	-1.558 (-3.50)	1.383 (5.13)	2.969 (6.73)	2	$I(1)$	-4.429 (-3.50)	$I(0)$
GDP/W	-1.321 (-3.50)	1.133 (5.13)	2.314 (6.73)	0	$I(1)$	-5.244 (-3.50)	$I(0)$

Notes: AIC, SC and HQ were used (maximum set at 6 lags). An unrestricted intercept and restricted linear trend were included in the ADF equation when conducting unit root test of all the series in levels. Numbers in parenthesis are the 5 per cent critical values, unless otherwise stated. All unit-root non-stationary variables are stationary in first differences.

Source: Author's Computations using E-Views 7.2

On the basis of unit root testing, we treat real UGX GDP/U and real UGX GDP/W as unit root non-stationary, so could be cointegrated. Thus, if there is a long-run relationship between real UGX GDP/U and real UGX GDP/W as non-stationary variables, deviations from the long-run relationship are stationary. The existence of long-run equilibrium relation is evaluated using the Johansen (1988) *trace statistic* test for cointegration. Central

[10] Derived probability estimates and associated critical values are likely to be unreliable for inference and may lack power owing to diminishing degrees of freedom for each of the resulting regressions (Mackinnon, 1996)

to this test is a choice of the deterministic components (trend, constant and dummies) and the lag length that describes an appropriate specification of the data generating process (DGP).

The graphical inspection of the data in figure 1.14, together with the discussion given in Juselius (2006: 99-100) offers a useful guide to the specification of the deterministic components we should be including in the cointegrating space. We include an unrestricted constant and a restricted deterministic trend, noting that the series in levels appear to be trending and we are not sure whether these linear trends would cancel out in the cointegrating relation. Such a specification allows for linear trends in both cointegrating space and in the variables in levels, and avoids creation of quadratic trends in the levels, which would arise if both the constant and trend are unrestricted. Given the deterministic components specification and under the $I(1)$ hypothesis, and letting k=3, we chose the lag-order using the SC and HQ information test criteria (as this allows for an additional penalising factor that represents the loss of degrees of freedom as a result of increasing the lag length).

SC suggested *k=1*, while *k=2* was suggested by the *HQ*. The disagreement in the lag selection arises because the information criteria are based on different penalties associated with the increase in model parameters as a result of adding more lags (Juselius, 2006; Johnston and Dinardo, 1997). SC however, has been shown to be strongly asymptotically consistent providing the actual DGP is a finite order autoregressive (AR) process, and the set maximum lag order is larger than the true order (Lütkepohl and Krätzig, 2004; Lütkepohl, 1991). Even where *SC* and *HQ* yield conflicting results, they show that SC would result in a more parsimonious specification (with fewer parameters) than HQ. So, *k=1* could be a reasonable approximation of the DGP without significantly affecting the degrees of freedom.

However, an analysis of the suitability of this model in terms of a battery of residual misspecification tests (see *inter alia* Godfrey, 1988) shows that the hypothesis of normality [$\chi^2(4) = 19.116$ (0.001)] is not supported. As we have already pointed out, this could be a result of the detected change in behaviour of Uganda's economic performance due to political and economic instability prior to mid-1980s and a change in institutional environment (ESAP reforms) and the Museveni regime thereafter. We acknowledge this upfront and as a common way of dealing with instability and intervention effects, may require incorporating some dummies. Nonetheless, in the results in Table 1.3, we obtain a cointegrating relation without dummies in the deterministic part of the model, suggesting that dummies do not have a long-run effect. Moreover, including dummies would impact on the distribution of the test statistics under the null hypothesis and thus should be used as indicative only.

Johansen's (1988) *trace* test has however been shown to have finite sample bias (Juselius, 2006: 140-2; Cheung and Lai, 1993b; Reimers, 1992). Hence, for a small sample like the one at our disposal, we also report the small sample Bartlett correction which ensures a correct test size (Johansen, 2002).

Table 1.3: Johansen's Cointegration *trace* test Results

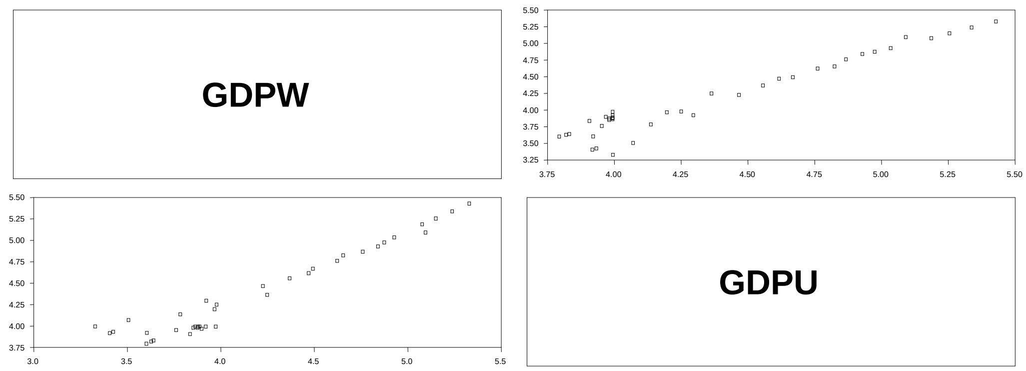
p-r	r	Eig.value	Trace	Trace*	Frac95	*p*-value	*p*-value*
2	0	0.46	31.963	31.205	25.731	0.006	0.008
1	1	0.202	8.568	8.498	12.448	0.215	0.22

Notes: Trend assumption: Linear deterministic trend restricted; *: the small sample corrected test statistic (Dennis, 2006: 159-60); Frac95: the 5% critical value of the test of H(r) against H(p). The critical values as well as the *p*-values are approximated using the Γ - distribution (Doornix, 1998).

Source: Author's Computations using *CATS in RATS, version 2* (by Dennis *et al.*, *Estima* 2005)

As the *trace*-statistic result in the table shows, presence of one equilibrium (stationary) relation between real UGX GDP/U and real UGX GDP/W is clearly suggeted, even when correcting for small sample bias. In fact, over 1970-76 and 2000-08 the two series are very close, and they are quite close for 1978-83 and 1993-99. Either series can be considered to represent trends in the size of the macroeconomy, but in a slightly different way. Even more, figure 1.16 shows cross plots of the two GDP measures, i.e. log of real UGX GDP (given in figure 1.14). Reading from the top row (left column) is real GDPW to real GDPU, and in the bottom row (right column) is real GDPU to real GDPW on the vertical (horizontal) axes in the matrix plot. As seen, it is quite easy to draw a straight line through most of the points. This is consistent with the correlations between the two series in Table 1.4.

Figure 1.16: Cross Plots of GDP measures



In the table, Spearman's rank correlation (ordinary correlation) is reported below the diagonal while standard Pearson correlation is reported above the diagonal. Using either formula, the correlation between the two GDP measures is 0.97.

Table 1.4: Correlation\Covariance between GDP measures

	GDPW	GDPU
GDPW		0.969
GDPU	0.969	

Notes: Spearman (Pearson) correlations below (above) diagonal

If we put together the statistical evidence, i.e. cointegration results in Table 1.3, cross plots in figure 1.16 and correlation/covariance results in Table 1.4, we see that either series can be considered to represent trends in the size of the macroeconomy (this is despite real GDPW being far more volatile). This suggests either series may be adopted in subsequent macroeconomic modelling. However, the UBOS real series is smoother and produces GDP growth measure that are stable compared to those of the WDI (these are volatile). Moreover, UBOS is also the underlying source from which macroeconomic data is sought by the international agencies, including WDI. This is consistent with the remarks in Deaton and Heston (2008) cited in Jerven (2010: 278). *''...it must always be remembered that the international accounts are no better than the national accounts ...''* (Deaton and Heston, 2009: 43-44). Given this, the less volatile UBOS real series (real UGX GDP/U) may be preferable as there is less need to incorporate dummies for future analysis. However, as the smoothing may be artificial (i.e. introduced by statisticians), we may also want to use the WDI series, at least if interested in performance during the period 1984-1992 when the two diverge. Moreover, an assessment of the short-run effects of reforms during 1985-95 would be sensitive to the start and end years and the series chosen in the analysis.

2.6 Conclusion

This chapter assessed the measurements of GDP for Uganda using data on GDP in current, constant and PPP prices from WDI, UBOS and PWT6.3 over the period 1970-2008 for GDP and 1982-2008 for GDP PPP. The extent of discrepancy in GDP estimates was investigated and year on year percentage GDP growth rates, including percentage and average growth rate discrepancies were derived.

The discrepancies in the USD GDP stem from the differences in the nominal exchange rate. Although the exchange rate adjusts to differences in price changes (inflation) between Uganda and the US, there are differences in the weighting of inflation. This is because it is augmented by the global exchange rate realignment with other trading partners (notably Europe) and there are policy reasons why Uganda may wish to limit changes in the exchange rate. Moreover, WDI converts its series at a market clearing exchange rate while a managed float is used by UBOS statisticians. Save for the exchange rate, discrepancies arise because of differences in the magnitude of revisions in the data in order to carry certain definitional changes back in time, differences in extrapolations to bridge years of missing data points and smoothing of data over various base years.

The two measures of economic performance: real UGX GDP and USD GDP (aggregate or per capita), differ depending on whether the series is derived from the implicit price deflator (inflation in Uganda) or the nominal exchange rate (to the extent that changes represent the inflation differential). Indices for the latter shows greater variability but no index is consistently above or below the other. On the other hand, GDP measures derived from LCU implicit price deflator, i.e. real UGX GDP series, are quite similar especially at the beginning and end of the sample period, although WDI has more variability than UBOS. WDI variability in growth could capture ‘true’ economic instability during a period of change, but may also reflect weak underlying statistics.

Although UBOS and WDI real UGX GDP year on year growth rate estimates have a 3.6 percentage point average absolute discrepancy per year, statistical evidence shows they are consistent, similar and cointegrated. The UBOS real series is smoother and produces a more stable measure of GDP than does the WDI series. It is also the underlying source from which macroeconomic data is sought by the international agencies, including WDI. Given this, the less volatile UBOS real series (real UGX GDP/U) is preferred as there is less need to incorporate dummies for future analysis. This implies that it is from this source that the fiscal data is derived and private consumption is taken as a preferred measure of growth in the rest of the thesis.

CHAPTER THREE

EVOLUTION OF THE FISCAL EFFECTS OF AID METHODS, THEORETICAL CVAR AND THE DATA

3.1 Introduction

In this chapter, we trace the evolution of the methods used in analyzing the fiscal effects of aid over the past 10 years or so. It begins, in section 3.2 with a brief review of fungibility studies and proceeds to the fiscal response models, which are now being estimated within a VAR framework, and then the short- and medium term macroeconomic effect of aid. The section gives a broader view of the gaps in the fiscal effects literature and lays out our contribution. Section 3.3 discusses the theoretical foundation of the cointegrated Vector Autoregressive (CVAR) model that we employ in the study while an overview of the economic performance in Uganda, structured around the data, measurement and sources, and the trend analysis of aid, fiscal aggregates and other macroeconomic variables are presented in section 3.4. Finally, Section 3.5 gives the statistical description of data and demonstrates that the series are unit-root non-stationary.

3.2 Evolution of the Methods

There is a significant empirical literature on the impact of aid on the fiscal behaviour of aid recipients and more recently, on short- and medium term effect of aid with important insights regarding absorption and spending not analysed in more classical fiscal response literature. The latter literature, only briefly touched on here is inspired by the International Monetary Fund (IMF), while a detailed review of the fiscal effects of aid is provided in McGillivray and Morrissey (2001a, 2004) and Morrissey (2012). The authors distinguish between fungibility and fiscal response studies.

Fungibility studies analyse effects of aid on the composition of government spending, in particular whether aid is spent on those sectors that donors intended. The evidence is generally 'imprecise' given the difficulty of linking aid, donor intentions and sector spending (Morrissey 2012). As this is not our focus and is discussed in detail in

McGillivray and Morrissey (2004), here we simply highlight four limitations with fungibility studies. First, the underlying theoretical model is restrictive in not allowing aid to affect expenditure allocations across all headings. The typical model posits two distinct types of expenditure headings, one to which aid is allocated and another to which aid is not allocated that are separable in the government's utility function so that only fungible aid affects the spending allocation (Feyzioglu *et al.*, 1998: 34 cited in Morrissey 2012: 3). Second, empirical estimation of the model requires that one must know how much of the aid donors intended to be spent on each expenditure heading, so the estimation is constrained by lack of appropriate data. Third, the econometric techniques used in most studies are deficient as they assume that the components of government spending are determined independently, but in practice, these are jointly determined and so, this should be allowed for in the estimation. Finally, the approach does not allow for the more fundamental issues of how aid over time impacts on recipient fiscal behaviour (i.e. effect on tax revenue and borrowing), including the interaction of expenditure and revenue variables.

The fiscal response models (FRMs) or studies allow for the dynamic effect of aid on expenditure patterns (current and capital spending), tax effort, and domestic borrowing. They start from the view point of utility maximization, in which government maximizes utility based on a quadratic loss function subject to targets for each revenue and expenditure category.[11] However, empirical applications of FRMs have short-comings, mostly related to difficulties in the use and estimation of targets for government expenditure and revenue, the treatment of aid, and the 3SLS non-linear econometric techniques that have been used are notoriously difficult to estimate, interpret and highly sensitive to (and demanding of) the data, often yielding inconsistent estimates of core parameters (Morrissey, 2012; Martins, 2010; McGillivray and Morrissey, 2001a: 29-30). Furthermore, Morrissey (2012) argues that whilst it is necessary to estimate budget targets, there is no acceptable theory regarding how governments form revenue and expenditure targets; the theoretical framework does not provide a good representation of government behaviour; and the behavioural relationship being estimated is assumed fixed over the period (i.e. the models do not allow for the fact that spending decisions are made within a fiscal framework in which aid is only one component). Osei *et al.* (2005) add to the list and

[11] A detailed exposition of this frame work is provided in Franco-Rodriguez *et al.* (1998: 1242-43)

argue that FRMs are not predictive theories as they do not generate specific testable hypotheses of the effect of aid on fiscal behaviour.

In an effort to overcome many of these difficulties, there is now a growing body of empirical literature estimating the FRM within a vector autoregressive (VAR) framework and complemented (in as many of the studies) by the estimation of impulse response functions. The novelty of VAR estimation techniques stems from its structure which provides a tractable frame-work, allowing for the formulation and testing of a number of different hypotheses of interest on causal links between aid and the domestic fiscal variables, and uncovers and describes data facts and characteristics. The technique takes into account the interactions between macrovariables over time, allowing a distinction in estimating the long-run (equilibrium) and short-run (adjustment to the equilibrium) relations. There is one equation for each and every variable, so all variables in the system are treated as potentially endogenous. Each variable is explained by own lags and lagged values of the other variables. Assumptions about exogeneity are tested for directly avoiding making strong *a priori* assumptions, thus by design, the econometric model can allow the data to speak freely about the empirical content of the model. It is an a-theoretical approach, i.e. one does not have to maintain the existence of, estimate or test specific theoretical formulations of the budgetary planning targets, rather economic theory is often invoked to choose the variables to include in the analysis, select the appropriate normalization and to interpret the results.

The first country-specific study to model the fiscal effects of aid using a VAR approach was Osei and Morrissey (2003), which later appears in the Journal of International Development (Osei *et al.,* 2005) for Ghana. Among the many fiscal inter relationships, they find that aid to Ghana is weakly exogenous to the domestic fiscal variables (i.e. donors do not respond to fiscal imbalance in determining how much aid to allocate to Ghana although aid has effects on spending, domestic borrowing and domestic tax revenue). Specifically, aid was associated with reduced domestic borrowing (which could likely be because the IMF required reductions in borrowing as a *quid pro quo* for increased aid) and increased tax revenue. They also find that recurrent spending rose more than investment spending following the increases in aid (suggesting that aid was fungible). This they argue, was not actually so because aid was used to reduce borrowing. Another interesting finding is that aid did not directly increase spending, although increase in aid permitted spending to rise because of the associated increase in tax revenue. However, they do not estimate the magnitude of the effect of aid on spending, nor do they formulate and impose any fiscal restrictions to fully test for specific aid- fiscal hypotheses.

Fägernas and Roberts (2004c) apply the VAR approach and study the fiscal effect of aid in Uganda, Zambia and Malawi. They find that aid has a strong positive impact on the development budget in all the three countries, but the other fiscal effects are country specific. Aid displaces tax effort, has a moderately positive impact on the current budget, and is associated with higher levels of domestic borrowing in Zambia. In Malawi, aid lowers domestic borrowing, and does not discourage tax effort; in Uganda, aid raises development and recurrent spending, has a positive long-run effect on domestic revenue and the impact on domestic borrowing is negligible. In all these studies, aid exogeneity is imposed and not tested and probably because they follow in the footsteps of Osei and Morrissey (2003), they neither formulate or test any specific testable hypothesis of the effect of aid on fiscal behaviour or estimate the magnitude of the effect of aid on spending. With particular reference to Uganda, features of the data over 1972-79 (a decade of economic collapse and social disorder) and effect of ESAP reform and the Museveni regime are not accounted for in the empirical analysis. Ignoring such shocks and reforms may bias estimates and result in invalid inference (Juselius, 2003).

Morrissey *et al.* (2007) extend the time series FRM approach with official Kenyan data for 1964-2004, and estimate two vectors; the fiscal effects of aid grants and loans, and the impact of aid on growth, but separately. Considering the fiscal effects, they find that aid grants were associated with increased spending while loans were a response to unanticipated deficits, i.e. if spending exceeded revenue (tax and grants) the government sought loans to finance the deficit. Aid grants have an insignificant effect on tax revenue. However, the study does not fully explore the CVAR methods. The fiscal and growth effect of aid are considered in isolation and assumptions about exogeneity are not tested although they avoid making strong *a prior* assumptions. In addition, similar to Osei and Morrissey (2003) and Osei *et al*. (2005), the study does not estimate the magnitude of the effect of aid (grants or loans) on spending nor do they formulate any testable fiscal hypotheses.

Martins (2010), provides a more recent comprehensive application of the CVAR in the analysis of the fiscal effect of aid using quarterly data set for Ethiopia for the period 1993-2008. His study is probably the first of its kind that provides new insights into the formulation of testable fiscal hypotheses. He finds evidence for a long run positive relationship between aid and development spending, but not between aid and recurrent spending (hence no evidence that aid is fungible), domestic borrowing increases in response to shortfalls in revenue (tax and grants), and there is no evidence that aid reduces tax effort. Furthermore, aid grants adjust to the level of development spending. However, the validity of some of the tested hypotheses, e.g. aid spending (defined as widening of the fiscal deficit (excluding aid) due to incremental aid (Hussain *et al.*, 2009; Foster and Killick, 2006: 3)), development spending and categorical fungibility hypotheses is suspect. Morrissey (2012) details the practical difficult of linking aid, donor intentions and sector spending, based on which these hypotheses could be evaluated. Moreover, the classification of spending is problematic (Morrissey 2012) so hypothesis testing based on expenditure categories may have been constrained by lack of appropriate data. This granted, the tests might not be legitimate and inference may be imprecise. Moreover, like the rest of the studies, the magnitude of the effect of aid on spending is not estimated.

In one of the the IMF initiated work on the macroeconomic effect of aid, Berg *et al.*, (2007) analyse key issues associated with large increases in aid, including absorptive capacity, Dutch disease, and inflation. They develop a framework that emphasizes the different roles of monetary and fiscal policy and apply it to the recent experience of five countries: Ethiopia, Ghana, Mozambique, Tanzania, and Uganda, i.e. countries that have often found it difficult to coordinate monetary and fiscal policy in the face of conflicting objectives, notably to spend the aid money on domestic goods and to avoid excessive exchange rate appreciation. The authors find no evidence of actual Dutch disease because a considerable part of the aid was used to build international reserves, rather than to transfer resources form donor to recipient country. This is ample evidence that the fear of exchange rate appreciation played an important part in the policy reaction to aid. While central banks held a substantial part of the aid in reserves, the fiscal authorities often increased expenditures on domestic goods and services, using the local currency obtained from selling the aid to the central bank. They argue, this in effect is an attempt to use the same aid dollar twice, once to build reserves and once to finance government expenditure – a policy similar to domestically financed fiscal expansion leading to identical outcomes: a surge in money supply, and a consequent need to decide between inflation, on the one hand, and crowding out the private sector through the sale of treasury bills, on the other.

Berg *et al.*, (2010) develop a dynamic micro-founded economic model calibrated to Uganda to analyse the short- and medium term issues associated with large aid surges. Their analysis is triggered considering that out of the fear of ‘‘Dutch disease’’, central banks in aid-dependent countries have frequently responded to aid surges by accumulating much of the additional aid in reserves (partial absorption) even as governments spend the local currency counterpart on domestic goods. They show that depending on the interaction between the policy mix, the efficiency of public investment and learning-by-doing externalities in the traded sector, this response may stem short-term appreciation pressures but can induce medium-term real GDP effects (through private sector crowding out). They show that with high efficiency and strong externalities, aid if invested well can produce even greater gains (in terms of greater increases in real GDP and welfare) – producing ‘‘Dutch vigor’’, such that avoiding reserve accumulation (full absorption) maximizes these gains. They also show that partial absorption policies while spending the local counterpart can succeed in narrow terms in resisting real exchange rate appreciation, but at a cost to private investment and medium-term growth. Finally, their calibration also shows that with low efficiency and strong externalities, aid spending can be harmful for growth, so partial absorption policies may be better than full absorption, but even better would be partial spending.

Portillo *et al.*, (2010) develop a tractable open-economy new-Keynesian model with two sectors to analyse the short-term effects of aid-financed fiscal expansions. The model is calibrated to help understand recent experience of Uganda, which saw an increase in government spending following a surge in aid yet experienced a real depreciation and an increase in real interest rates. They distinguish between spending the aid (which is under the control of the fiscal authorities), and absorbing the aid, i.e. using the aid to finance a higher current account deficit (which is influenced by the central bank’s reserves policy when access to international capital markets is limited). They show that although the standard treatment of the transfer problem implicitly assumes spending equals absorption, a policy mix that results in spending but not absorbing the aid generates demand pressures and results in an increase in real interest rates and can also lead to a temporary real depreciation if demand pressures are strong enough to threaten external balance. They also argue that limited participation in domestic financial markets – a key feature of low income countries make a real depreciation more likely by amplifying demand pressures when aid is spent but not absorbed.

Hussein *et al*. (2009) develop an analytical framework to investigate the macroeconomic challenges created by a surge in aid inflows. They examine possible policy responses to increased aid, in terms of *absorption* and *spending* of aid – where the central bank controls absorption through monetary policy and the sale of foreign exchange, and where the fiscal authority controls spending. They show that different combinations of absorption and spending lead to different macroeconomic consequences. Their evidence from five countries (Ethiopia, Ghana, Mozambique, Tanzania, and Uganda) that recently experienced an aid surge shows no support for aid-related real exchange rate appreciation, but does indicate that the *fear* for Dutch disease played an important part in the policy reaction to aid surges.

Foster and Killick (2006) explores the consequences for macroeconomic management of the envisaged scaling-up of aid to African countries. They show that it is the extent to which the resulting increased availability of foreign exchange is absorbed (in the form of a widened balance of payments current account deficit) which is critical. The argument is that it is only when additional foreign resources enter the economy that aid has an impact on the levels of production, consumption and investment that the economy can attain. They also find that the country cases produced little evidence of aid increases resulting in symptoms of Dutch disease (because governments consciously sought to avoid it). Importantly, as you may have found out, the key feature of the IMF initiated work lies in important insights regarding absorption and spending not analysed in more classical fiscal response literature.

In sum, the studies of interest, i.e. the fiscal response studies show the effect of aid on spending (including showing that the effect of aid, grants or loans differ for the two types of spending (recurrent and capital)). But despite their important contribution, few (if any) estimate the magnitude of the effect of aid on public spending. Table 3.1 presents results of selected country-specific studies on the dynamic effect of aid, but in general, it is difficult to find a consistent pattern regarding the impact of aid on fiscal aggregates. The impact appears to be country specific and so lacks a basis for comparing results. This suggests that empirical evidence and theoretical predictions regarding the impact of aid is to the best patchy, often contradictory and generally ambiguous.

This study contributes to the aid and fiscal aggregates literature on one country, Uganda, over the period 1972-2008. Riddell (2007), cited in Juselius *et al.* (2011) argues that country-based evidence provides the only reliable backdrop against which to judge aid effectiveness. This paper follows leads provided by the most recent cointegrated vector autoregressive (CVAR) model in Juselius *et al.* (2011) (as this is a powerful and scientifically strict tool that facilitates learning about complex empirical reality) to test for specific fiscal hypothesis mostly from Martins (2010). Our work also improves on Fagernäs and Roberts (2004a), the only study to our knowledge on the fiscal impact of aid on Uganda using a VAR method, by paying attention to features of the data over 1972-79 (a decade of economic collapse and social disorder), and the effect of ESAP reform and the Museveni regime in Uganda. In addition and contrary to many studies of aid impact in the literature, our work does not impose endogeneity/exogeneity except where such restrictions have been tested and accepted, uses data in absolute terms[12] and estimates the magnitude of the effect of aid on spending.

[12] This avoids many of the problems associated with data transformation (logs, ratios, growth rates etc) which, even if seemingly innocuous may be invalid (see Juselius *et al.*, 2011: 5 for a detailed discussion).

Table 3.1: Results of Selected Studies on the Dynamic Impact of Aid

Study	Sample	Aid Measure	Incremental Impact of Aid on: Current Spending	Capital Spending	Total Spending	Domestic Revenue	Domestic Borrowing
Martins (2010)	Ethiopia (1993Q3-2008Q2)	Grants	n.r	++	n.r	++	**?**
		Loans	n.r	n.r	n.r	n.r	n.r
Osei *et al.*, (2005)	Ghana (1966-1998)	ODA	++	+	++	++	**--**
Morrissey *et al.*, (2007)	Kenya (1964-2004)	Grants	n.r	n.r	+	n.r	n.r
		Loans	n.r	n.r	+	--	n.r
Fagernäs & Schurich (2004)	Malawi (1970-2000)	ODA	**--**	++	+	+	**--**
		Grants	**--**	++		+	**--**
		Loans	**?**	+		+	**--**
Fagernäs & Robert (2004a)	Uganda (1974-1999)	ODA	++	+		+	**..**
		Grants	+	++	++	+	**..**
		Loans	++	++		+	**..**
Fagernäs & Robert (2004b)	Zambia (1972-1998)	ODA	+	++		--	+
		Grants	+	++	+	--	+
		Loans	+	+		--	**..**

Notes: i). ++ (strongly positive), + (moderately positive), **--** (strongly negative), **-** (moderately negative), **..** (insignificant), **?** ambiguous), n..r (not reported or cannot be inferred).

ii) Due to differences in the measurement of aid, results are not directly comparable across the table

Source: Author’s compilation

3.3 The Theoretical CVAR Model

Based on the Johansen (1988) approach, Vector autoregressive (VAR) methods have become the 'tool of choice' for the estimation and testing of multivariate relationships among non-stationary data in much of time series macro-econometrics. As a reduced form representation of a large class of dynamic structural models (Hamilton 1994: 326-7), VAR offers both empirical tractability and a link between data and theory in economics. Accordingly, in the current application, where the aid, fiscal variables, exports and private consumption[13] are likely to be non-stationary and Cointegrated, it will be convenient to couch the empirical analysis in a VAR framework (Hendry and Doornik, 2001: 129). Consider an unrestricted n-dimensional VAR (k) model:

$$\mathbf{y}_t = \mathbf{\Pi}_1 \mathbf{y}_{t-1} + \mathbf{\Pi}_2 \mathbf{y}_{t-2} + \ldots + \mathbf{\Pi}_k \mathbf{y}_{t-k} + \mathbf{\Phi D}_t + \boldsymbol{\varepsilon}_t \text{ , } t = 1, 2, T \tag{3.1}$$

By recursive substitution the equation defines $\mathbf{y}_t$ (a ($n \times 1$) vector of endogenous variables) as a function of initial values, $y_0, ..., y_{t-k+1}$; deterministic terms, $D_1, ..., D_t$ (constant, linear trends, ‘spike’ and intervention dummies, or other regressors that we consider fixed and non-stochastic). The VAR (k) model is linear in the parameters and assumes that these are constant over time. Errors, $\varepsilon_1, ..., \varepsilon_t$ which are assumed to be identically and independently distributed, that is, they are serially uncorrelated ($E(\varepsilon_t \varepsilon'_{t-k}) = 0$ for $k \neq 0$), have zero mean ($E(\varepsilon_t) = 0$), and have a time-invariant positive definite covariance matrix $\mathbf{\Lambda}_u$. Thus, the error terms follow a white noise process, i.e. $\varepsilon_t \sim N_{\mathrm{P}}(0, \mathbf{\Lambda}_u)$. The residual covariance matrix, $\mathbf{\Lambda}_u$ has dimensions k x k , and contains information about possible contemporaneous effects. And parameters, $(\Pi_1, ..., \Pi_k, \Phi, \Lambda_u)$. Providing the data are $I(1)$, it will be convenient to express (3.1) in its unrestricted error correction representation of the form,

$$\Delta \mathbf{y}_t = \mathbf{\Pi y}_{\mathbf{t-1}} + \sum_{i=1}^{k-1} \mathbf{\Gamma}_1 \Delta \mathbf{y}_{t-i} + \mathbf{\Phi D}_t + \boldsymbol{\varepsilon}_t \tag{3.2}$$

[13] Exports and private consumption are included because in one of the chapters, we analyse the effect of aid and public sector on the growth of private consumption.

Where each of the ($n \times n$) matrices $\Gamma_i = -(\mathbf{I} - \mathbf{A_1} -,..., \mathbf{A_i})$ $(i = 1,..., k-1)$ and $\mathbf{\Pi} = -(\mathbf{I} - \mathbf{A_1} - ..., \mathbf{A_k})$ comprise coefficients to be estimated by Johansens's (1988) maximum likelihood procedure using a (t = 1, . . ., T) sample of data in this model. $i = 1,2,..., k-1$ is the number of lags included in the system and Δ is a difference operator. The properties of the error correction model in (3.2) are determined by the properties of the characteristic polynomial of the process

$$\mathbf{A}(z) = (1-z)\mathbf{I}_n - \mathbf{\Pi} z - \sum_{i=1}^{k-1} \mathbf{\Gamma}_i (1-z) \tag{3.3}$$

Where the complex number $z \in \mathbb{C}$ is a root of $\mathbf{A}$ if $|\mathbf{A}(z)| = 0$. It is the roots of $\mathbf{A}(z)$ that are particularly interesting. If we assume that all roots of $\mathbf{A}$ have modulus larger than one y_t would be stationary, but would be $I(1)$ if $\mathbf{A}$ has unit roots. It follows then that if $z = 1$ is a root, $\mathbf{\Pi}$ has reduced rank $r < n$ since $|\mathbf{A}(1)| = |\mathbf{\Pi}| = 0$. Thus, providing the data are Cointegrated, this allows $\mathbf{\Pi}$ to be factorised such that $\mathbf{\Pi} = \boldsymbol{\alpha\beta}'$ where $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are both ($n \times r$) matrices of full column rank. Under this decomposition, (3.2) becomes

$$\Delta \mathbf{y}_t = \boldsymbol{\alpha\beta}'\mathbf{y_{t-1}} + \sum_{i=1}^{k-1} \mathbf{\Gamma}_1 \Delta \mathbf{y}_{t-i} + \mathbf{\Phi D}_t + \boldsymbol{\varepsilon}_t \text{ , } t = 1, 2, \dots, T \tag{3.4}$$

Where ε_t are independent $N_{\text{P}}(0, \mathbf{\Lambda})$ and $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \mathbf{\Gamma_1}, ..., \mathbf{\Gamma_{k-1}}, \mathbf{\Phi})$ are freely varying parameters. The advantage of this parameterization is in the interpretation of the coefficients. The effect of the levels is isolated in the matrix $\boldsymbol{\alpha\beta}'$ while $\mathbf{\Gamma_1}, ..., \mathbf{\Gamma}_{k-1}$ describes the short-term dynamics of the process (Johansen, 1995: 89 and Harris, 1995). It therefore delivers a neat economic interpretation to the vector error correction model of (3.2). The r columns of $\boldsymbol{\beta}$ represent the *co-integrating vector*s that quantify the 'long-run' (or equilibrium) relation(s) between the variables in the system, and as we have suggested, this could be the statistical analogue of the budgetary equilibrium among the core fiscal variables (*DB, G, A, TR*) as predicted by fiscal response theory (McGillivray and Morrissey, 2000, 2004). With a unique relationship among the fiscal variables, the identification of the long-run relation becomes relatively direct.

The r columns of *error correction coefficients* $\boldsymbol{\alpha}$ load deviations from equilibrium into $\Delta\mathbf{y}_t$ for correction, thereby ensuring that the equilibrium is maintained. The $\boldsymbol{\Gamma}_i$ matrices in (3.4) estimate the short-run or transient effect of shocks on $\Delta\mathbf{y}_t$ and thereby allow the short and long-run responses to differ. In addition, the parameterisation in (3.4) allows the short run adjustment effects embodied in the new equilibrium (which lead to permanent changes in the level) to be distinguished from the effects of lagged differences (which are transitory). Moreover, the specification reduces any multicollinearity, since the first difference of the variables tend to be more 'orthogonal' than the levels (Juselius, 2006: 60). Also, the reformulation of a VAR model in (3.1) as a VECM in (3.4 or 3.2) does not impose any binding restrictions on the original parameters (Juselius, 2006), i.e. does not change the value of the maximized likelihood function. There is therefore a direct correspondence between the estimated parameters of the two forms. But before we examine the existence of long-run relationship(s) among the macrovariables in the system, it is instructive to recognise the role of deterministic terms and the lag-length in Cointegrated VARs.

Deterministic Terms

As set-out in Johansen (1994) the specification of deterministic terms contained in $\mathbf{D}_t$ (such as intercepts, trends and intervention dummies) have an important implication for cointegration, as these alters the interpretation of the coefficients (Hendry and Juselius, 2001). A mixture of levels and first differences that characterize the VECM underscores the potentially complex role of deterministic terms in dynamic models comprising non-stationary variables. Consider for example, a scenario where a unrestricted constant is included in $\mathbf{D}_t$ in (3.2) or (3.4) to account for the non-zero mean of the cointegrating relationships (i.e. $\mathrm{E}[\boldsymbol{\beta}'\mathbf{y}_{t-1}] = \boldsymbol{\mu}$). This unrestricted constant will also allow for linear trends in $\mathbf{y}_t$ via accumulation of the constant in the first difference (in which case $\mathrm{E}[\Delta\mathbf{y}_t] = \boldsymbol{\gamma}$). Should these linear trends not cancel out in the cointegrating relation, $\mathbf{D}_t$ would have to be augmented with a linear trend to account for it, which if left unrestricted, would allow for quadratic trends in $\mathbf{y}_t$ (this being implied where $\mathrm{E}[\Delta\mathbf{y}_t] = \boldsymbol{\rho}t$). Hence, allowing for a unrestricted constant and intercepts (trends) in $\mathbf{D}_t$ may give rise to linear (quadratic) trends in $\mathbf{y}_t$. Where these do not occur in the data parsimony dictates they should not appear in the model either.

In fact, Juselius (2006) demonstrates that each unrestricted deterministic term in $\mathbf{D}_t$ of (3.2) or (3.4) represents the combined sum of its contribution to the cointegrating relation(s) and growth rates in $\Delta\mathbf{y}_t$. To illustrate this, consider the Cointegrated VAR(2) model in its error correction model representation given in (3.2) or (3.4) where $\mathbf{D}_t$ is simply a ($k \times 1$) vector of constants giving

$$\Delta\mathbf{y}_t = -\boldsymbol{\alpha}\left[\boldsymbol{\beta}'\mathbf{y}_{t-1}\right] + \boldsymbol{\Gamma}_1\Delta\mathbf{y}_{t-1} + \boldsymbol{\Phi} + \boldsymbol{\varepsilon}_t \tag{3.5}$$

Under cointegration, all terms in (3.5) are stationary and thus have a constant mean which we may obtain by taking expectations. Hence, taking expectations of (3.5) and letting $\mathrm{E}\left[\Delta\mathbf{y}_t\right] = \boldsymbol{\gamma}$ = a ($q \times 1$) vector describing the unconditional growth rates of each series and $\mathrm{E}\left[\boldsymbol{\beta}'\mathbf{y}_{t-1}\right] = \boldsymbol{\mu}$ = a ($r \times 1$) vector of intercepts in the cointegrating relations, yields

$$\begin{aligned}\left[\mathbf{I} - \boldsymbol{\Gamma}_1\right]\gamma &= \boldsymbol{\alpha}\mathrm{E}\left[\boldsymbol{\beta}'\mathbf{y}_{t-1}\right] + \boldsymbol{\Phi} \\ &= \boldsymbol{\alpha\mu} + \boldsymbol{\Phi}\end{aligned}$$

Thus, $\boldsymbol{\Phi} = \left[\mathbf{I} - \boldsymbol{\Gamma}_1\right]\gamma - \boldsymbol{\alpha\mu}$ demonstrating that the constant term in (3.5) consists of two components, one related to linear growth rates in the data and the other to the mean values of the cointegrating relations (as given by the intercepts of the equilibrium relations). The implication is that deterministic components have to be restricted in certain ways to avoid undesirable effects.

The precise specification of $\mathbf{D}_t$ is important not least because deterministic terms are not merely nuisance parameters but they affect the limiting distributions of the cointegration test statistics.

Determination of the Lag-Length

The appropriate lag-length (ρ) of the VAR in (3.1) is chosen using the minimum of the information criteria, which derives from the log likelihood ratio (LR) function, given in (3.6).

$$LR = -2\ln Q(\mathrm{H}_k/\mathrm{H}_{k+1}) = T\left(\ln\left|\hat{\mathbf{\Omega}}_{\mathbf{k}}\right| - \ln\left|\hat{\Omega}_{k+1}\right|\right) \tag{3.6}$$

Where $\mathbf{\Omega}$ is the residual covariance matrix, T is the length of the effective sample, which is kept constant.[14] H_κ is the null hypothesis that the model needs k lags and H_{k+1} is the alternative hypothesis that the VAR model needs $k+1$ lags. The test statistic is approximately distributed as χ^2 with p^2 degrees of freedom. However, the LR test alone may not be particularly informative, since an extra lag will almost always add information and improve the log-likelihood value. Hence, we discount the log-likelihood by an appropriate (penalising) factor that represents the loss of degrees of freedom. The Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) information criteria serves this purpose. These are all based on the maximal value of the LR function with an additional penalizing factor which is related to the number of estimated parameters (as a result of increasing the lag-length). That is, the lower the values, the better the model. Following Juselius (2006: 70-1), these are defined in (3.7), (3.8) and (3.9) respectively

$$AIC = \ln\left|\hat{\mathbf{\Omega}}\right| + \left(p^2 k\right)\frac{2}{T} \tag{3.7}$$

$$SC = \ln\left|\hat{\mathbf{\Omega}}\right| + \left(p^2 k\right)\frac{\ln T}{T} \tag{3.8}$$

$$H-Q = \ln\left|\hat{\mathbf{\Omega}}\right| + \left(p^2 k\right)\frac{2\ln\ln T}{T} \tag{3.9}$$

As shown in Lütkepohl and Krätzig (2004), AIC asymptotically over estimates the order with positive probability, HQ estimates the order consistently (i.e. $p\lim \hat{p} \to p$) and SC is

[14] The size of the effective sample needs to be the same when testing H_k against H_{k+1}; hence it is determined by the longest lag.

even more strongly asymptotically consistent (i.e. $\hat{p} \to p$) under quite general conditions if the actual data generating process (DGP) is a finite order AR process and the maximum order $p_{\max}$ is larger than the true order. It is further shown that even in small samples of fixed size $n \geq 16$, the following relations $\hat{p}(SC) \leq \hat{p}(H-Q) \leq \hat{p}(AIC)$ hold. So the appropriate order of VAR is based on SC in this paper.

As we discuss in the following section, (3.4) readily facilitates estimation and inference on key parameters relevant to aid and public sector response and growth in private consumption modelling. These are however partial derivatives (by construction) predicated on the *ceteris paribus* clause (Lütkepohl and Reimers 1992), and are interpreted in this light. In cases where variables in an economic system are characterised by potentially rich dynamic interaction, inference based on 'everything else held constant' may be of limited value (Lloyd *et al*., 2006) and may give a misleading impression of the short- and long-run estimates. If what is actually wanted is an estimate of what might happen to all variables in the system following a perturbation of known size in one of the equations, then impulse response analysis, which describes the resulting chain reaction of knock-on and feedback effects as it permeates through the system, provides a tractable and potentially attractive solution providing that no other shocks hit the system thereafter (Johnston and DiNardo, 1997). Thus, we may have to augment estimated parameters in (3.4) with the estimation of impulse response functions. The estimation of these functions uses the moving average representation of the model in equation (3.4) or (3.1). For simplicity, the model

$$\Delta y_t = \alpha\beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \varepsilon_t \text{ or } y_t = \left(I_p + \alpha\beta'\right) y_{t-1} + \Gamma_1 \Delta y_{t-1} + \varepsilon_t$$ [15]

Shows that a change in ε_t $(\varepsilon_t \mapsto \varepsilon_t + c)$ is equivalent to a change in y_t $(y_t \mapsto y_t + c)$ so that clearly, ε_t is *a shock* and *c* is *a change*. Granger Representation theorem referred to above shows

$$y_{t+h} = C(\varepsilon_1 + \ldots + \varepsilon_t + \ldots + \varepsilon_{t+h}) + C_0 \varepsilon_{t+h} + \ldots + C_h \varepsilon_t + \ldots + A \tag{3.10}$$

[15] We have in either equation assumed no deterministic terms for simplicity.

Where $\mathbf{C} = \boldsymbol{\beta}_\perp(\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp)^{-1}\boldsymbol{\alpha}'_\perp$ [16] or in a more compact form and similar to the $\boldsymbol{\Pi}$ matrix, $\mathbf{C} = \tilde{\boldsymbol{\beta}}_\perp \boldsymbol{\alpha}'_\perp$ (where $\tilde{\boldsymbol{\beta}}_\perp = \boldsymbol{\beta}_\perp(\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp)^{-1}$); C_h is the transitory effect and A contains the effect of the initial values defined so that $\beta' A = 0$, i.e. A represents stationary process in y_t.

Equation (3.10) implies that the effect at time $t+h$ of a change c to ε_t (or y_t) is given as

$$\frac{\partial y_{t+h}}{\partial \varepsilon_t} c = (C + C_h)c \rightarrow Cc, h \rightarrow \infty \tag{3.11}$$

Equation (3.11) is the impulse response function. A change c to the system at time t propagates through the system and becomes Cc in the long-run. The permanent effect of a change is Cc and C_h is the transitory effect.

In what follows, one may want to use the generalised impulse response function (Koop *et al*. 1996 and Pesaran and Shin, 1998) to assess the effect of one standard error shock to the j^{th} equation (aid in this case) at time t on $\mathbf{y}_{t+n}$. The decomposition of the generalized impulse responses derives from the reduced form impulse responses and is obtained as

$$(C + C_h)\varepsilon_t = \sum_{i=1}^{p}(C + C_h)e_i e'_i \varepsilon_t = \sum_{i=1}^{p}(C + C_h)e_i \varepsilon_{it} \tag{3.12}$$

Where e_i is the $i'th$ unit vector.

The effect at time horizon *h* of variable *i* on variable *j* is given by

$$e'_j(C + C_h)e_i = (C + C_h)_{ji}, \quad h = 1,2,3,... \tag{3.13}$$

Where e_j is an $m \times 1$ selection vector that identifies the source of the shock (hence unit is its j^{th} element with zeros elsewhere). The strength of generalized impulse response function over its orthogonalized counterpart is that they are invariant to the ordering of the variables in the model. This notwithstanding, the effects of a shock are legitimate if the

[16] $\boldsymbol{\alpha}_\perp$ defines the common stochastic trends driving the long-run relation out of equilibrium, while $\boldsymbol{\beta}_\perp$ defines the loadings to the common stochastic trends.

causality of the economic structure is known or they are prone to misinterpretation (Ericsson *et al.*, 1998: 379 cited in Osei *et al.*, 2005). Thus, in order to legitimately conduct the impulse response, the simulation exercise may need to be supported by both statistical and economic evidence. A major limitation with impulse response analysis for VECMs is that standard errors may be large with small samples of data and since they increase with the number of periods for which the responses are estimated (Fagernäs and Schurich, 2004), they are often stationary insignificant.

3.4 Economic Performance in Uganda

Data, Measurement and Sources

Annual time series data for the period 1972-2008 is used. Foreign aid is defined as the total net disbursement of aid from all donors to Uganda, and is an aggregate of grants and loans having a grant element of at least 25 percent. Alternative measures of aid, including International Monetary Fund-Government Financial Statistics (IMF-GFS), Ministry of Finance Planning and Economic Development (MoFPED) and Organization for Economic Cooperation and Development-Development Assistance Committee: OECD-DAC (2009) databases were explored to ensure a consistent series. Some previous applications (see among others, Table 3.1) disaggregate aid into grants and loans, because they may have different effects (governments prefer grants because they do not have to be repaid; loans may encourage fiscal planning for future servicing and repayment costs), such that there could be aid aggregation bias. McGillivray and Morrissey (2001) downplay this argument, contending that in practice such bias is likely to be minor as aid loans are long-term and present governments are unlikely to be around when repayment is due, such that they could be treated as grants.

In Uganda, loans accounted for 50-60 per cent of aid flows during the 1980s but grants have increased steadily and account for most aid disbursements since 1990 (Holmgren *et al.*, 1999). Moreover, as noted in Egesa (2011), aid loans/GDP ratio fell by half from about 8 per cent in the early 1990s to about 4 per cent in the subsequent years while aid grants/GDP share increased from 2 per cent in 1986 to a high of about 12 per cent in 1992 and averaged 8 per cent each year up to 2004. Nonetheless, whilst a distinction between loans and grants may matter (see for example Martins, 2010; M’Amanja, *et al.*, 2005), Uganda became a beneficiary of the highly indebted poor countries' (HIPC) debt relief in 1998/99 (Atingi-Ego, 2005; Collier and Reinikka, 2001) and could have anticipated significant debt relief. Thus, loans are similar to grants and are treated as net aid disbursements in this study. Data on aid disbursement is obtained from *Geographical Distribution of Financial Flows* (OECD-DAC, 2009) databases.

Data on tax revenue and net domestic borrowing from the banking system are from various annual reports of the Bank of Uganda (BoU). The non-tax revenue component of domestic revenue is omitted from the system so that we are not estimating an identity. Also, as aid is based on DAC measures it overstates the amount of aid actually going through the budget. It includes some that is not even spent in Uganda (most technical cooperation and assistance is spent in the donor country), while some is spent under the control of the donors (donors retain control over project aid). So again, there is no true identity. Data on total government spending (and its disaggregated components: current and capital spending) is from Uganda Bureau of Statistics (UBOS). Capital spending constitutes central government outlays on additions to fixed assets plus net changes in the government's level of inventories net of private investment. Current spending sums up expenditures by all government bodies on general public administration, defence, public order and safety affairs, education, health, community, social and economic services, agriculture, roads, water, loans repayment and pensions, among others. Total government spending is the sum of current and capital spending. The disaggregated components of total government spending are considered because we analyse a variant model as a refinement of one in which spending is aggregated.

We also extract data on GDP and exports from UBOS because we shall delve into how, the fiscal policy mediated by aid impact on the growth (measured by growth in private consumption). It is also from UBOS that private consumption is taken as the preferred correlate of GDP. Exports include the value of all goods and other market services provided to the world (i.e. value of merchandise, freight, insurance, travel, and other non-factor services). Private consumption is measured as the market value of all goods and services, including durable products purchased or received as income in kind by households and payments and fees to governments to obtain permits and licenses, and the expenditures of non-profit institutions serving households. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. All the data are in millions of constant 2005 Uganda Shillings (UGX) prices, and are shown in Figures (3.1) and (3.2) below

Trend Analysis

Trends in fiscal variables are given in Figure (3.1), while the trends in GDP, private consumption and exports are in Figure (3.2). Both figures track Uganda's economic performance over the period 1972-2008, covering successive phases of mismanagement, conflict and economic decline prior to 1988, and the Museveni regime and economic stability from the late 1980s.

In 1971, Uganda was considered among those African countries with a chance of achieving a GDP growth rate of 7 per cent for the rest of the century (O'Connell, 2002). However, that same year, Uganda embarked on a spiral of violence and economic decline (O'Connell, 2002). Economic wars, political turmoil, social disorder, a highly over valued exchange rate, export taxation and quantitative restrictions on imports were at the root of poor economic performance. Public expenditure fell from over 20 per cent of GDP in 1972 to less than 10 per cent of GDP by 1978 while the tax base and tax yields shrank more rapidly on account of new distorting taxes (Fagernäs and Roberts, 2004a). Aid inflows from the World Bank and Western countries generally ceased on account of highly distorted macroeconomic framework, and probably the tendency of the regime to lean towards socialism (Baffoe, 2000; Kasekende and Atingi-Ego, 1999) – so that inflationary pressures increased with monetization of the deficit (Fagernäs and Roberts, 2004a).

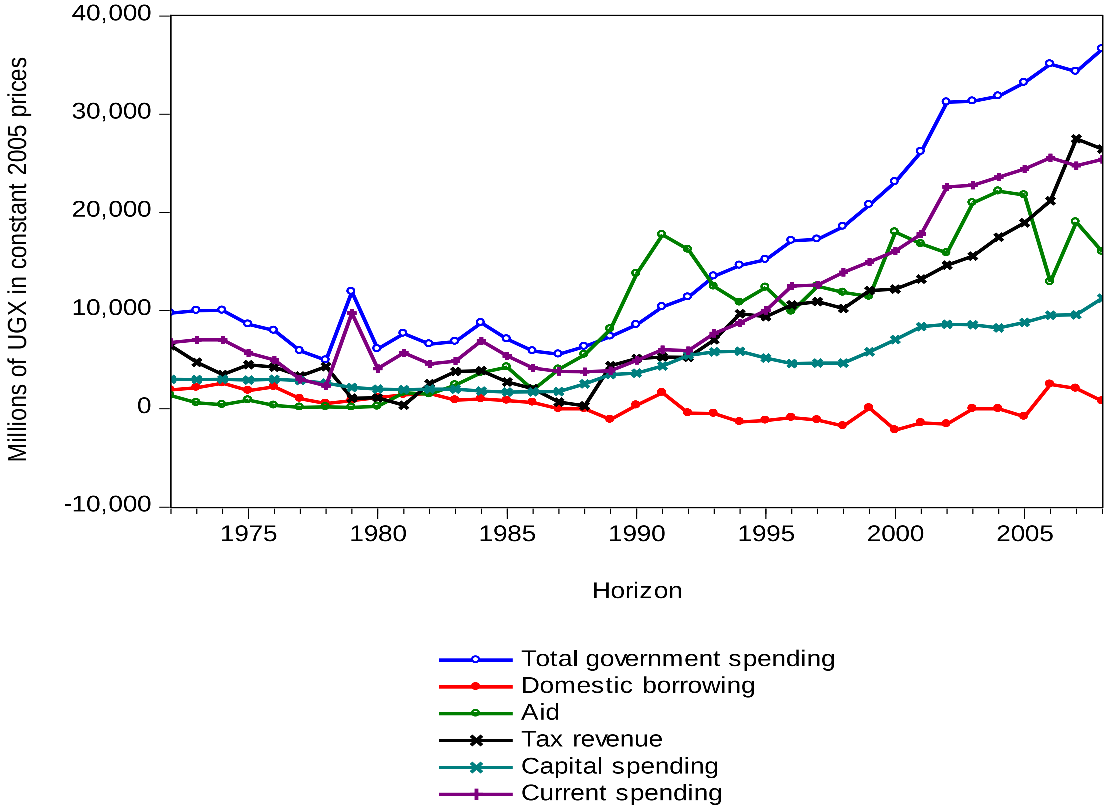
ODA flows fell from an already low level of 0.2-0.6 per cent of GDP at the beginning of 1970s to virtually nothing at the end of the decade, then rose to an average of 1.5 per cent of GDP between 1981 and 1985 (OECD/DAC data, 2009) during the implementation of the first standby arrangement supported by IMF with considerable donor support. This was a result of the return of Milton Obote to power in 1980. The only distinct feature in the 1970s is the high value of total government expenditure (and its current spending component) in 1979, which coincides with the overthrow of Idi Amin's regime, the second oil price shock and the collapse of the East African Community (EAC) at the end of 1970s. Between 1973 and 1979, real GDP per capita fell by over 3 per cent per year (O'Connell, 2002), qualifying Uganda as a chronic case of economic failure.

With political stability and the successful implementation of a World Bank and IMF Economic Structural Adjustment Programme (ESAP) in mid-1980s after the Museveni regime was established, Uganda began its recovery, reversing the economic decline of 1970s and early 1980s. By the late 1980s, Uganda had restored macroeconomic stability, and by 1992 it had undergone comprehensive goods and factor markets liberalization; down sized the public service; demobilized the army; privatized inefficient and loss making state owned enterprises (SOEs) and returned the confiscated property to their former Asian owners and established an independent revenue authority (Uganda Revenue Authority (URA)) to improve tax collection (Bwire and Tamwesigire, 2007; Kasekende and Ating - Ego, 1999). Together with the resolve to alleviate poverty and the good relationship with major donors made it an attractive target for official aid inflows.

ODA inflows (in absolute terms), increased from UGX 12,489.26 (or equivalently USD 869.92) million in 1996/97 to UGX 15,990.39 (USD 1,377.12) million in 2008/09 (OECD/DAC data, 2009), much of which took the form of budget support rather than project aid (Berg *et al.*, 2007). As a result, tax revenue and government expenditure became more relatively stable than ever in the mid-1990s, with the latter increasing more rapidly beginning 1998, rising from 15.9 per cent of GDP in 1998/9 to 21.6 per cent of GDP in 2002/3 (Brownbridge and Tumusiime-Mutebile, 2007). Over the same period, aid inflows rose from 9.67 per cent of GDP in 1997/98 to 16.88 per cent of GDP in 2001/2, while domestic revenue increased less quickly (declining from 10.3 per cent of GDP in 1997/8 to 9.6 per cent of GDP in 2001/2) (Brownbridge and Tumusiime-Mutebile, 2007).

There are two prominent peaks in the ODA flows with one around 1992 and 1993 and the second between 1998 and 2001 (see Figure (1)). This coincides with donors' effort to assist Uganda with the reduction in its external debt burden. During the first peak, the country received funds towards its debt reorganization that resulted in retiring of most of the commercial loans that had been contracted (Egesa, 2011). The second peak resulted from additional funding that was received in the second attempt to rid the country of its large debt burden under the highly indebted poor countries (HIPC I and II) debt relief initiatives (Egesa, 2011). Besides this, significant donor funding was received to fund infrastructure rehabilitation in the early 1990s while the increases during the late 1990s was partly due to improved coordination of government's social programs enshrined in the first Poverty Eradication Action Plan (PEAP) in 1997/98, which led to the introduction of the Poverty Action Fund (PAF) in 1998/99 in support of the PEAP (Egesa, 2011). In terms of composition, loans accounted for 50-60 per cent of aid flows during the 1980s but grants have increased steadily and account for most aid disbursements since 1990 (Holmgren *et al.*, 1999). The ratio of loans to GDP fell by half from about 8 per cent of GDP in the early 1990s to about 4 per cent of GDP in the subsequent years while grants-GDP share increased from 2 per cent in 1986 to a high of about 12 per cent in 1992 after which it averaged 8 per cent each year up to 2004 (Egesa, 2011).

Figure 3.1: Trends in Fiscal Variables



Sources: OECD/DAC (2009) databases and UBOS National Accounts Estimates of main Aggregates, and Authors' estimates.

The sector allocation of aid over time has been characterized by an adjustment in donor funding from heavy capital expenditures in the early 1990s to current expenditures towards poverty reduction through the PAF. As shown in Figure (3.1), development expenditures matched current expenditures during the early 1990s. However, effective the late 1990s current expenditures rose faster than development expenditures probably in line with the PEAP objectives. In addition, much of the HIPC resources which became available after concluding the HIPC initiative in the late 1990s were directed into key sectors identified for poverty reduction such as health, education, agriculture, water and sanitation with much of the expenditures being of current nature (Egesa, 2011). Subsequently, the increase in donor inflows through the years have resulted in a rapid increase in current expenditures with an equally fast increase in PAF which rose from USD 3.5 million in 1998 to a high of USD 142 million in 2004 and was estimated at USD 138 million in 2009 (Egesa, 2011).

Table 3.2 shows selected indicators of the central government fiscal operations between 2003/04 and 2008/09. Over the period 2003/4-2008/9, total donor support has averaged 43 per cent of the national budget (Macroeconomic Policy Department, MoFPED) and currently stands at some 42.4 per cent (Background to the Budget, 2008/9: 51). ODA flows are some 6.61 per cent share of GDP (MoFPED). Current spending rose exponentially at an average of 1.6 percentage points per annum over the period 2003/04-2006/07 while capital formation spending decayed at an average of 8.4 percentage points per annum over the same period. This trend however has changed in the last two periods, and as the table shows, current spending has fallen while capital spending has shown a strong increase. Though there has been remarkable improvement in current revenue, the current share of about 13 per cent of GDP still remains low even by SSA standards.

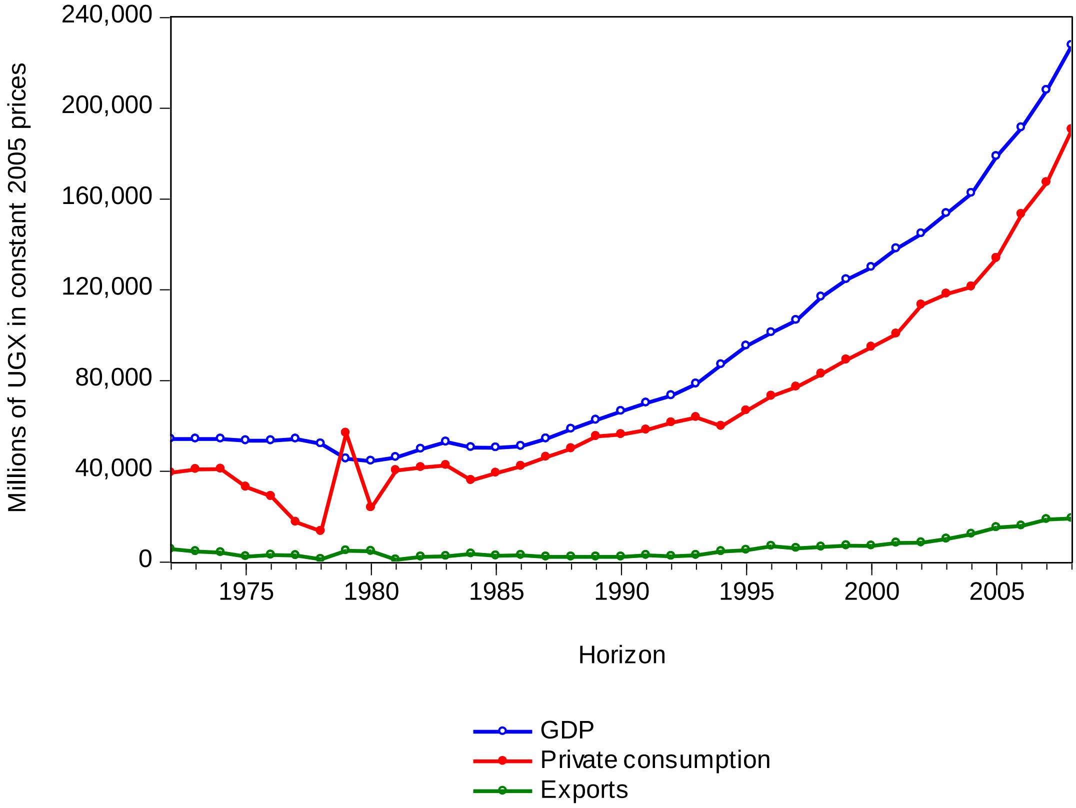
Table 3.2: Selected Indicators of Central Government Fiscal Operations

Indicators	2003 /04	2004 /05	2005 /06	2006 /07	2007 /08	2008 /09
Gov't final consumption expenditure/Total Budget	82.7	83.7	84.3	88.1	87.6	79.8
Public Investment/ Total Budget	17.3	16.3	15.7	11.9	12.4	20.2
Gov't final consumption expenditure /GDP	15.3	14.5	14.1	12.7	11.2	10.1
Public Investment/ GDP	5.4	5.0	4.6	4.9	4.4	4.6
Aid/Total Budget	52.3	46.9	38.5	48.4	27.6	42.4
Aid/GDP	11.3	10.5	7.5	9.0	4.9	6.6
Domestic revenue/GDP	11.8	13.8	12.7	12.8	13.3	12.6
Tax revenue/GDP	n.a	13.6	12.3	12.4	12.9	12.2

Source: Uganda Bureau of Statistics (UBOS) and Macroeconomic Policy Department, MoFPED in Background to the Budget, various issues

Turning to Figure (3.2), we see that GDP and private consumption declined at an accelerating rate during the 1970s, with no discernible trend during the first half of 1980 but seems to have increased steadily thereafter. The cumulative effect of inappropriate policies of successive governments together with the second oil price shock and the collapse of the EAC at the end of 1970s may explain this brink of collapse. The only exception is the high value in 1978/9 in private consumption, which coincides with the peak of political and economic instability and subsequent overthrow of Idi Amin's regime. Economic recovery started in 1986 with the successful implementation of ESAP.

Figure 3.2: Trends in GDP, Private Consumption and Exports



Source: UBOS National Accounts Estimates of main Aggregates

As seen from the graph, GDP and private consumption plots move together, although (as one may expect), the former plot is consistently above the latter. This suggests they may be highly correlated and thus, may signal that Uganda's GDP growth has, on average expanded household living standards. In fact, over the sample period, Uganda has witnessed declining trends in income poverty, which fell from 44 per cent in 1997/98 (Appleton *et al.*, 1999) to 38.4 per cent in 2002/03 and further to 31.3 per cent in 2005/06 (UBOS, 2006; Appleton, 2001). There has also been significant reductions achieved in HIV/AIDS prevalence (Nannyonjo and Okello, 2008; Okidi *et al.*, 2002), and in the late 1990s, the country achieved universal primary education (McGee, 2000). Exports exhibited a steady decline in the 1970s, remained moderately low through the 1980s and increased above its historically low levels thereafter.

The decline in exports in the 1970s is probably because exports were discriminated against through the tax system, price and marketing controls and the overvaluation of the exchange rate, which encouraged outward smuggling of exports (Kasekende and Atingi-Ego, 1999). As a result, all exports except for coffee collapsed (leaving exports to be highly concentrated in coffee) (Collier and Reinikka, 2001 and Henstridge, 1996), and this also meant that changes in world prices were not passed through to farmers. Effective 1992 however, the government underwent comprehensive goods and factor markets liberalization-rescinding massive implicit taxation by liberalizing financial and foreign exchange markets as well as coffee marketing; signalling a conscious effort by the government to improve the ‘pass-through’ of export proceeds to farmers. This may help explain why exports, and private consumption and GDP appear to move together in the latter period-a history that provides a useful frame-work for the next chapter which examines how, the public sector mediated by aid has over time impacted on the growth of private consumption in Uganda. The potential regime or level shift from 1988 and transitory blip in 1979/80 are accounted for in the empirical analysis.

3.5 Exploratory Data Description

Descriptive Statistics

The statistical description of the level data in Figures (3.1) and (3.2) is presented in Table 3.3. The table contains a summary of the commonly used statistical data descriptors. Comparing the minimum, maximum and standard deviation suggests wide dispersion of the data points for each series without exception. The mean and median for all series (with the exception of *GC*) are not numerically different, suggesting impotence of outliers in the data. The Jarque-Bera (J-B) statistics (Mukherjee, White and Wuyts, 1998) suggests normal distribution is not rejected (for *A*, *DB* and *GK*), is weakly supported (for *G*, *GC* and *TR*) and is rejected (for *PC* and *X*). The J-B statistics for *G* and *GC* are not statistically different, which probably suggests that the behaviour of *G* is dominated by *GC*.

Table 3.3: Descriptive Statistics

	A	DB	G	GC	GK	TR	X	PC
Mean	8911.991	373.2584	15333.57	10643.32	4690.250	8282.460	5929.902	69448.48
Median	9895.760	541.6023	10387.18	7011.720	3622.220	5239.507	4656.970	56829.17
Maximum	22157.33	2603.623	36633.31	25552.16	11251.79	27494.23	19224.58	190606.8
Minimum	141.6200	-2165.340	4948.450	2334.040	1706.970	282.7985	1036.290	13594.49
Std. Dev.	7421.362	1322.810	10205.15	7598.886	2757.660	7096.173	4766.058	42466.54
Skewness	0.230086	-0.100861	0.911189	0.904180	0.758426	1.145152	1.527921	1.171293
Kurtosis	1.630121	1.952707	2.364289	2.334927	2.346647	3.618367	4.472371	3.725377
Jarque-Bera	3.219504	1.753666	5.742997	5.723419	4.205221	8.676299	17.73848	9.271403
Probability	0.199937	0.416099	0.056614	0.057171	0.122137	0.013061	0.000141	0.009699
Observations	37	37	37	37	37	37	37	37

Notes: A = aid; DB = domestic borrowing; G = total government spending; GC = current spending; GK = capital spending, TR = tax revenue; X = exports; and PC = private consumption expenditure. All the data are in millions of constant 2005 UGX prices.

The order of Integration

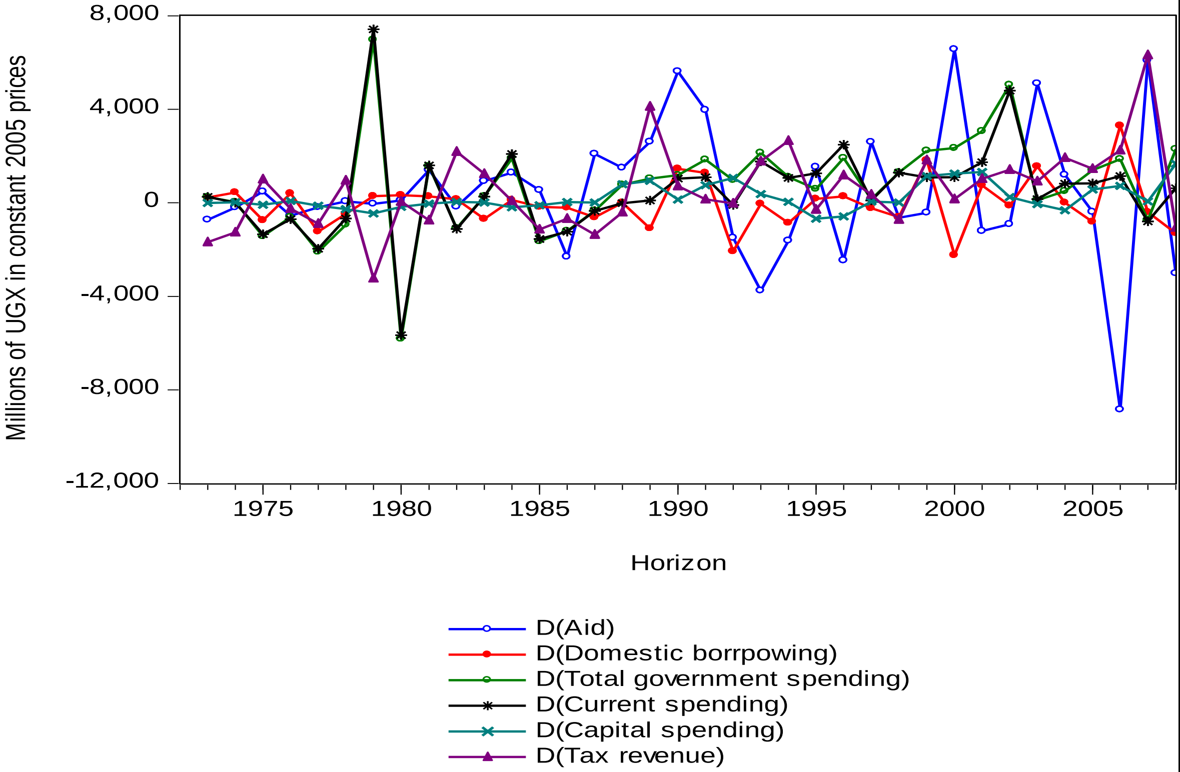
As a precursor to empirical analysis of time series models, it is crucial that the data are investigated and tested for order of integration. It is customary to begin with the graphical expositions of the level and first difference of the series to reveal important data features. The series in level is given in Figures (3.1 & 3.2), and exhibit trend like behaviour over time (i.e. trending). The first difference is provided in Figure (3.3), and appears stationary around trend (i.e. trend-stationary).

Both level and first difference plots point to possible breaks associated with outlier observations in 1978-79 (for total public spending, current spending, private consumption and to a small extent, exports) and a slight but detectable change in behaviour from about 1988 (this appears to occur in all the series to different degrees except for domestic borrowing and exports).

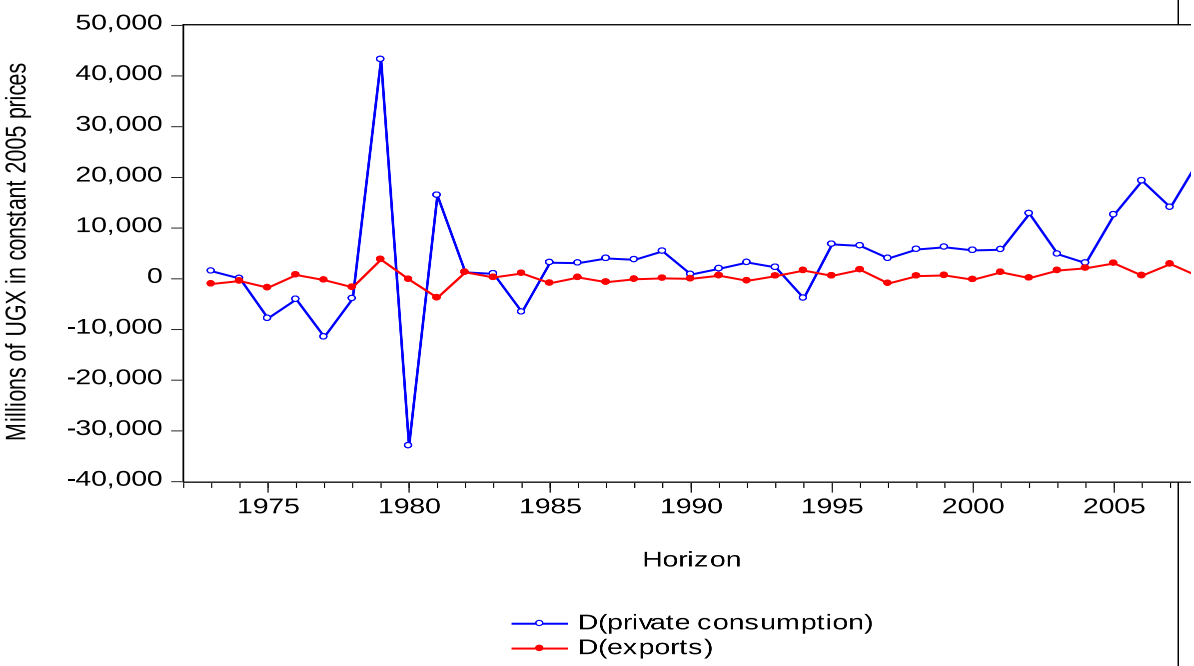
The former corresponds to the climax of the decade of economic collapse and social disorder in Uganda (Collier and Reinikka, 2001; Baffoe, 2000; Kasekende and Atingi-Ego, 1999; Jamal, 1988) and possibly the second oil price shock and the breakdown of the East African Community (EAC) in 1977 (Niringiye, 2009; Jerven, 2010). The latter could be a result of a shift in policy regime after the Museveni regime was established in 1987, notably from a regulated to a deregulated system following the effective implementation of broad economic structural adjustment programme (ESAP) that started in 1986 (Bwire and Tamwesigire, 2007; Kasekende and Atingi-Ego, 1999) and was associated with large increases in aid inflows on a scale that Uganda had never previously received.

Figure 3.3: Series in First Difference

Fiscal variables



Private consumption and Exports



Sources: OECD/DAC (2009) databases and UBOS National Accounts Estimates of main Aggregates, and Authors' estimates.

Finally, we conducted a formal Augmented Dickey Fuller (ADF) unit root test (ADF) test (Dickey and Fuller, 1979, 1981), to determine the series order of integration and the degree of differencing required to induce stationarity. The ADF specification estimated to generate results in Table 3.4 is given in Section 2.5 of Chapter 2 of the thesis. In the table, $\gamma = 0$ is the null hypothesis that the sequence { $\mathbf{y}_t$ } contains a unit root. This is rejected if the *t*-statistic is less than the critical value of the τ_τ - statistic (for $n = 50$ usable observations scaled by the 5 per cent critical values) reported by Dickey and Fuller (1981) (see Table A in Enders, 2010: 488).

Whether the data generating process (DGP) is characterized by non-stationarity with or without a linear deterministic trend and a drift, and non-stationarity with or without a linear deterministic trend is also evaluated by testing joint hypotheses on the γ, c_0 and c_2 coefficients. As noted earlier, under non-stationarity, the computed ADF- test statistic does not follow a standard *t*-distribution, but rather a dickey Fuller (DF) distribution and so the critical values for these joint tests are also non-standard. Instead, they follow the non-standard *F*-statistics denoted by the ϕ_i - statistics (ϕ_2 and ϕ_3 statistics here). The test for the joint significance or otherwise of a constant term, time trend and non-stationarity is given in the table as $c_0 = c_2 = \gamma = 0$ and is tested using ϕ_2 - statistic, while the joint hypothesis that $\mathbf{y}_t$ contains unit roots and no linear deterministic trend, i.e. $\gamma = c_2 = 0$ is tested using the ϕ_3 -statistic. The null hypothesis for these tests is that the data are generated by the restricted model and the alternative hypothesis is that the data are generated by the unrestricted model. Thus, if ϕ_i (calculated) is smaller than ϕ_i (critical) (reported by Dickey and Fuller for $n = 50$ usable observations scaled by the 5 per cent critical values), we accept the restricted model. Or we reject the null hypothesis if ϕ_i (calculated) is greater than ϕ_i (critical). Critical values for the ϕ_i - statistics are obtained from Table B in Enders (2010: 489).

As expected, test results in Table 3.4 indicate that the series are $I(1)$ in levels, but no time trend or draft. However, ADF unit root test is known to have (very) low power if the series has undergone a (permanent) regime shift during the period under consideration (Harris and Sollis, 2005: 57) or if there are outliers in regression residuals. We have already pointed to presence of an outlier observation which occurs around 1979 and a slight but detectable change in behaviour from about 1988. Opoku-Afari *et al.* (2004) argue that shocks and reforms are likely to have a fundamental impact on economic behaviour and need to be included in the deterministic part of the model, and is likely to bias estimates and result in invalid inference if ignored (Juselius, 2003). Moreover, Perron (1989: 1371), Hendry and Neale (1991) and Campos *et al.* (1996) argue that in the presence of structural breaks, the various Dickey-Fuller test statistics are biased towards the non-rejection of a unit root.

Table 3.4: The Augmented Dickey-Fuller (ADF) Unit root test

Macro variables	ADF test in Level					ADF test in First difference	
	$H_0: \gamma = 0$	$H_0: c_0 = \gamma = c_2 = 0$ (ϕ_2 - test)	$H_0: \gamma = c_2 = 0$ (ϕ_3 - test)	Lag-length	Inference	$H_0: \gamma = 0$	Inference
A_t	-3.049 (-3.50)	-.946 (5.13)	2.754 (6.73)	0	$I(1)$	-6.705 (-3.50)	$I(0)$
TR_t	-1.143 (-3.50)	-1.867 (5.13)	2.704 (6.73)	0	$I(1)$	-6.550 (-3.50)	$I(0)$
G_t	-1.476 (-3.50)	-1.526 (5.13)	2.951 (6.73)	1	$I(1)$	-8.350 (-3.50)	$I(0)$
GC_t	-1.568 (-3.50)	-1.270 (5.13)	2.663 (6.73)	1	$I(1)$	-8.646 (-3.50)	$I(0)$
GK_t	-1.515 (-3.50)	-.641 (5.13)	2.279 (6.73)	1	$I(1)$	-8.646 (-3.50)	$I(0)$
DB_t	-2.857 (-3.50)	1.244 (5.13)	-1.130 (6.73)	0	$I(1)$	-8.188 (-3.50)	$I(0)$
X_t	.0293 (-3.50)	-2.069 (5.13)	2.421 (6.73)	1	$I(1)$	-5.810 (-3.50)	$I(0)$
PC_t	.862 (-3.50)	-2.185 (5.13)	1.039 (6.73)	2	$I(1)$	-9.600 (-3.50)	$I(0)$

Notes: A = aid; DB = domestic borrowing; G = total government spending; GC = current spending; GK = capital spending, TR = tax revenue; X = exports; and PC = private consumption expenditure. All variables are measured in millions of constant 2005 UGX prices. Akaike Information criterion [AIC], Schwarz Bayesian criterion [SC] and Hannan-Quinn Criterion [HQ] were used (maximum set at 9 lags). An unrestricted intercept and restricted linear trend were included in the ADF equation when conducting unit root test of all the series in levels. Numbers in parenthesis are the 5 per cent critical values, unless otherwise stated. All unit-root non-stationary variables are stationary in first differences.

Source: Author's Computations using E-Views 7.2

It is argued that using such a test would lead one to believe that most series contain a unit root and hence are non-stationary when in reality the series could simply be trend-stationary but characterized by a structural break, which the test would fail to take into account (Nelson and Plosser, 1982). However, the series at hand is too short to enable us reliably conduct unit root tests that allow for breaks in trend. Moreover, whilst it is necessary that we check and test for breaks using various methods that have been developed in the literature, a Chow test for structural breaks has not been performed. This is because imposing a break point in a small sample (like ours) may render the test less informative.[17] The econometric methodology, the data and unit –root test results discussed in this chapter forms a basis for the CVAR analysis in the subsequent chapters.

[17] Derived probability estimates and associated critical values are likely to be unreliable for inference and may lack power owing to diminishing degrees of freedom for each of the resulting regressions (Mackinnon, 1996)

CHAPTER FOUR

A TIME SERIES ANALYSIS OF THE IMPACT OF AID ON CENTRAL GOVERNMENT ‘S FISCAL BUDGET IN UGANDA

4.1 Introduction

This chapter is motivated by the Fiscal response models (FRMs) (see McGillivray and Morrissey, 2000, 2004), which offer fiscal insights into how donors could expect their aid to impact on the fiscal behaviour of recipient governments, i.e. affect spending, tax effort and domestic borrowing. Aid inflows are expected to be associated with a direct and significant effect on public spending (Morrissey 2012). Aid may also be expected to affect taxation either because aid influences tax effort or because reforms linked to aid conditionality affects tax rates or the tax base (Morrissey, 2012; Greenaway and Morrissey, 1993). It could also be expected to be associated with lower domestic borrowing (Adam and O’Connell, 1999; Azam and Laffont, 2003) as donor conditionality often requires the aid recipient to reduce the budget deficit (McGillivray and Morrissey, 2000).

In principal, because most of the aid that is spent in the country goes to (or through) the government, or finances services that would otherwise be a demand on the budget (Morrissey, 2012), effectiveness of aid depends on public sector fiscal behaviour (McGillivray, 1994; Franco-Rodriguez *et al.*, 1998; McGillivray and Morrissey, 2001). This chapter investigates the impact of aid on fiscal behaviour, i.e. effects on public spending, tax revenue and borrowing in Uganda.

As noted earlier, Uganda is an interesting case study for the fiscal effects of aid as for over twenty years significant aid inflows have supported government spending in an environment of low tax revenue. The aid-GDP share, which was about 1 per cent in 1980 rose significantly to about 5 per cent in 1986 reaching a peak of about 19 per cent in 1992, and averaged about 11 per cent between 1990 and 2006 (Egesa, 2011; Mugume, 2008). In terms of the budget, total donor support (both direct budget support and project aid) has averaged 43 per cent of the national budget over the 2003/4-2008/9 period (Macroeconomic Policy department, MoFPED in Background to the Budget, 2008/9).

The empirical analysis in the chapter is founded on the econometric methodology and unit-root test results discussed respectively in Section 3.3 and Section 3.5 of Chapter 3. Based on this, we treat the core fiscal variables - tax revenue (*TR*), aid (*A*), domestic borrowing (*DB*) and total public spending (*G*) – as unit root non-stationary, i.e. $I(1)$, so could form (an) equilibrium relation(s) in a 4-variable VAR model. The fact that the series are non-stationary suggests a multiplicative rather than additive model specification, which under log transformation is brought back into additive form. However, this transformation is innocuous as long as the series data points are strictly positive or are at least not too close to zero (Juselius *et al.*, 2011). As Figure (3.1) shows, this is problematic in the case of domestic borrowing, jeopardizing the validity of log-transformations. Thus, we chose to use all series in non-log specification, which in addition to the advantage of not reducing the already small sample addresses some of our key questions of interest. For example, by how much would the level government spending change following a one million UGX level injection of aid?. The analysis is executed using *CATS in RATS, version 2* (by J.G. Dennis, H. Hansen, S. Johansen and K. Juselius, *Estima* 2005), unless otherwise stated. *CATS in RATS* is preferred because it is a tailor made toolbox with a number of features, probably not available elsewhere. This includes automatic model selection based on CATSmining procedure, small sample correction of tests for the cointegrating rank and hypotheses on the long-run $\boldsymbol{\beta}$. It also includes hypotheses on the long-run $\boldsymbol{\alpha}$ and easy loading of restricted model structures.

The rest of the Chapter is structured as follows. Section 4.2 presents the determination of the DGP for cointegration analysis, while the residual misspecification tests of the appropriate DGP model is discussed in Section 4.3. Section 4.4 describes the determination of the cointegration rank and the empirical CVAR model is given in Section 4.5. The long-run fiscal estimates, long-run structural analysis and testable fiscal hypotheses are presented in Section 4.6 and the common trends analysis is given in Section 4.7. Estimates of a disaggregated variant model are given in Section 4.8, while the conclusions and implications for policy are drawn in Section 4.9.

4.2 Determination of the DGP for Cointegration Analysis

In this section, we evaluate the existence of equilibrium relation(s) using the Johansen (1988) *trace statistic* test[18] for cointegration, also recommended in Lütkepohl *et al.*, (2001: 304). The *trace* test is a simple likelihood ratio test to discriminate between those eigenvalues which correspond to stationary relations and those eigenvalues which correspond to non-stationary relations. It is designed to test the restricted model H(r) with rank of *r* against the general model H(p) with full rank *p*. Central to cointegration analysis is a choice of the deterministic components (trend, constant and dummies) and the lag-length that describes an appropriate specification of the DGP. These have an important implication for cointegration, both statistically and economically (Opoku-Afari *et al.*, 2004; Johansen, 1994).

Specification of Deterministic Terms and Determination of the Lag-Length

Given the visual inspection of the data in figure 3.1 and the discussion in Section 3.3 of Chapter 3, it is reasonable to modify the standard unrestricted CVAR model given by (3.4) with a restricted trend and an unrestricted constant in the VECM at least initially. The variables in levels appear to be trending and we are not sure whether these linear trends will cancel out in the cointegrating relation. Including an unrestricted constant allows for linear trends in both cointegrating space and in the variables in levels and produces a non-zero mean in the cointegrating relation. Furthermore, it avoids creation of quadratic trends in the levels, which would arise if both the constant and trend are unrestricted. Further justification for this type of specification is in Juselius (2006: 99-100).

When choosing the lag-length we want to reduce the number of lags as much as possible to get as simple a model as is possible, but at the same time we want enough lags to remove autocorrelation of the error terms. The appropriate lag-length (ρ) of the VAR is determined using the minimum of the SC and HQ information criteria, but subject to non-rejection of the time independence of the residuals. With a relatively small sample, it is not

[18] In the test, the determination of the cointegrating rank, *r* relies on a top-to-bottom sequential procedure. This is asymptotically more correct than the bottom-to-top alternative (i.e. Max-Eigen statistic) [Juselius, 2006: 131-134].

possible to test long lag-lengths.[19] As aid impact is likely to be contemporaneous or with relatively quick adjustment dynamics (also see Martins, 2010), we started with lag 2. Thus, considering a 4-dimensional CVAR model, an unrestricted constant, a restricted trend, and letting k=2 (to facilitate the serach for an initial model specification), and given that the series are $I(1)$ we estimated a VECM of the form

$$\Delta\mathbf{y}_t = \boldsymbol{\alpha\beta}'\mathbf{y}_{t-1} + \sum_{i=1}^{k-1}\boldsymbol{\Gamma}_1\Delta\mathbf{y}_{t-i} + \boldsymbol{\mu}_0 + \boldsymbol{\alpha\beta}'\mathbf{t} + \boldsymbol{\varepsilon}_t \text{ , } t = 1, 2, \ldots, T \tag{4.1}$$

Where $\varepsilon_t \sim iid\left(0,\delta^2\right)$, $\mathbf{y}_t = \begin{bmatrix} DB \\ G \\ A \\ TR \end{bmatrix}$, $\left(\boldsymbol{\alpha},\boldsymbol{\beta}',\boldsymbol{\Gamma}_1,\boldsymbol{\mu}_1\right)$ are freely varying parameters to be estimated, $\boldsymbol{\mu}_0$ is a $(p\times1)$ vector of an unrestricted constant, and $\boldsymbol{\alpha\beta}'\mathbf{t}$ is a $(p\times1)$ vector of linear trend restricted to lie in the cointegrating space. Based on this model, the appropriate lag-length as shown in Table 4.1 is determined.

Table 4.1: Lag Length Determination

Model (k)	**Regr**	**SC**	**HQ**	**LM(1)**
VAR (2)	10	61.241	60.077	0.333
VAR (1)	6	60.619	59.920	0.329

Notes: SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion; LM (1): LM order autocorrelation test at lag 1.

Test results for minimising the information criteria are given in Table 4.1. As the recommendation is to select the lowest value for the information criteria, both *SC* and *HQ* suggest *k=1*. Lütkepohl and Krätzig (2004) and Lütkepohl (1991: Chap. 5) show that *SC* is strongly asymptotically consistent providing the actual DGP is a finite order autoregressive (AR) process, and the set maximum lag order is larger than the true order. Even where *SC* and *HQ* yield conflicting results, they show that SC would result in a more parsimonious specification (with fewer parameters) than HQ. Thus, VAR(1) could be a reasonable approximation of the DGP, but subject to non-rejection of the time independence of the residuals. Accordingly, the system is subjected to the autocorrelation

[19] Lütkepohl and Krätzig (2004) suggest that an "excessively large value of $p_{\max}$ [maximum lags for test] may be problematic" since it affects the overall Type I error of the testing sequence.

Lagrange Multiplier (LM) test (Johansen, 1995: 21-23). Test results are presented in the last column of Table 4.1. The presence of autocorrelation is rejected for both VAR(1) and VAR(2). While this suggests that VAR(2) could as well potentially serve the purpose at hand, there is a trade-off considering the small sample. Moreover, it is not a choice model as per the information criteria. Thus, based on the information criteria, together with the LM test, we adopt VAR(1) without significantly affecting the degrees of freedom.

Given $k = 1$, then $\mathbf{\Gamma}_1 = 0$ and therefore, the lagged first difference terms stacked in $\mathbf{\Delta y}_{t-1}$ drops out, so (4.1) is reduces to

$$\Delta \mathbf{y}_t = \boldsymbol{\alpha\beta}'\mathbf{y}_{t-1} + \boldsymbol{\mu}_\mathbf{0} + \boldsymbol{\alpha\beta}'\mathbf{t} + \boldsymbol{\varepsilon}_t \;, t = 1, 2, \ldots, T \tag{4.2}$$

In (4.2), we no longer have short-run dynamics and all terms are defined as before. In what follows, we assess the suitability of this model in terms of a battery of residual misspecification tests (see *inter alia* Godfrey, 1988).

4.3 Residual Misspecification Tests

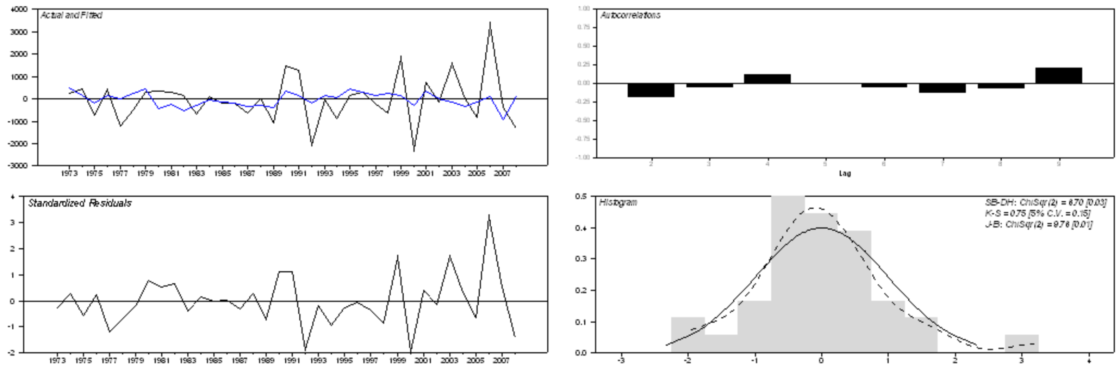
In this section, we focus on the formal system residual misspecification tests to assess the validity of the assumptions underlying the VAR(1) model under a restricted deterministic trend assumption. This comprises: the residuals plots; normality; autocorrelation; ARCH effects and the models goodness of fit tests.

Residuals Plots

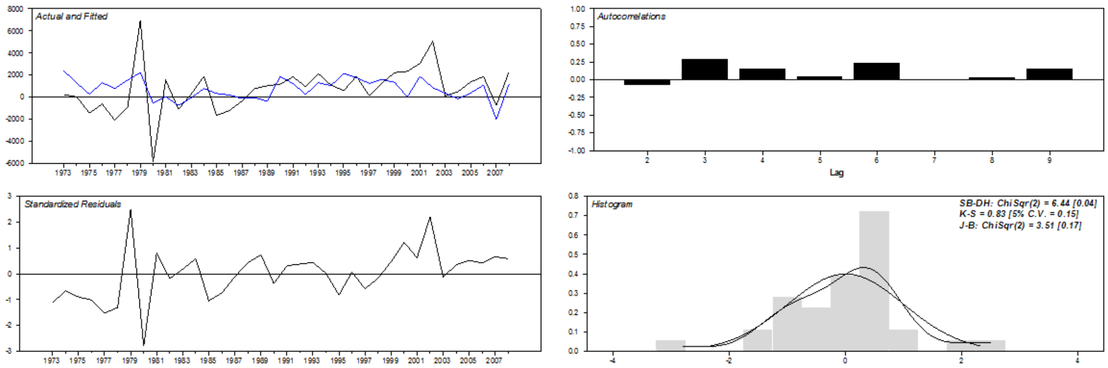
We start with the graphical inspection of the residuals since this can help identify potential problems. The figure below is a panel containing 4 plots, for each error correction model equation: (a) Actual and fitted values (top left); (b) standardized residuals (bottom left); (c) autocorrelations (top right); and (d) histogram (bottom right). Overlaid on the histogram is the estimated density function of the standardized residuals (appears as a dotted line in print) and the density of the standard normal distribution. It also contains some statistics: the univariate normality test by Doornik and Hansen-DH (2008) and Kolmogorov-Smirnov-K-S (Lilliefors, 1967) test for normality, and the Jarque-Bera test computed by the RATS' statistics instruction (Dennis, 2006).

Figure 4.1: Actual, Fitted and Standardized Residuals, Autocorrelations and Histograms

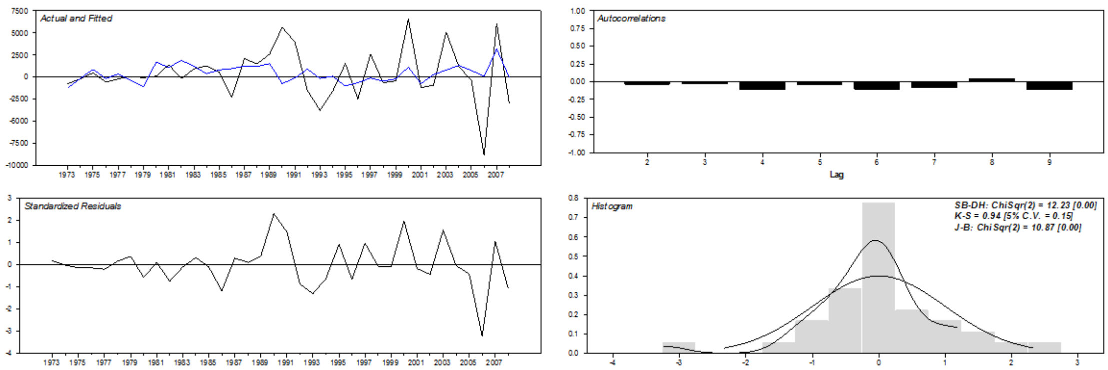
DDB

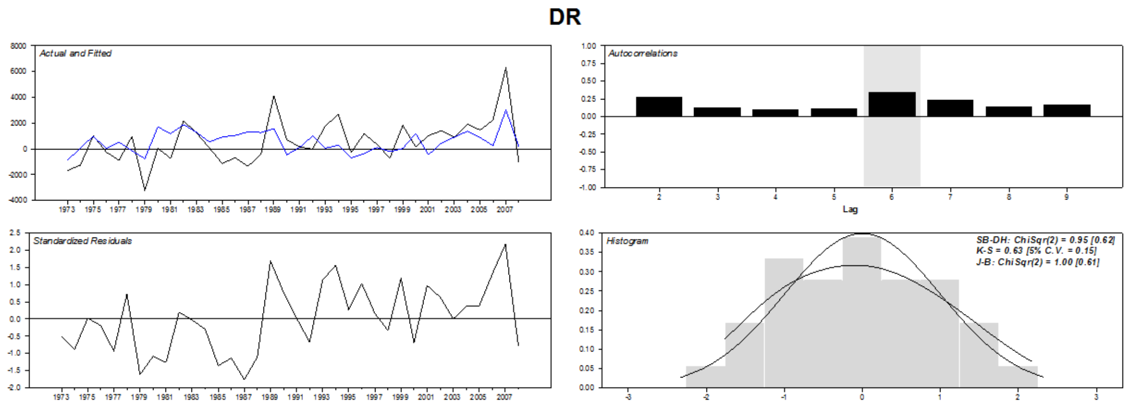


DG



DA





The plots show an outlying observation in the residuals of *G* equation that occurs around 1979. The actual and fitted residuals show a slight but detectable change in behaviour in most of the series equations (from about 1988). This notwithstanding, the histograms portray reasonably normal distribution behaviour.

Table 4.2 reports results for autocorrelation, the Doornik and Hansen-DH (2008) test for multivariate and univariate normality, multivariate LM test for the ARCH effects and the model's goodness of fit. From the results, we cannot reject the null of no first or second order autocorrelation (see LM(1) and LM(2). The multivariate test for ARCH rejects the presence of first order ARCH effects, although it is moderate in the system. Rahbek *et al.* (2002) cited in Juselius (2006) and Dennis (2006) show that the rank tests are robust to moderate ARCH effects, so this may not be a problem here. In the table, both measures of goodness of fit, i.e. the trace correlation (overall measure of goodness of fit, which is roughly an average R^2 in the p VAR equations) and the R^2 for each error correction equation suggest that our model captures, to a reasonable extent, the correlation among the fiscal variables in Uganda.

The hypothesis of multivariate normality is not strongly supported. Looking at the univariate statistics, normality of the error term is rejected at the conventional 10 percent level of significance for *G*, *A* and *DB*. As the standard normal distribution has Skewness of 0 and kurtosis of 3, we see from the results that *G*, *DB* and *A* have excess kurtosis (fat tails). In addition, *G* has a large degree of Skewness (this is usually due to a problem with large outliers). CVAR model is quite robust towards excess kurtosis, but not towards the presence of Skewness. We observe non-normality of the error terms in *G*, *DB* and *A* equations, although the residuals are not autocorrelated, which is very important.

Table 4.2: Residual Analysis

```
Residual S.E. and Cross-Correlations
       DDB         DG         DA         DTR
      843.3586  1589.9078  2477.0003  1272.3122
DDB   1.000
DG    -0.005     1.000
DA    -0.167     0.031      1.000
DTR   0.151      -0.038     -0.001     1.000

LOG(|Sigma|)                      =  58.090
Information Criteria: SC          =  60.479
                      H-Q         =  59.792
Trace Correlation                 =   0.355

Tests for Autocorrelation
Ljung-Box(9):         ChiSqr(128) = 122.406 [0.623]
LM(1):                ChiSqr(16)  =  19.125 [0.262]
LM(2):                ChiSqr(16)  =  17.442 [0.358]

Test for Normality:   ChiSqr(8)   =  22.308 [0.004]

Test for ARCH:
LM(1):                ChiSqr(100) = 128.796 [0.028]
LM(2):                ChiSqr(200) = 223.949 [0.118]

Univariate Statistics

    Mean   Std.Dev   Skewness Kurtosis Maximum  Minimum
DDB  0.000  843.359     0.732   4.411  2591.759 -1922.272
DG  -0.000 1589.908     1.060   5.812  5478.301 -3515.626
DA  -0.000 2477.000    -0.059   4.324  5296.400 -7447.000
DTR  0.000 1272.312     0.469   2.468  3037.071 -2120.722

    ARCH(1)           Normality          R-Squared
DDB  0.649   [0.421]    5.703  [0.058]    0.345
DG   2.686   [0.101]    9.814  [0.007]    0.422
DA   0.022   [0.882]    7.569  [0.023]    0.259
DTR  0.002   [0.968]    2.591  [0.274]    0.451
```

Notes: The multivariate diagnostic test is the chi-square for the joint significance of the variables. Null hypothesis is: VEC residuals are Gaussian errors.

Using CATSmining procedure, "*Find large residuals*", we estimate and report results for extreme values of standardized residuals scaled by the 5 per cent critical values of 3.1934 simulated for T=36 (i.e. effective sample in the study). Thus, any standard residual larger than a threshold of 3.1934 is considered an outlier. Based on the results in Table 4.3, the largest residuals are in the *G* equation (i.e. 3.397). This corresponds to the climax of the decade of economic collapse and social disorder in Uganda.

Table 4.3: Extreme Values of Standardized Residuals

Date	Entry	SRes_DB	SRes_G	SRes_A	SRes_TR
1973:01	1	-0.196	-0.097	0.674	0.260
1974:01	2	0.338	0.447	0.406	-0.237
1975:01	3	-0.609	0.120	0.304	0.804
1976:01	4	0.446	-0.247	0.067	0.553
1977:01	5	-0.988	-0.987	-0.102	-0.236
1978:01	6	-0.661	-0.887	-0.038	1.598
1979:01	7	0.094	3.397 *	-0.032	-1.138
1980:01	8	-0.192	-2.180	-0.651	-1.029
1981:01	9	0.678	1.431	-0.180	-0.918
1982:01	10	0.697	0.328	-0.868	0.649
1983:01	11	0.034	0.455	-0.392	0.589
1984:01	12	0.574	0.838	-0.023	0.195
1985:01	13	0.256	-1.041	-0.307	-1.190
1986:01	14	0.374	-0.848	-1.548	-0.978
1987:01	15	-0.011	-0.247	-0.343	-1.644
1988:01	16	0.429	0.374	-0.412	-1.115
1989:01	17	-0.805	0.712	0.073	2.039
1990:01	18	1.371	-0.759	2.108	0.896
1991:01	19	2.197	-0.109	2.066	-0.051
1992:01	20	-0.868	-0.082	0.184	-0.955
1993:01	21	0.037	0.116	-0.829	0.893
1994:01	22	-1.035	-0.345	-0.626	1.547
1995:01	23	-0.451	-1.402	0.577	0.072
1996:01	24	-0.143	-0.410	-0.973	0.865
1997:01	25	-0.607	-1.156	0.508	-0.039
1998:01	26	-1.116	-0.776	-0.427	-0.756
1999:01	27	1.288	0.067	-0.608	0.855
2000:01	28	-2.247	0.848	1.806	-1.085
2001:01	29	-0.503	0.332	-0.036	0.168
2002:01	30	-1.161	2.272	-0.354	-0.176
2003:01	31	0.330	-0.188	1.778	-1.066
2004:01	32	-0.273	0.110	0.784	-0.600
2005:01	33	-1.167	0.162	0.381	-0.540
2006:01	34	3.030	0.032	-2.964	0.463
2007:01	35	1.032	0.156	1.026	2.354
2008:01	36	-0.173	-0.437	-1.030	-1.046

Notes: * Maximum Value occurring at 1979:01; 5% C.V = 3.1934

From the actual and standardized residuals for *G* equation, we observe two non-cumulated blips (one in 1979 and the other in 1980) with opposite directions in level plus two cancelling cumulated mean shifts (one before 1979 and the other after 1980, 1979 and

1980 exclusive). As a common way of dealing with outlier observations, this suggests the need to generate and incorporate a transitory innovation dummy in the model, dum_{79} = (...,0, 0, 1, -1, 0, 0,...), i.e. 1979=1, 1980=-1, 0 elsewhere.[20] In addition, inspection of actual and fitted residuals reveal a slight but detectable shift in behaviour from about 1988 corresponding to a change in institutional environment (ESAP reforms) and the Museveni regime. This institutional knowledge motivates the inclusion of a shift dummy, $D_{88} = (...,0,0,0,1,1,1,...)$, taking the value 1 for each year after 1988 inclusive, 0 otherwise to capture the 'ESAP reform intervention and the Museveni regime effects'.

So allowing for transitory blip and level shift, we restrict dum_{79} and D_{88} to lie in the cointegrating space, albeit noting that dum_{79} cancels out as a consequence of cointegration.[21] In the residual analysis in Table 4.4, we consider whether this modification improves the specification of the model. From the univariate analysis, the errors for *G* are now normally distributed. In effect, the specification of the model is slightly improved, but we still reject multivariate normality (ChiSqr(8) = 20.878 [0.007]). This suggests that the two variant models, i.e. without (and with dummies) are not statistically different, so dummies may be impotent in the model. This notwithstanding, the good news is that estimates of the VAR model are robust to deviations from normality provided residuals are not autocorrelated. Furthermore, as the subsequent *trace* - test results will show, we obtain a cointegrating relation without dummies, but cointegration disappears when dummies are incorporated[22] in the deterministic part of the model. Although this is puzzling, theoretical predictions would suggest existence of a budgetary equilibrium among the fiscal variables, especially that we have allowed for a complete *fiscal representation* (albeit with some omissions so that we are not estimating an identity). Thus, we let a model without dummies (basic model) to override the alternate specification (i.e. model with dummies) so that subsequent analysis in the rest of the chapter is based on the basic model.

[20] Graphical exposition of this transitory innovation dummy is available with the author on request.

[21] In the cointegrating space, a transitory innovation dummy produces two non-cumulated blips with opposite directions but no adjustment after wards as they cancel each other

[22] *Trace-test* results of a model with dummies can be obtained from the author on request

Table 4.4: Residual Analysis with Modification

Residual S.E. and Cross-Correlations

	DDB	DG	DA	DTR
	804.2523	982.1165	2281.6572	1168.6320
DDB	1.000			
DG	0.039	1.000		
DA	-0.143	-0.048	1.000	
DTR	0.308	-0.180	-0.069	1.000

LOG(|Sigma|)		=	56.586
Information Criteria:	SC	=	60.169
	H-Q	=	59.138
Trace Correlation		=	0.517

Tests for Autocorrelation

Ljung-Box(9):	ChiSqr(128)	=	147.419 [0.115]
LM(1):	ChiSqr(16)	=	22.094 [0.140]
LM(2):	ChiSqr(16)	=	12.276 [0.725]

Test for Normality:	ChiSqr(8)	=	20.878 [0.007]

Test for ARCH:

LM(1):	ChiSqr(100)	=	94.777 [0.629]
LM(2):	ChiSqr(200)	=	215.910 [0.209]

Univariate Statistics

	Mean	Std.Dev	Skewness	Kurtosis	Maximum	Minimum
DDB	0.000	804.252	1.077	4.087	2387.962	-1418.509
DG	0.000	982.117	0.746	3.986	3064.238	-1682.427
DA	-0.000	2281.657	-0.117	4.297	4931.003	-6932.060
DTR	-0.000	1168.632	0.154	2.449	2603.715	-2408.370

	ARCH(1)		Normality		R-Squared
DDB	1.969	[0.161]	8.054	[0.018]	0.404
DG	0.104	[0.748]	4.363	[0.113]	0.779
DA	0.010	[0.919]	7.323	[0.026]	0.371
DTR	0.218	[0.641]	0.249	[0.883]	0.537

4.4 Trace test Statistics for Cointegration

Having determined the appropriate specification of the DGP, i.e. VAR(1), we use the *trace statistic* test to determine the cointegration rank, and also test for the presence of unit roots in the multivariate framework given the cointegration space.[23] Note (for emphasis) that we specify the deterministic component of the cointegrating space to include an unrestricted constant, a restricted deterministic trend, and exclude dummies. Including dummies would impact on the distribution of the test statistics under the null hypothesis and thus should be used as indicative only.

Johansen's (1988) *trace* test has however been shown to have finite sample bias with the implication that it often indicates too many cointegrating relations, i.e. the test is over-sized. A number of simulation studies suggest that there can be substantial size and power distortions, mainly because the asymptotic distributions are poor approximations of the true distribution in small samples (Juselius, 2006: 140-2; Cheung and Lai, 1993b; Reimers, 1992). Hence, for a small sample like the one at our disposal, we also report the small sample Bartlett correction which ensures a correct test size (Johansen, 2002 given in Dennis, 2006: 159-60).

Table 4.5: Johansen's Cointegration *trace* test Results

p-r	r	Eig.value	Trace	Trace*	Frac95	P-Value	P-Value*
4	0	0.521	66.002	61.916	63.659	0.031	0.070
3	1	0.413	39.535	37.835	42.770	0.104	0.148
2	2	0.303	20.368	19.854	25.731	0.211	0.238
1	3	0.185	7.374	7.310	12.448	0.316	0.323

Notes: Trend assumption: Linear deterministic trend restricted; *: the small sample corrected test statistic (Dennis, 2006: 159-60); Frac95: the 5% critical value of the test of H(r) against H(p). The critical values as well as the *p*-values are approximated using the Γ - distribution (Doornix, 1998).

Trace test suggests presence of one equilibrium (stationary) relation, even when correcting for small sample bias among the variables at the 10 per cent level of significance. However, Juselius *et al.* (2011: 12) show that the determination of the cointegrating rank is often crucial and may have a significant impact on the analysis. Specifically, the formal (*trace*) test becomes literally uninformative (i.e. the test power is often unacceptably low) for

[23] This could serve as a good robust check for the ADF univariate unit root test results implemented in **E-views 7.1** and reported in Table 3.4.

samples as small as 40-45. With as few as 36 observations in our case, this may be of even greater concern. Therefore, we do not exclusively rely on the *trace* test but follow the suggestions in Juselius (2006: 142) and complement the standard analysis with some sensitivity checks. These include examination of: the roots of the companion matrix and corresponding eigenvalues, and graphs of the cointegrating relations.

The roots of the companion matrix are equal to the inverse of the roots of the characteristic equation (Juselius, 2006: 50-2). y{t} is stationary when the roots of the characteristic equation are all outside the unit circle or equivalently when the roots of the companion matrix are all inside the unit circle. In practice, we need to choose the rank so that the largest unrestricted root is far from a unit root, i.e. it has modulus lower than 1. The model here is defined for $p = 4$, $k = 1$ implying $p \times k = 4$ roots in the characteristic polynomial (i.e. we assume full rank of the $\mathbf{\Pi}$ matrix). Roots of the companion matrix for the model, including the corresponding sorted eigenvalues are respectively presented in Figure 4.2 and Table 4.6.

Figure 4.2: Roots of Companion Matrix

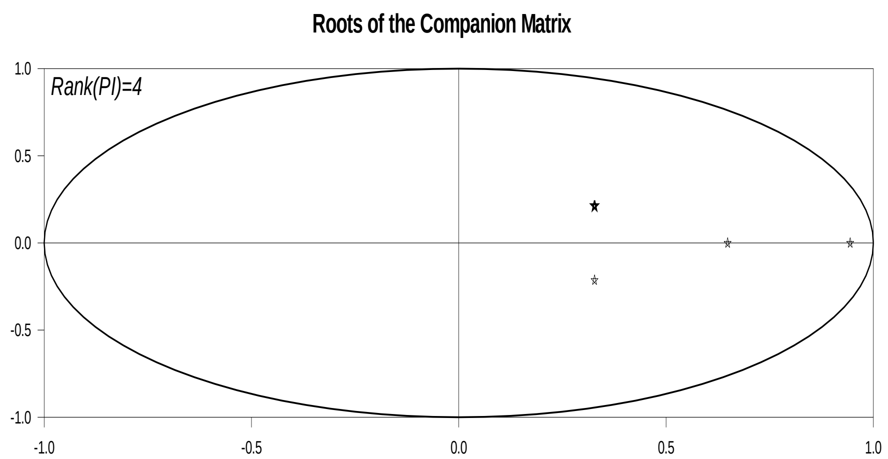


Table 4.6: Roots of the companion matrix

The Roots of the COMPANION MATRIX // Model: H(4)

	Real	Imaginary	Modulus	Argument
Root1	0.944	0.000	0.944	0.000
Root2	0.648	0.000	0.648	0.000
Root3	0.328	-0.213	0.391	-0.577
Root4	0.328	0.213	0.391	0.577

The Roots of the COMPANION MATRIX // Model: H(3)

	Real	Imaginary	Modulus	Argument
Root1	1.000	0.000	1.000	0.000
Root2	0.947	0.000	0.947	0.000
Root3	0.317	0.209	0.379	0.583
Root4	0.317	-0.209	0.379	-0.583

The Roots of the COMPANION MATRIX // Model: H(2)

	Real	Imaginary	Modulus	Argument
Root1	1.000	0.000	1.000	0.000
Root2	1.000	0.000	1.000	0.000
Root3	0.945	0.000	0.945	0.000
Root4	0.147	0.000	0.147	0.000

The Roots of the COMPANION MATRIX // Model: H(1)

	Real	Imaginary	Modulus	Argument
Root1	1.000	0.000	1.000	0.000
Root2	1.000	0.000	1.000	0.000
Root3	1.000	0.000	1.000	0.000
Root4	0.148	0.000	0.148	0.000

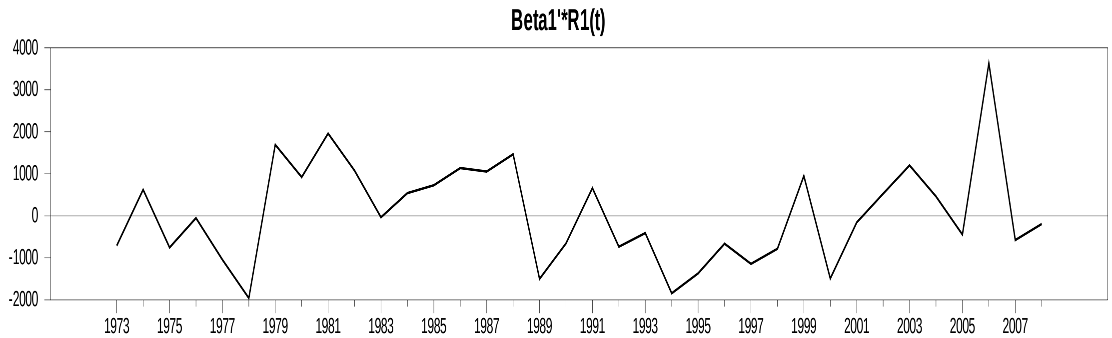
The Roots of the COMPANION MATRIX // Model: H(0)

	Real	Imaginary	Modulus	Argument
Root1	1.000	0.000	1.000	0.000
Root2	1.000	0.000	1.000	0.000
Root3	1.000	0.000	1.000	0.000
Root4	1.000	0.000	1.000	0.000

In Figure 4.2, all roots are inside the unit circle, and if we start from Table 4.6 with the highest possible rank, i.e. $r = 4$, there is 1 root (root1) with moduli very close to unit, which we in practice cannot distinguish from a unit root. With $r = 3$ we impose one unit root on the process, but we still have one root (root2) with moduli very close to unit. For $r = 2$ we impose two unit roots and only one root (root3) has moduli very close to unit. For $r = 1$ we impose three unit roots and now the modulus of the largest unrestricted root is 0.148, which is far from a unit root, i.e. there are no more unit roots. The eigenvalues of the companion matrix indicate that $r = 1$ seems reasonably well supported by the data.

Plots of this potential cointegrating relation comprise two sets of residuals, $\hat{\beta}'Z_{1t}$ and $\hat{\beta}'R_{1t}$. The former is the equilibrium error as a function of short run dynamics and deterministic components, while the latter concentrates out the lagged short-run dynamics (i.e. the concentrated model. Given the DGP (i.e. lag-length $k = 1$) in the model, $\hat{\beta}'Z_{1t}$ and $\hat{\beta}'R_{1t}$ are similar as this nullifies the short run adjustment effects embodied in $\hat{\beta}'Z_{1t}$ which $\hat{\beta}'R_{1t}$ corrects for.[24] As the **Z**-form (full model) and the **R-**form (concentrated) versions of the model are similar, there may be no need of reporting both. So inference is based on the concentrated model, $\hat{\beta}'R_{1t}$ in Figure 4.3.

Figure 4.3: Residuals of Cointegrating Relation



This appears to be stationary and as pointed out earlier, it is the statistical analogue of the budgetary equilibrium as predicted by fiscal response theory. Since this cointegrating relation is stationary, and given the theoretical expectation, suggests the presence of one cointegrating vector and also points to impotence of the dummies (no evidence of a break

[24] $\hat{\beta}'Z_{it}$ and $\hat{\beta}'R_{it}$ pairs for each of the remaining ($p-r$) potential cointegrating relations are similar, but look non-stationary. These are not reported but can be obtained from the Authors on request.

in the long-run relation). All this checks are in conformity with the formal (*trace*) test, and together, suggest that $r = 1$ seems reasonably well supported by the data.

Following the confirmation of the cointegrating rank, we tested for the presence of unit roots within the multivariate framework using the CATS procedure. The procedure expresses the hypothesis of stationarity of variable y_i as

$$H_O : \beta = \left(\beta_1^0, \beta_2\right),$$

Where $\beta_1^0 = \boldsymbol{\varepsilon}_i$ and β_2 is a $p \times (r-1)$ dimensional matrix of unrestricted coefficients (Dennis, 2006: 73). The procedure takes as the null hypothesis that a series is stationary (against the alternative of a unit unit) (see, for example Kahn and Ogaki, 1992; Kwiatkowski *et al.*, 1992), is conditional on the $r(\mathbf{\Pi})$(which is 1 in our case) and is a $\chi^2(p-r)$test (*ibid*: 11-2). This formulation makes it differ from the ADF type testing procedure (for which results in Table 3.4 are generated).[25] Although the two procedures may not be directly comparable, inference on unit root non-stationarity ought not to be altered. The CATS procedure test results for stationarity are presented in Table 4.7.

Table 4.7: Test for Stationarity: LR – test, $\chi^2(3)$

DB	G	A	TR
7.710 (.052)	7.882 (.049)	8.334 (.040)	7.389 (.060)

Notes: Restricted trend included in the cointegrating relationship(s); 5% C.V = 7.815; *P*-values in parentheses

Given the results in the table, we see that stationarity of each variable by itself in the system is rejected at the conventional 10 per cent level of significance. This suggests that each of the series in the system is unit-root non-stationary, and is consistent with the ADF (implemented in E-views 7.2) results given in Table 3.4. So together, these test procedures yield a consistent inference, i.e. the series are unit root non-stationary or $I(1)$.

[25] Note that the ADF null hypothesis is nonstationarity and the tests are Dickey-Fuller type test

4.5 The Empirical Specification of Cointegrated VAR(1) Model

We considered (from the preceding analysis) a 4-variable CVAR model for $\mathbf{y}_t = (DB_t, G_t, A_t, TR_t)'$, and structured the restricted empirical error correction specification around $r = 1$ cointegrating relation and $p - r = 3$ common trends, an unrestricted constant, $\boldsymbol{\mu}_0$ and a vector of linear trends, $\boldsymbol{\alpha\beta}'\mathbf{t}$ restricted to lie in the cointegrating space. The restricted CVAR model for the data becomes

$$\begin{bmatrix} \Delta DB_t \\ \Delta G_t \\ \Delta A_t \\ \Delta TR_t \end{bmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} \left\{ (\beta_1, \beta_2, \beta_3, \beta_4, \beta_0) \begin{bmatrix} DB_{t-1} \\ G_{t-1} \\ A_{t-1} \\ TR_{t-1} \\ t \end{bmatrix} \right\} + \boldsymbol{\mu}_0 + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{pmatrix} \tag{4.3}$$

Where $\boldsymbol{\beta}_i \mathbf{y}_t$ is the equilibrium error, $\boldsymbol{\alpha}_\mathbf{i}$ is the adjustment coefficient, $\boldsymbol{\mu}_0$ is a $(p \times 1)$ vector of an unrestricted constant, Δ is the first difference operator and $\boldsymbol{\varepsilon}_{it} \sim N_\mathrm{P}(0, \boldsymbol{\Lambda}_u)$. In (4.3), the long-run is then the same as the short-run since $\boldsymbol{\Gamma}_1 \Delta \mathbf{y}_{t-1}$ dropped out of the unrestricted ECM representation in (3.4). So the system, after having been pushed away from equilibrium by an exogenous shock, will adjust back to equilibrium exclusively through $\boldsymbol{\alpha}_\mathbf{i}$ (see *inter alia* Juselius *et al.*, 2011: 7).

To provide empirical content to the structural analysis underlying the causal links between aid and domestic fiscal variables, we focus on two types of long-run parameter restrictions. Restrictions on $\boldsymbol{\beta}$ tests long-run exclusion (and is evaluated by $H_o : \boldsymbol{\beta}_i = 0$), while restrictions on $\boldsymbol{\alpha}$ (evaluated as $H_o : \boldsymbol{\alpha}_\mathbf{i} = 0$) tells us which fiscal aggregates adjust to restore budgetary equilibrium in light of disequilibrium. Considered also is a test of a unit vector in $\boldsymbol{\alpha}$, corresponding to the hypothesis that variable i is purely adjusting to the system variables (or is completely endogenous in the system). We now move on to identify the long-run stationary relationship implied in (4.3), after which we turn to structural analysis.

4.6 The Long-run Fiscal Estimates, Structural Analysis and Testable Fiscal Hypotheses

4.6.1 The Long-run Fiscal Estimates

The statistical choice of the rank of one is supported by the fiscal response theory (McGillivray and Morrissey, 2004) that these variables together determine the long-run fiscal equilibrium. With a unique relationship among the fiscal variables, the identification of the long-run relation becomes relatively direct. So normalizing the only existing cointegration relation on domestic borrowing (this is a residual and is incorporated to identify the fiscal balance), we identified a cointegrated relation among the fiscal variables. This translates into a relation explicitly for the long-run fiscal equilibrium for Uganda. The corresponding estimates as set out in Equation (4.4a) are obtained (t-ratios in parentheses). In addition, in equation (4.4b-d) the existing cointegration relation is normalized respectively on government spending, tax revenue and aid to establish the magnitude of the impact of aid on spending and the impact on tax revenue of incremental aid (t-ratios in parentheses).

$$\underset{}{DB_t} = \underset{(3.159)}{0.223G_t} - \underset{(-2.064)}{0.137A_t} - \underset{(-4.929)}{0.484TR_t} + \underset{(4.638)}{244.387trend} \tag{4.4a}$$

$$G_t = \underset{(5.234)}{4.485DB_t} + \underset{(2.064)}{0.614A_t} + \underset{(4.929)}{2.171TR_t} - \underset{(-4.638)}{1096.077trend} \tag{4.4b}$$

$$TR_t = \underset{(5.234)}{-2.066DB_t} + \underset{(2.064)}{0.283A_t} - \underset{(-4.929)}{0.461G_t} - \underset{(-4.638)}{504.878trend} \tag{4.4c}$$

$$A_t = \underset{(-5.234)}{-7.31DB_t} - \underset{(-4.929)}{1.63G_t} + \underset{(4.929)}{3.538TR_t} - \underset{(-4.638)}{1786.46Trend} \tag{4.4d}$$

Ceteris paribus, estimates of the long-run coefficients in equation (4.4a) suggest a negative correlation of aid and tax revenue with domestic borrowing and a positive correlation with government spending. Estimates show that any increase in the revenue pool (tax revenue or aid) is associated with reduction in borrowing and an increase in public spending appears to balloon the budget deficit and hence a need for increased borrowing. We also see from the estimates in equation (4.4b) that public spending increase with any increase in the revenue pool, including domestic borrowing.

Another interesting result from equation (4.4a-b) is that the coefficient on tax revenue is larger than the coefficient on aid, suggesting that in the long-run the budget is largely driven by tax revenue (or domestic revenue in general). This could probably be because a budget driven by domestic revenue reduces the risk of fiscal vulnerability associated with aid (aid is both unpredictable and volatile (Bulir and Hamman, 2003)). Furthermore, aid and tax revenue coefficients have the same sign, suggesting that borrowing in general is the main financing item of primary budget deficit net of aid. As poor countries face the greatest difficulty in increasing tax revenue (Teera and Hudson, 2004) given their desired expenditure levels, but face a surge in aid, this result imply that Uganda easily alters borrowing after aid. In fact, trends in Figure 3.1 and extreme values of standardized residuals in Table 4.3 suggest that a surge in aid is associated with lower domestic borrowing (i.e. aid implies a lower deficit to finance) and vice versa. This association suggests that the net long-run effect of aid in Uganda has, in part, been a reduction in domestic borrowing (or aid is used to offset domestic borrowing).

Parameters of interest in equation (4.4c-d), i.e. aid and tax revenue are positively correlated. This suggests that in the long-run, aid receipts or reforms linked to aid conditionality have been associated with either tax revenue collection efficiency or reforms in public finance management. Finally, the trend term is significantly different from zero in all the three normalizations. This suggests *prima facie* that holding other factors constant, borrowing does increase every time, while spending and tax revenue or aid decrease for the same period. However, neither of this is likely given the graphical inspection of the data in Figure 3.1. Trends in domestic borrowing suggest there have been reductions in the variable, while spending and tax revenue seem to have been on the rise since the mid-1980s so the implication of the trend term seems counter inituitive. Given this, it is possible that the trend term is picking up measurement errors in the donor measure of aid which is a significant over estimate of the aid that actually goes to government or it could be that the omitted budget variables are exhibiting trend behaviour (e.g. non-tax revenue may be increasing steadily). The latter possibility is statistically tested under hypothesis 1 in Section 4.6.3 below, but does not hold leaving the former as the only plausible explanation. We recognize the limitations of DAC measure of aid used in the study up-front but note that these are the only available consistent data.

4.6.2 Structural Analysis

Long-run exclusion tests

Long-run exclusion is a test of whether (or not) a variable can be excluded from the cointegrating relation that has been suggested in (4.4) above. Although the *t*-ratios imply that all variables are significant, the variable exclusion is a further test. If accepted, the variable is redundant to the long-run relation(s) (Juselius, 2006: 176) and so can at most have a short-run impact. This implies that in the current set up where we do not have short-run dynamics, a variable that is excludable from the long-run would be of no impact in the system. With particular focus on aid, a test of whether it is long-run excludable involves evaluating the null hypothesis that $\beta_3 = 0$ in (4.3), whilst other $\boldsymbol{\beta}$ coefficients are unrestricted. As $A \sim I(1)$, accepting the null hypothesis is akin to suggesting that aid has not had any significant long-run impact on Uganda's fiscal variables (aid ineffectiveness). It could describe a situation where there may be institutional factors preventing aid from playing a role in the fiscal equilibrium (for example, 'aid leakage' where corrupt government officials use the aid money for private purposes).

Table 4.8: Variable Exclusion: LR-test, $\chi^2(1)$

		Statistic		*p-value*	
Variable	Null Hypothesis	Asymptotic	Bartlett correction	Asymptotic	Bartlett correction
DB	$\beta_1 = 0$	6.846	4.315	0.009	0.038
G	$\beta_2 = 0$	4.310	2.717	0.038	0.099
A	$\beta_3 = 0$	4.384	2.684	0.036	0.101
TR	$\beta_4 = 0$	7.200	4.539	0.007	0.033
Trend		5.929		0.015	

Note: Null hypothesis: a variable can be excluded from the cointegrating relations; *p*-values indicate the level at which the null hypothesis can be rejected. Bartlett correction factor is 1.586

Given the results in Table 4.8, the null hypothesis of long-run variable exclusion is rejected for all variables in the cointegrating relation and is robust when corrected for small sample bias, albeit being borderline so for *A* at the 10 per cent level of significance. Thus, all variables enter into the system cointegrating space in (4.4). Aid is a significant element of long-run fiscal equilibrium and suggests that aid or strictly policy conditions attached to aid is likely to have caused beneficial fiscal policy responses in Uganda or that in fiscal terms, aid may have been used sensibly.

Long-run weak exogeneity tests

This focuses upon the role played by aid and the domestic fiscal variables in Uganda's budgetary process and is gleaned from a set of restriction tests on the vector of error correction coefficients $\boldsymbol{\alpha}$. These restrictions are accomplished econometrically by long-run weak exogeneity test procedure described in Johansen (1996) (i.e. a zero row in $\boldsymbol{\alpha}$). As $\boldsymbol{\alpha}_i$ measures the speed at which the corresponding variable in $\Delta\mathbf{y}_t$ in (4.3) adjusts to deviations from the equilibrium, a zero coefficient implies that the variable impacts on the long-run stochastic path of the other variables of the system, while at the same time has not been influenced by them (Juselius, 2006: 193), and is as such considered to be weakly exogenous for the long-run parameters $\boldsymbol{\beta}$.

At a more general level, it's of economic interest to know which of the variables adjust to maintain equilibrium, since by Granger Representation Theorem (Engle and Granger, 1987), at least one variable must adjust in order to maintain equilibrium relation. In light of the domestic fiscal variables in $\mathbf{y}_t$, the test offers insights into the behaviour of budget planning authorities in Uganda, indicating which fiscal aggregates adjust in light of budget disequilibrium (budget deficit or surplus) to restore the budgetary equilibrium. As our focus is on aid, we would wish to establish whether in Uganda's fiscal planning, aid is treated as given or whether its allocation actually reflects the state of the budget in some way. As with tests on $\boldsymbol{\beta}$, this from equation (4.3) can be evaluated from the null hypothesis that $\alpha_3 = 0$, whilst other $\boldsymbol{\alpha}$ coefficients are unrestricted.

The results in Table 4.9 indicate that the null hypothesis of weak exogeneity cannot be rejected only for domestic borrowing. This suggests *DB* does not adjust to system disequilibrium and is exogenous to the long-run relation. Although this is surprising, it appears that *DB* may be determined by factors other than the domestic fiscal variables (corroborations from the trend analysis and estimates of the long-run relation suggest this may depend on aid and not tax revenue). Long-run weak exogeneity is firmly rejected at the 10 per cent level of significance for aid, government spending and tax revenue. Thus, these adjust to maintain equilibrium and are endogenous to the long-run relation. Allowing for adjustments in government spending as the results suggest may appear counter intuitive as spending is very difficult to reverse once implemented (especially if it involves increases in public payroll or statutory expenditures). But, it may imply that government spending is planned given the expected revenue envelop but the allocation of spending is affected when the revenue outcome is realized, i.e. spending allocation responds to revenue outturn.

Table 4.9: Long-run Weak Exogeneity: LR-test, $\chi^2(1)$

Variable	Null Hypothesis	Statistic	p-value
DB	$\alpha_1 = 0$	1.899	0.168
G	$\alpha_2 = 0$	3.018	0.082
A	$\alpha_3 = 0$	3.102	0.078
TR	$\alpha_4 = 0$	3.309	0.069

Notes: Null hypothesis: a variable is weakly exogenous. A large test statistic (small prob.) indicates that the null hypothesis of weak exogeneity is rejected.

The long-run weak-exogeneity of aid is not supported demonstrating the peril of assuming that aid is exogenous to the fiscal variables without testing. This result suggests, in part, that Ugandan fiscal planners have a target for aid revenue, and this expected revenue is incorporated into fiscal planning (i.e. when determining revenue and expenditure allocations, aid revenue is taken into account) (see *inter alia* McGillivray and Morrissey, 2000).[26] Alternatively, it could be the case that donors incorporate government spending in deciding how much aid to allocate to Uganda, which seems less likely but is possible.

Either way, while we would usually expect causality to run from aid to spending, this interpretation paints a different picture for Uganda. It suggests that the government sets spending targets according to her development objectives, and then tries to find aid resources to finance those ambitions. The existing mutual cooperation in the politics of

[26] In Foster and Killick (2006: 19), it is noted that Uganda has a more forward-looking view, and has achieved some success in getting more aid allocated as budget support, and released early in the budget year. Uganda has also been relatively sophisticated in adjusting donor promises based on past disbursement performance.

donor assistance between the Ugandan government and her major donors (Alesina and Dollar, 2000; Burnside and Dollar, 2000; Boone, 1996) makes it likely that donors have been keen to finance these expenditures, albeit with some levels of unpredictability, which could be due to a donor disbursement rule.[27] Aid agreements often include performance-related triggers for disbursement or general conditionalities. This however does not mean that the Ugandan government has control over the aid allocated to her (i.e. aid commitment) by donors but rather disbursement could be a reaction to government's ability to meet donor's administrative or internal procedural requirements and/or other policy pre-conditions (Eifert and Gelb, 2005). Or it may reflect the exercise of incentive clauses by donor's in response to events over which the Ugandan government has some direct control in the context of an on-going aid relationship (O'Connell *et al.*, 2008) or both.

Test of a Unit Vector in $\boldsymbol{\alpha}$

Under this heading, we test the hypothesis of $\boldsymbol{\alpha}$ containing a unit vector. This corresponds to testing the hypothesis that variable i is purely adjusting to the system variables (or is completely endogenous in the system). For example, a test of whether *DB* is a unit vector in $\boldsymbol{\alpha}$ involves evaluating the null hypothesis that $\alpha_1 = 1$ in (4.3), whilst other $\boldsymbol{\alpha}$ coefficients are unrestricted. If accepted, then, shocks to the corresponding variable have no lasting impact on any of the variables in the system (including itself). Intuitively, it implies that the cumulated disturbances from the i^{th} variable do not enter the common trends defined by $\boldsymbol{\alpha}_\perp$, noting that $\boldsymbol{\alpha}'\boldsymbol{\alpha}_\perp = 0$ such that a unit vector in $\boldsymbol{\alpha}$ corresponds to a zero row in $\boldsymbol{\alpha}_\perp$. Thus, if variable i is purely adjusting in $\boldsymbol{\alpha}$, one would expect it to have transitory effects in $\boldsymbol{\alpha}_\perp$.[28] To sum up, a variable with a unit vector in $\boldsymbol{\alpha}$ is purely adjusting to the cointegrating relation and shocks to the variable only have transitory effects. Table 4.10 gives test results of a unit vector in $\boldsymbol{\alpha}$.

Reading from the row corresponding to *r =1*, we note that the null hypothesis of a unit vector cannot be rejected only for *TR*, while we reject the null for the remaining domestic

[27] The amount they give is unpredictable, sometimes varying by as much as 40 per cent from one year to the next (2005 Commission for Africa Report).

[28] $\boldsymbol{\alpha}$ defines the adjustment to the equilibrium error given by the cointegrating relation, while $\boldsymbol{\alpha}_\perp$ defines the common stochastic trends.

fiscal variables. This means that we can accept that shocks to *TR* only have transitory effects and that only *TR* is purely adjusting to the long-run equilibrium.

Table 4.10: Test of Unit Vector in Alpha

r	DGF	5% C.V.	DB	G	A	TR
1	3	7.815	11.579	7.617	17.049	4.921
			[0.009]	[0.055]	[0.001]	[0.178]
2	2	5.991	6.081	2.714	11.137	0.783
			[0.048]	[0.257]	[0.004]	[0.676]
3	1	3.841	0.003	1.453	5.039	0.766
			[0.957]	[0.228]	[0.025]	[0.382]

Notes: LR-test, Chi-Square(4-r), P-values in brackets.

4.6.3 Testable Fiscal Hypotheses

Now that we have established the variables in the long-run fiscal relationship, in another phase of test restrictions on the long-run $\boldsymbol{\beta}$; we focus on some $\boldsymbol{\beta}$ vectors that are assumed to be known. Fiscal response models (FRMs) offer important insights into how donors could expect recipient governments to respond to aid receipts or how aid revenue may be expected to affect the budgetary situation of recipient governments. Aid inflows are expected to be associated with an increase in government spending (aid additionality) because aid packages come with strong pressures to spend (O'Connell *et al.*, 2008). The effect of aid on tax revenue is ambiguous, although the logic is that it is undesirable that aid should displace tax effort or be viewed as an alternative to tax revenue by recipients. Besides, aid is expected to be associated with lower domestic borrowing (Adam and O'Connell, 1999; Azam and Laffont, 2003) as donor conditionality often requires the aid recipient to reduce the budget deficit (McGillivray and Morrissey, 2000). Applying restrictions on the long-run fiscal coefficients ($\boldsymbol{\beta}_i$) allows us to assess whether the above hypothetical known fiscal vectors are stationary (see *inter alia* Juselius, 2006). We could for example test whether a revenue displacement or whether balanced budget and/or whether aid additionality hypotheses are each stationary, i.e. whether each of this is a long run relation. Note that equation (4.4) can be normalized on any variable (as we do in (4.5) or (4.6)), but for testing of the hypotheses of the fiscal effect of aid, it may be best to interpret it in equilibrium form

$$\begin{bmatrix}\beta_1, & \beta_2, & \beta_3, & \beta_4, & \beta_0\end{bmatrix}\begin{bmatrix}DB \\ G \\ A \\ TR \\ t\end{bmatrix} = I(0) \tag{4.5}$$

Basing on Equation (4.5), we test, where applicable the long-run fiscal vector restrictions in Martins (2010). However, test restrictions in Martins are based on a disaggregated model. Aid is disaggregated into aid grants and aid loans and government spending is categorized into current and development components. The disaggregation of the latter is problematic as investment and consumption spending are intertwined, so that expenditure classification is blurred (Morrissey 2012; Osei *et al.*, 2005; McGillivray and Morrissey, 2000). Furthermore, it is difficult to know what the donors intended the aid to be used for or as argued in Morrissey (2012), the difficulty of linking aid, donor intensions and sector spending. Despite these data difficulties, Martins tests aid spending, development funding and categorical fungibility hypotheses. It is assumed that aid is intended to finance investment/development expenditure, but is fungible when government diverts these funds to finance consumption spending. However, not all aid is intended to finance investment; and consumption and investment spending are necessary complements. Moreover, legitimate testing of the above hypotheses requires that one knows how much of the aid the donors intended to be spent on each of the expenditure headings (Morrissey, 2012; McGillivray and Morrissey, 2004). Thus, the test restrictions on categorical spending, compounded by the difficult of linking each of this to donor intentions raises concerns as to whether some the hypotheses tested in Martins are legitimate and whether the corresponding inferences are precise.

With this caveat in mind, we differ from Martins to the extent that we are not concerned with donor aid allocation and where we disaggregate spending, we acknowledge the difficulties in expenditure classifications, and do not disaggregate aid. Hence, we restrict our tests to the aid additionality/illusion, budget constraint, balanced budget, tax revenue displacement and aid-domestic borrowing substitution hypotheses, but with modifications where appropriate. These are described in detail below and test results are given in Table 4.11.

Hypothesis 1: **Budgetary constraint**

$$(G-(TR+A+DB)$$

The evaluation of whether budgetary constraint is long-run stationary or non-stationary is based on the accounting identity above. The null hypothesis is that the total resource envelop (*TR*, *A*, including *DB*) is insufficient to meet the required public expenditures consistent with the achievement of Uganda's growth targets. This, from (4.5) is accomplished by testing whether the estimated *G* coefficient is **not** statistically different from +1, while *TR* and other financing coefficients (*A* and *DB*) **are not** statistically different from -1 (i.e. $H_0 : \beta_1 = -1, \beta_2 = 1, \beta_3 = -1, \beta_4 = -1$ (Martins, 2010; McGillivray and Morrissey, 2001b: 4-7)), whilst the trend coefficient is left unrestricted. If accepted, it would imply that inasmuch as the aid inflows have been substantial over the sample period, spending needs have been on the rise so that the resource gap remains unfilled (i.e. the budget deficit after grants remains), and that the 'residual components or net errors and omissions' (omitted budget variables)[29] are stationary. It would also imply that expansions in domestic borrowing as financing of the last resort to balance the fiscal accounts have been dismal probably because of compliance with donor aid requirements.

Budget constraint hypothesis over the sample period under consideration is not rejected [$\chi^2(4) = 6.915$ (0.140)], suggesting that aid inflows remain insufficient to cover the spending needs (albeit noting that there is a trend present in the long-run relation) and the 'omitted budget variables' are stationary. To demonstrate the latter, we performed unit root test on non-tax revenue. This yielded the ADF test statistic: -3.725, which when scaled by the 5 per cent critical value of -3.50 (for *n=50* usable observations) suggests this is stationary.

[29] Some of these include External commercial borrowing, non-concessional external loans and non-tax revenue

Hypothesis 2: Balanced / Cash Budget

$$(G-(TR+A)=0; DB=0)$$

This investigates the hypothesis that the government tries to meet expenditures exclusively with the resource envelope (domestic tax revenue and aid) with no recourse to deficit financing. A budget is said to be balanced if the expenditure and revenue envelope (*TR* and *A*) are equal, assuming no domestic borrowing, while the trend coefficient is left unrestricted. From (4.5), this is evaluated as ($H_0: \beta_2 = 1, \beta_3 = -1, \beta_4 = -1; \beta_1 = 0$). This hypothesis is rejected [$\chi^2(4) = 8.458\,(0.076)$], suggesting that over the sample period, the government has relied on non-concessional foreign loans and/or domestic borrowing to balance its fiscal accounts. This is not surprising. The fiscal literature suggests that non-aid borrowing is typically considered to be financing of the last resort, i.e. is intended to finance an unanticipated gap between expenditure and revenue (McGillivray and Morrissey, 2001b). Since poor aid-recipient developing countries face the greatest difficulty in increasing tax revenue (Keen and Simone, 2004; Teera and Hudson 2004) but face a surge in aid, domestic borrowing could be affected by the way aid is provided.[30] For example, government's domestic borrowing requirements reversed from a saving of 1.6 per cent of GDP in 1997/8 to a borrowing of 0.9 per cent of GDP in 2001/2 due to actual aid disbursements falling short of what had been programmed when the annual budgets were drawn up (Brownbridge and Tumusiime-Mutebile, 2007).

Related to the above, we attempt to establish whether domestic borrowing is avoidable as lower borrowing has been part of aid conditionality since the 1980s (Adam and O'Connell, 1999; Azam and Laffont, 2003). This is accomplished by testing the null hypothesis that the coefficient on *DB* in the fiscal equilibrium in (4.5) is not statistically different from zero (i.e. $H_0: \boldsymbol{\beta}_1 = 0$, whilst keeping all other coefficients, and the trend, unrestricted). This hypothesis is rejected [$\chi^2(4) = 13.768\,(0.008)$], suggesting that avoiding domestic borrowing has not been feasible, a result that could probably be attributed to binding resource constraints. It is worth noting that in Uganda, like in many other developing

[30] Aid agreements often include performance related triggers for disbursement (conditionality). Provisions may therefore reflect the exercise of incentive clauses by donors, in response to events over which the Ugandan government has some direct control and in the context of an on-going aid relationship (O'Connell *et al.*, 2008).

countries, sources of financing fiscal deficits are limited. The tax base is very small due to low incomes per capita and wide spread poverty; capital markets are under developed such that only few firms and households hold government debt papers; and while inflow of the aid has been substantial and expected to play its 'gap-filling' role, disbursement has been characterized by unpredictability and volatility (Brownbridge and Tumusiime-Mutebile, 2007; Easterly, 2006; Bulir and Hamman, 2003).

Hypothesis 3: Aid additionality/illusion

$$(G = -A; TR = DB = 0)$$

In practice, aid packages come with strong pressures to spend (O'Connell *et al.*, 2008). Eifert and Gelb (2005) and Berg *et al.*, (2007) observe that recipient governments that ignore such donor sentiments for too long may face a suspension of aid. Thus, aid inflows are additional if they entail an equivalent increase in government expenditure. However, spending may not increase by the full amount of the aid, either because some aid is directed to other uses such as interest payments or accumulation of reserves (the aid is fungible), or because tax receipts decline or some of the aid 'leaks' (corruption). On the other hand, spending can increase by more than the aid if, for example, governments have to match aid revenue or aid-financed government spending generates subsequent claims on future spending (that may need to be financed by domestic resources), such as the recurrent costs required to maintain an investment. Aid-financed government spending especially social overhead capital (e.g. roads, utilities, building schools or hospitals) often induce an expansion in recurrent spending.[31] The situation where government spending increases by more than the amount of the net aid inflow has been described as aid illusion, such that the impact on spending is more than proportional to aid (McGillivray and Morrissey, 2001).

Although the increase in spending as a ratio of the aid alone may not be demonstrated with precision, inference on aid additionality/illusion hypothesis can be drawn from the long-run coefficients in the fiscal relation as suggested in Martins (2010: 38). The coefficient on

[31] The construction of schools and health units for example has to be accompanied with increased spending on consumables such as text books, recruitment of teachers, enhancement of teacher's salaries, training of health workers, equipment, ambulances and medicines etc.

government spending is less than 1 (about 0.63), suggesting aid is less than additional and thus, precludes aid illusion. However, since this cannot be demonstrated with precision (i.e. not possible to ascertain the proportion of spending due to aid alone), we treat this result with reservation. In fact, as we model the fiscal relationship any observed effect of aid on spending is mediated by changes in borrowing capacity, noting that low-income countries in general have limited ability to affect tax revenue (Keen and Simone, 2004; Teera and Hudson, 2004) but can readily alter borrowing (Morrissey, 2012).

Our estimated long-run coefficients show that a 1 million Uganda shillings (UGX) increase in the amount of aid disbursed results in UGX 614,349.78 increase in total public spending. Thus, about 61 per cent of incremental aid was spent, suggesting that spending was less than proportional to aid over the period 1972-2008. This is consistent with the findings of Mugume (2008), Foster and Killick (2006) and McGillivray and Morrissey, 2004).[32] A formal test of whether *G* and *A* coefficients in the fiscal equilibrium in (4.5) are equal and opposite (i.e. $H_0 : \beta_2 = 1, \beta_3 = -1$, $\beta_1 = 0; \beta_4 = 0$) (albeit keeping the trend unrestricted in the long-run relation) is also rejected [$\chi^2(4) = 12.186$ (0.016)]. This evidence is at variance with the flypaper effect as represented by the World Bank (1998).[33] A combination of various factors caveats this finding.

The most obvious being that we use DAC data on aid, which overstates not only the amount of aid actually spent in Uganda (some technical cooperation is spent in the donor country) but also the amount delivered through the budget (aid that does not go through the government cannot appear as government spending). Given this, it is unlikely that any more than 61 per cent of the DAC measure of aid to Uganda goes through the budget (to the extent that many donors retain control over project spending, the proportion could be considerably less). Our estimates are consistent with all aid to the government being spent (i.e. aid is fully additional), and does not preclude aid illusion. Also, the concessionality implicit in debt relief or write-offs is recorded as ODA grants by the donors even though they do not give more money to Uganda. Furthermore, the preceding conclusions are based

[32] About 63 per cent of incremental aid was spent over the period 1966-2006 (Mugume, 2008), Foster and Killick (2006) estimate the same at 74 per cent during 1999-2002 period while McGillivray and Morrissey (2004) put it at an average of 70 per cent over 2001-07.

[33] The flypaper effect is a term used in the fiscal federalism literature to capture situations where ''a higher tier of government provides a grant to a lower tier of government, with the result that lower tier expenditure increases by more than the amount of the grant (Barnett, 1993). In this way, the grant is used to expand the public budget'' (Dollery and Worthington, 1996 cited in McGillivray and Morrissey, 2000: 420).

on estimates in which normalization is on total public spending and as such ignore indirect feedback effects operating through the system.

It could also be due to a time lag between aid flows being received and the actual expenditure (low absorptive capacity of the government budget). Foster and Killick (2006) argue that only 74 per cent of the increase in aid during 1999-2002 was spent by the government, of which only 27 per cent was absorbed in higher aggregate spending on goods and services in the economy.[34] Also, part of the aid is used to reduce borrowing because the *IMF* has often required reductions in borrowing as a *quid pro quo* for increased aid, some is held in Bank of Uganda (BOU) as foreign exchange reserves (Berg *et al.*, 2010: 4; Brownbridge and Tumusiime-Mutebile, 2007: 208; Foster and Killick, 2006: 14) and we may not preclude the possibility that some 'leaks', so not all the aid is used to support spending.

As Brownbridge and Tumusiime-Mutebile (2007) argue, holding any surge in aid in foreign exchange reserves has, in part been Uganda's macroeconomic management strategy of large scale aid inflows but also importantly because of the concerns that aid flows will not be a permanent budget resource. So any increase in spending due to incremental aid is cautiously implemented to avoid slipping into a fiscal crisis although such fears wouldn't arise if donors could make credible commitments to provide predictable long-term support (O'Connell *et al.*, 2008).

> ''*The key problem for fiscal vulnerability is not short-term volatility, but the danger that the large increase in aid flows to Uganda which occurred after 1998/9 will not prove sustainable: i.e. they will not represent a permanent budget resource''* (Brownbridge and Tumusiime-Mutebile, 2007: 208).

Donor aid is both volatile and unpredictable (Bulir and Hamman, 2003).[35] Disbursements of budget support for example fell short of the budgeted amount by 54 per cent in 1999/2000, by 30 per cent in 2000/1, by 38 per cent in 2001/2 and by 10 per cent in 2003/4

[34] Absorption is the widening of the current account deficit (excluding aid) due to more aid while spending is the widening of the fiscal deficit (excluding aid) due to incremental aid (Hussain *et al.*, 2009; Foster and Killick, 2006: 3)

[35] O'Connell and Soludo (1999) show that aid flows are affected by business-cycle conditions within donor countries and Fleck and Kilby (2006a, 2006b) show that party transition in the US presidency affect not only bilateral US flows but also the allocation of World Bank aid.

and exceeded the budgeted amount by 2 per cent in 2002/3 (Brownbridge and Tumusiime-Mutebile, 2007). This notwithstanding, a 'use-it-or-lose-it constraint hangs over aid flows (O'Connell *et al.*, 2008) such that spending cautiously in the current period amounts to risking a reduction in the future flows (Eifert and Gelb, 2005). Therefore, as spending pressures are intrinsic to the aid relationship, aid surges carry with them an expectation of macroeconomic repercussions and potential macroeconomic management problems (subjects beyond the scope of this paper but appropriate for further country specific research).

Hypothesis 4: Revenue displacement

$$(A = -TR\,; G = DB = 0)$$

A particular concern of the donors is that aid may discourage incentives to increase tax effort in poor aid dependent countries (Franco-Rodriguez and Morrissey, 1998: 1243). However, addressing the tax effect associated with aid tend to be difficult as there can be many effects in opposing direction (Morrissey, 2012). Economic liberalization policies associated with aid conditionality tend to reduce tax revenue (Greenaway and Morrissey, 1993). For example, reforms such as trade liberalization erode the revenue from 'easy to collect' taxes such as tariffs (Aizenman and Jinjarak (2006, 2009 cited in Morrissey, 2012). Moreover, tax reforms that may ultimately replace the lost revenue through 'hard to collect' taxes, such as VAT take some time to become fully operational and may need significant investment in tax collection and resources for monitoring and enforcement. Baunsgaard and Keen (2005) cited in Morrissey (2012) show that periods of economic policy reforms in developing countries tend to be associated with reductions in the tax/GDP ratio, especially for the poorest countries, noting that these are the very periods that tend to be associated with aid episodes. Thus, a negative correlation between aid and tax ratios may be due to aid conditionality, but not a behavioural effect of aid reducing tax effort.

Also, when tax efforts are fairly high, recipient governments may use the extra fiscal space provided by aid flows to offer tax subsidies to key sectors of the economy or reduce tax induced distortions and crowd in private investment (Martins, 2010; Fagernäs and Schurich, 2004). In this case, aid has a behavioural effect on the tax rates and may reduce tax effort, although such reductions may not necessarily be undesirable. However, studies on the fiscal effect of aid and on the determinants of tax/GDP ratios do not provide solid evidence that aid has a behavioural effect on tax effort. Probably because the repayment obligation of aid grants and aid loans differ[36], Gupta *et al.* (2004) find that aid grants have a negative effect on tax effort while loans encourage tax effort. On the contrary, Clist and Morrissey (2011) find no robust evidence for a negative effect of aid grants on the tax/GDP ratio. Similarly, Morrissey *et al.* (2007) find no evidence for an effect of aid on tax effort.

On the other hand, some of the policy conditions attached to aid have the aim of increasing the tax base, tax collection efficiency, and tax rates (Morrissey, 2012: 11-2). Evidence shows that since the mid-1980s, aid has been associated with conditions including measures to increase tax revenue (Clist and Morrissey, 2011), and aspects of governance (Brun *et al.*, 2009 cited in Morrissey 2012).

Therefore, as there tends to be many effects of aid on tax revenue but in opposing directions, the actual effect is for empirical evidence to resolve. We test the hypothesis that aid displaces tax effort, i.e. the hypothesis that the coefficients on *A* and *TR* in (4.5) (whilst keeping the trend term unrestricted) are equal and opposite [i.e. $H_0 : \beta_3 = 1, \beta_4 = -1$, $\beta_1 = 0; \beta_2 = 0$] using the Ugandan fiscal data. This hypothesis is not supported [$\chi^2(4) = 21.470$ (0.000)], which suggests that aid to Uganda has not had a pervasive dampening effect on domestic revenue effort in the long-run. Since low income countries are severely constrained in their ability to increase tax/GDP ratios, it may be the case that Uganda is raising as much tax revenue as is feasible because of concerns that the aid will not be sustained or because there are associated public finance management reforms and revenue collection efficiency. A similar result has been found in Martins (2010) for Ethiopia and in Osei *et al.* (2005) for Ghana. In Kenya, no significant effect was found (Morrissey *et al.*, 2007).

[36] Aid grants create no repayment obligation (so they have a negative effect on tax effort, while aid loans have repayment obligation (so they encourage tax effort (Gupta *et al*., 2004).

Hypothesis 5: Aid-domestic borrowing 'perfect substitution'

$$(A = -DB \; ; G = TR = 0)$$

The relationship between aid and non-aid borrowing is not clear. Fiscal theory would suggest that domestic borrowing is a consequence of the cost of aid unpredictability and volatility (Bulir and Hamman, 2003) such that aid flows and domestic borrowing could be viewed as substitutes and would be negatively correlated. But some empirics show that aid facilitates increased non-aid borrowing (Franco-Rodriguez *et al.*, 1998) in which case, it is plausible to think in terms of the vicious circle in which aid flows are diverted to retire onerous public loans, especially the 'odious debt' (debt servicing), but this makes it easier to borrow again in the future. Alternatively, as McGillivray and Morrissey (2001) argue, the knowledge that a government is in receipt of aid allows it to increase borrowing, as creditors perceive that it has the ability to service debts.

Besides, certain aid expenditures require matching spending by the recipient or spending officials may misperceive their budget constraint given incremental aid (especially in an environment of poor public expenditure management) – aid illusion arises and the direct link between aid and spending is weakened. McGillivray and Morrissey (2001a) argue that even if recipient governments do not have 'malicious' intentions, aid can be associated with expenditure increases in excess of the aid itself, and this may lead to the need for borrowing to finance the deficit.

The hypothesis of whether aid and non-aid borrowing are perfect substitutes, i.e. whether *DB* and *A* coefficients in the fiscal equilibrium in (4.5) are equal and opposite ($H_0 : \beta_1 = -1, \beta_3 = 1, \beta_2 = 0, \beta_4 = 0$), keeping the trend unrestricted is tested. Although the hypothesis is weakly rejected, it is not supported [$\chi^2(4) = 7.992\,(0.092)$] and suggests that these effects take place, but is not persistent, i.e. domestic borrowing is a response to shortfalls in foreign aid (and is repaid when there is good performance in aid flows). This result is consistent with the evidence for Ethiopia (Martins, 2010). Although for Ghana, this hypothesis is not tested, simulation results show that aid significantly reduced domestic borrowing because *IMF* demanded borrowing reductions in the 1980s (Osei *et al.*, 2005: 5).

Conversely, the alternative hypothesis that aid and domestic borrowing are complements, i.e. whether *DB* and *A* coefficients in (4.5) are equal ($H_0 : \beta_1 = 1, \beta_3 = 1, \beta_2 = 0, \beta_4 = 0$), keeping the trend coefficient unrestricted in the long-run fiscal relation is also not supported [$\chi^2(4) = 10.247$ (0.036)]. Although this could not be rejected in the case of Pakistan (Franco-Rodriguez *et al.*, 1998), it may not be surprising for Uganda. It could be due to the benefits of the HIPC debt relief that Uganda qualified for in 1997/98 and a series of debt rescheduling packages that followed thereafter.

Table 4.11: Hypotheses Tests on the Fiscal Effect of Aid: L-R test, $\chi^2(4)$.
Restrictions derive from Equation (7): $\beta_1 DB + \beta_2 G + \beta_3 A + \beta_4 TR + \beta_0 t = I(0)$

Testable Fiscal Hypotheses		Statistics	*p-value*	Inference
Budget Constraint	$\beta_1 = -1, \beta_2 = 1, \beta_3 = -1, \beta_4 = -1$	6.915	0.140	Accept
Balanced Budget	$\beta_2 = 1, \beta_3 = -1, \beta_4 = -1; \beta_1 = 0$	8.458	0.076	Reject
Aid additionality/ Illusion	$\beta_2 = 1, \beta_3 = -1, \beta_1 = 0; \beta_4 = 0$	12.186	0.016	Reject
Tax Revenue Displacement	$\beta_3 = 1, \beta_4 = -1, \beta_1 = 0, \beta_2 = 0$	21.439	0.000	Reject
A-DB 'perfect substitutes'	$\beta_1 = -1, \beta_3 = 1, \beta_2 = 0, \beta_4 = 0$	7.992	0.092	Reject
A-DB 'complement'	$\beta_1 = 1, \beta_3 = 1, \beta_2 = 0, \beta_4 = 0$	10.247	0.036	Reject

Notes: Test results are robust to small sample bias correction. Bartlett correction factor = 1.461. The deterministic time trend is unrestricted in all these tests to measure non-zero average linear growth rates.

The preceding investigations on the potential long-run relation among the fiscal variables provide interesting insights into fiscal dynamics in Uganda. Existence of a budget constraint and not a balanced budget is supported. Thus, while aid flows to Uganda have been substantial, the resource gap has remained big and is often reduced by domestic borrowing (which is repaid when revenues are health). Aid induces increased tax effort, reduces domestic borrowing and increases public spending. This result suggests that aid or strictly policy conditions attached to aid were associated with or caused beneficial policy responses in Uganda. Our evidence suggests that a 1 million UGX increase in the DAC aid disbursed results in UGX 614,350 increase in total public spending. Although spending is less than proportional to incremental aid, it is more than what it could have been in the absence of aid. The evidence that a budget constraint hangs over the budget implementation suggests that aid to the government (budget) is likely to be fully additional and it is even possible that total spending increases by more than aid actually delivered through the budget. So aid additionality/illusion hypothesis remains inconclusive given the nature of the aid measure used. Moreover, as noted in Osei *et al.*(2005), our conclusion is subject to a distinction between aid as finance from aid as policy condition, i.e. if one could infer that good policy (say improved public finance management) means that aid was used better, or that aid promoted good policy. Regrettably, neither distinction has been possible in our case. Ultimately, it could be the case that in fiscal terms, aid appears to have been utilized sensibly.

As demonstrated in the empirical CVAR specification in equation (4.3), the DGP cannot allow for the analysis of short-run dynamics and this has a bearing on the simulation of the impulse response functions. It implies that the chain reaction associated with the knock-on and feedback effects (save for the time it would take for the system to stabilize) following a shock of known size to aid cannot be simulated. Instead, it is the interactions of the long-run parameters of the model that are simulated, but this has comprehensively been analysed in a battery of hypotheses tests, so the simulations are not intuitively relevant and are not reported. Most importantly, the hypothesis of aid exogeneity is not statistically supported. As aid impact has been the main theme in this study and aid is not exogenous to the estimation of the long-run parameters, the impulse responses could not be statistically legitimate (Pesaran *et al.*, 2000). In an alternative approach, we extend the above CVAR analysis and delve into the identification of common trends, permanent and transitory shocks in the system (Juselius, 2006: 84-85).

4.7 The Common Trends Representation

In this section we consider the Granger Representation of the CVAR model in (4.3) to decompose y{t} into two parts: A unit root process into pushing forces (the common trends) and a stationary part (the cointegrating relation). We then explore the duality property between the $\mathbf{\Pi}$ matrix and the long-run impact matrix (the C-matrix) to decompose the system into transitory and permanent components (Gonzalo and Granger, 1995). The permanent components then represent the budgetary equilibrium while the transitory components capture deviations from equilibrium. Now consider a VAR(1) model in (4.3), with linear trend restricted to lie in the cointegrating relation to avoid quadratic trends in the data.

$$\mathbf{\Delta y_t} = \boldsymbol{\alpha\beta}'\mathbf{y_{t-1}} + \boldsymbol{\mu}_0 + \boldsymbol{\alpha\beta}'\mathbf{t} + \boldsymbol{\varepsilon}_t, \qquad t = 1,...,T$$

where $\varepsilon_t \sim i.i.d(0,\Sigma)$ and $\boldsymbol{\mu}_0$ is an unrestricted constant.

With an initial value y_0, we note that $\boldsymbol{\alpha}_\perp$ has full rank and is of dimension $p \times (p-r)$ so that $\boldsymbol{\alpha}'\boldsymbol{\alpha}_\perp = 0$ holds and rank$(\boldsymbol{\alpha},\boldsymbol{\alpha}_\perp) = p$.

Given the unique relationship between $\boldsymbol{\alpha}$ and $\boldsymbol{\alpha}_\perp$ (i.e. $\boldsymbol{\alpha}'\boldsymbol{\alpha}_\perp = 0$), and $\boldsymbol{\beta}$ and $\boldsymbol{\beta}_\perp$ (i.e. $\boldsymbol{\beta}'\boldsymbol{\beta}_\perp = 0$), it follows that

$$\boldsymbol{\beta}_\perp(\boldsymbol{\alpha}'_\perp\boldsymbol{\beta}_\perp)^{-1}\boldsymbol{\alpha}'_\perp\mathbf{y_t} + \boldsymbol{\alpha}(\boldsymbol{\beta}'\boldsymbol{\alpha})^{-1}\boldsymbol{\beta}' = \mathbf{I} \qquad (4.6)$$

Using this identity, the *p*-dimensional vector $\mathbf{y_t}$ can then be decomposed as follows

$$\mathbf{y_t} = \underbrace{\boldsymbol{\beta}_\perp(\boldsymbol{\alpha}'_\perp\boldsymbol{\beta}_\perp)^{-1}}_{sp(\beta_\perp)}\boldsymbol{\alpha}'_\perp\mathbf{y_t} + \underbrace{\boldsymbol{\alpha}(\boldsymbol{\beta}'\boldsymbol{\alpha})^{-1}}_{sp(\alpha)}\boldsymbol{\beta}'\mathbf{y_t} \qquad (4.7)$$

Where

a) $\boldsymbol{\beta}'\mathbf{y_t}$ in $sp(\alpha)$ cointegrating relations, i.e. pulling forces are

$$\boldsymbol{\beta}'\mathbf{y_t} = (\mathbf{I} + \boldsymbol{\alpha\beta}')\boldsymbol{\beta}'\mathbf{y}_{t-1} + \boldsymbol{\beta}'\boldsymbol{\mu} + \boldsymbol{\beta}'\boldsymbol{\varepsilon}_\mathbf{t} \tag{4.8}$$

Noting that the Eigen value of $(\mathbf{I} + \boldsymbol{\beta}'\boldsymbol{\alpha})$ should be inside of the unit circle when $\beta' y_t$ is stationary, and

b) $\boldsymbol{\alpha}'_\perp \mathbf{y_t}$ in $sp(\boldsymbol{\beta}_\perp)$ common trends, i.e. pushing forces are

$$\boldsymbol{\alpha}'_\perp \mathbf{y_t} = \underbrace{\boldsymbol{\alpha}'_\perp \sum_{i=1}^{t} \boldsymbol{\varepsilon}_\mathbf{i}}_{\substack{common\\stochastic\\trends}} + \underbrace{\boldsymbol{\alpha}'_\perp \boldsymbol{\mu}\mathbf{t}}_{\substack{\text{deterministic}\\\text{trend}}} + \boldsymbol{\alpha}'_\perp \mu_\mathbf{0}, \; \boldsymbol{\mu} = \boldsymbol{\alpha\beta}' \tag{4.9}$$

Substituting (4.8) and (4.9) into (4.7), we obtain moving average representation corresponding to (4.3).

$$\mathbf{y_t} = \mathbf{C}\sum_{i=1}^{t} \boldsymbol{\varepsilon}_\mathbf{i} + \mathbf{C}\mu t + \mathbf{C}\mu_0 + \tilde{Y}_t \tag{4.10}$$

Where

$\mathbf{C} = \boldsymbol{\beta}_\perp (\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp)^{-1} \boldsymbol{\alpha}'_\perp$; $C\mu$ measures the slope of the linear trends in y_t, $C\mu_0$ measures the initial values, and $\tilde{Y}_t$ represents the stationary process in y_t.

If we define $\tilde{\boldsymbol{\beta}}_\perp = \boldsymbol{\beta}_\perp (\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp)^{-1}$ or alternatively $\tilde{\boldsymbol{\alpha}}_\perp = \boldsymbol{\beta}_\perp (\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp)^{-1}$, then, it is possible to re-write the $\mathbf{C}$-matrix as a product of two matrices, i.e. $\mathbf{C} = \tilde{\boldsymbol{\beta}}_\perp \boldsymbol{\alpha}'_\perp$ (in case of the former formulation. This is similar to $\prod = \boldsymbol{\alpha\beta}'$. So the decomposition of $\mathbf{C} = \tilde{\boldsymbol{\beta}}_\perp \boldsymbol{\alpha}'_\perp$ resembles the decomposition of $\prod = \boldsymbol{\alpha\beta}'$, hence the duality property between the $\mathbf{C}$-matrix and the $\boldsymbol{\Pi}$ matrix. In the $\boldsymbol{\Pi}$ matrix form, $\boldsymbol{\beta}$ determines the common long-run relations and $\boldsymbol{\alpha}$ load deviations from equilibrium for correction, while in the $\mathbf{C}$- matrix form, $\boldsymbol{\alpha}_\perp$ determines the common stochastic trends driving the long-run relation out of equilibrium and $\boldsymbol{\beta}_\perp$ defines the loadings to the $p - r$ common stochastic trends, $\boldsymbol{\alpha}'_\perp \sum_{\mathbf{i=1}}^{\mathbf{t}} \boldsymbol{\varepsilon}_\mathbf{i}$. The only important difference is that in the $\mathbf{C}$- matrix, $\tilde{\boldsymbol{\beta}}_\perp$ is a function not only of $\boldsymbol{\beta}_\perp$, but also of $\boldsymbol{\alpha}_\perp$. Based on the $\mathbf{C}$ - matrix, we decompose the stochastic driving forces in the system into permanent and transitory effects (and hence determine which shocks have long-run impact on the variables in the system).

Table 4.12: The MA-Representation and Decomposition of the Trend (Unrestricted Model)

```
The Coefficients of the Common Trends:

RE-NORMALIZATION OF ALPHA Orthogonal:

ALPHA Orthogonal (transposed)
       DB     G      A      TR
CT(1) 0.969 -0.093  0.229 0.000
CT(2) 0.093 -0.721 -0.686 0.000
CT(3) 0.120  0.359 -0.361 0.852

ALPHA Orthogonal (transposed)
         DB      G     A     TR
CT(1)   3.012  0.000 1.000 0.000
       (1.492) (.NA) (.NA) (.NA)
CT(2)  -2.996  1.000 0.000 0.000
      (-1.579) (.NA) (.NA) (.NA)
CT(3)   2.683  0.000 0.000 1.000
       (1.493) (.NA) (.NA) (.NA)

The Loadings to the Common Trends, BETA_ORT(tilde):
     CT1      CT2      CT3
DB   0.040   -0.066    0.143
    (2.400) (-2.400)  (2.400)
G    0.121    0.802    0.429
    (2.899) (11.766)  (2.899)
A    0.878    0.199   -0.432
   (16.125)  (2.240) (-2.240)
TR  -0.109    0.177    0.616
   (-3.387)  (3.387)  (5.425)

The Long-Run Impact Matrix, C
      DB       G        A        TR
DB   0.704   -0.066    0.040    0.143
    (5.708) (-2.400)  (2.400)  (2.400)
G   -0.887    0.802    0.121    0.429
   (-2.899) (11.766)  (2.899)  (2.899)
A    0.892    0.199    0.878   -0.432
    (2.240)  (2.240) (16.125) (-2.240)
TR   0.794    0.177   -0.109    0.616
     (3.387)  (3.387) (-3.387)  (5.425)

The Linear Trends in the Levels, C*MJU
   DB       G       A       TR
 -47.943 698.682 455.424 598.954

Residual S.E. and Cross-Correlations
       DB          G          A          TR
     782.5694  1940.3185  2525.3800  1487.3711
DB   1.000
G    0.377     1.000
A   -0.205     0.115      1.000
TR  -0.762     0.136     -0.187     1.000
```

Transitory shocks (*r*) have no long-run impact on the variables in the system and are defined by zero (insignificant) columns in the $\mathbf{C}$ - matrix. Permanent shocks (*p-r*) have a significant long-run impact on the variables of the system, and are defined as non-zero (significant) columns in the C-Matrix. The extent to which each variable in the system has been influenced by any of the cumulated empirical shocks is given by the rows of the C-Matrix. Test results for the unrestricted moving average representation and decomposition of the trend are given in Table 4.12.

With $p = 4$ and a cointegration rank of $r = 1$, results in the table show that we have $r = 1$ cointegrating relation and $p - r = 3$ common stochastic trends driving the long-run relations out of equilibrium. The common stochastic trends are given by ALPHA Orthogonal and beta_ort(tilde) define their loadings. In the unrestricted estimates in Table 4.12, it appears that the first common stochastic trend is shocks to aid with a small (potentially insignificant) effect from domestic borrowing, while the second and third common stochastic trends are respectively shocks to government spending and shocks to tax revenue (each with a small and potentially insignificant effect from domestic borrowing). As the loadings in beta_ort(tilde) (given by $\tilde{\boldsymbol{\beta}}_\perp = \boldsymbol{\beta}_\perp\left(\boldsymbol{\alpha}'_\perp \boldsymbol{\Gamma} \boldsymbol{\beta}_\perp\right)^{-1}$) define how the variables in the system react to the common stochastic trends, the results show that atleast each variable in the system is affected by the individual cumulated empirical shocks.

However, estimates of $\tilde{\boldsymbol{\beta}}_\perp$ and $\boldsymbol{\alpha}_\perp$ in Table 4.12 are unrestricted, and so the common trend estimates are not uniquely determined. From the results in Table 4.9, we see that the null hypothesis of long-run (weak) exogeneity of domestic borrowing could not be rejected. Clearly, this corresponds to a zero row in $\boldsymbol{\alpha}$, which, by construction corresponds to a unit vector in $\boldsymbol{\alpha}_\perp$. A unit vector in $\boldsymbol{\alpha}_\perp$ means that one of the common stochastic trends in the model is given by the cumulated shocks to the weakly exogenous variable, so the cumulated residuals to long-run weakly exogenous variable (domestic borrowing in our case) can be considered a common stochastic trend even though the results in Table 4.12 show that the variable itself is not a common stochastic trend (see Juselius 2006: 263). Hence, the 3 common stochastic trends in the model are given by the cumulated shocks to domestic borrowing, i.e. domestic borrowing is purely pushing the system as the shocks to it cumulate into common stochastic trends in the model and it does not adjust to the equilibrium error.

This notwithstanding, the $sp(\boldsymbol{\beta}_{\perp})$ and $sp(\boldsymbol{\alpha}_{\perp})$ is uniquely determined and so the estimated $\mathbf{C}$ - matrix is unique. This is similar to $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ where the $\boldsymbol{\Pi}$ matrix was uniquely estimated, even though the unrestricted $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ vectors were not) (Juselius, 2006: 258). A column-wise inspection of the $\mathbf{C}$ - matrix shows there could be borderline significant coefficients in the tax revenue column, with only own coefficient being clearly significant, while there is atleast one variable with a significant long-run impact in the columns to domestic borrowing, spending and aid. As the null hypothesis for a unit vector in $\boldsymbol{\alpha}$ could not be rejected for tax revenue, it is purely adjusting to the only cointegrating relation and shocks to this variable only have transitory effects. Together, these results suggest that shocks to tax revenue have no lasting effect on the variables in the system, while shocks to domestic borrowing, spending and aid do have a permanent effect. This finding that the pulling forces are primarily given by empirical shocks to tax revenue is consistent with our previous findings and confirms that budget spending plans in Uganda for the sample period considered here have been adjusting to, but not pushing tax revenue. Conversely, empirical shocks to domestic borrowing, spending and aid are the pushing forces of the system. Also reported in the table are estimates of the long-run covariance matrix and the slopes of the common trends.

In the next step, we proceed to just-identify the $p-r$ common trends by imposing an identifying weak exogeneity restriction on domestic borrowing (similar to restrictions on $\boldsymbol{\alpha}$ in Section 4.6.2) in one of the common trends without changing the value of the likelihood function. Thus, the common trends are just-identified by this operation and no testing is involved (*ibid*: 257). Further details of this form of operation are provided in Juselius (2006: 262-64). The restricted moving average representation and decomposition of the trend test results are given in Table 4.13.

Table 4.13: The MA-Representation and Decomposition of the Trend (Restricted Model)

```
The Coefficients of the Common Trends:

RE-NORMALIZATION OF ALPHA Orthogonal:

ALPHA Orthogonal (transposed)
       DB     G      A      TR
CT(1) 0.000 -0.713 -0.702 0.000
CT(2) 1.000  0.000  0.000 0.000
CT(3) 0.000  0.458 -0.465 0.757

ALPHA Orthogonal (transposed)
       DB     G     A      TR
CT(1) 0.000 1.000  0.985 0.000
      (.NA) (.NA)  (.NA) (.NA)
CT(2) 1.000 0.000  0.000 0.000
      (.NA) (.NA)  (.NA) (.NA)
CT(3) 0.000 0.000 -1.210 1.000
      (.NA) (.NA)  (.NA) (.NA)

The Loadings to the Common Trends, BETA_ORT(tilde):
     CT1     CT2      CT3
DB  0.000    1.000    -0.000
   (0.000)  (6.785) (-0.000)
G   0.737   -0.701    0.488
   (7.662) (-2.736)  (2.736)
A   0.267    0.712   -0.496
   (2.008)  (2.008) (-2.008)
TR  0.323    0.861    0.400
   (4.037)  (4.037)  (2.692)

The Long-Run Impact Matrix, C
      DB       G        A        TR
DB   1.000   -0.000    0.000   -0.000
    (6.785) (-0.000)  (0.000) (-0.000)
G   -0.701    0.737    0.135    0.488
   (-2.736)  (7.662)  (2.736)  (2.736)
A    0.712    0.267    0.863   -0.496
    (2.008)  (2.008) (12.654) (-2.008)
TR   0.861    0.323   -0.166    0.400
    (4.037)  (4.037) (-4.037)  (2.692)

The Linear Trends in the Levels, C*MJU
   DB       G       A       TR
 -31.893 692.154 462.547 623.001

Residual S.E. and Cross-Correlations
       DB         G          A          TR
    1041.8890  1811.6333  2506.4927  1508.6730
DB   1.000
G   -0.325     1.000
A    0.093     0.187      1.000
TR   0.739     0.239     -0.246     1.000
```

From the results of the restricted model in Table 4.13, one of the three common trends is now identified as cumulated shocks to domestic borrowing ($\sum_{i=1}^{t} \hat{\varepsilon}_{DB,i}$), i.e. the weakly exogenous variable. Thus, the restriction on $\hat{\varepsilon}_{DB,i}$ is just-identifying, i.e. the weak exogeneity restriction on $\boldsymbol{\alpha}_{\perp,2}$ imply that $\tilde{\boldsymbol{\beta}}_{\perp,2}$ and the first column of the $\mathbf{C}$ - matrix ($\sum \hat{\boldsymbol{\varepsilon}}_{\mathbf{DB}}$) are identical, so is the third column ($\sum \hat{\boldsymbol{\varepsilon}}_{TR}$) of the $\mathbf{C}$ - matrix and $\tilde{\boldsymbol{\beta}}_{\perp,3}$, while $\tilde{\boldsymbol{\beta}}_{\perp,1}$ is approximately equal to the second column ($\sum \hat{\boldsymbol{\varepsilon}}_{G}$) of the $\mathbf{C}$ - matrix. Compared to the $\mathbf{C}$ - matrix in unrestricted model in Table 4.12, we note that the coefficients to tax revenue in the restricted model have now become less significant and those of domestic borrowing generally more significant. In conclusion, the weak exogeneity identifying restriction on domestic borrowing removes the previous highly significant coefficient in the tax revenue column, although the conclusion regarding adjustment is unaltered.

4.8 A disaggregated Variant Model

Equation (4.4) assumed that all forms of public spending have an equal effect on the other items in the budget. However, as we would like to offer insights into the disaggregated spending impact of aid, disaggregation of *G* into current consumption (*GC*) and development (*GK*) spending as a refinement of (4.4) is warranted. So a disaggregate variant of (4.4) is also analysed and the resulting long-run estimates are set out in (4.11) [t-ratios in parentheses]:

$$\underset{}{DB_t} = \underset{(5.029)}{1.428GK_t} - \underset{(-1.376)}{0.110GC_t} - \underset{(-3.676)}{0.269A_t} - \underset{(-5.571)}{0.541TR_t} + \underset{(9.109)}{365.876Trend} \qquad (4.11)$$

Similar to the aggregate model, these estimates suggest, *ceteris paribus*, a negative correlation of aid and tax revenue with domestic borrowing and a positive correlation of domestic borrowing with capital spending. Thus, the same interpretation as in the aggregate model holds for corresponding correlations. Current spending is insignificant, suggesting it could be excludable from the long-run relation. So we re-estimate (4.11) excluding *GC* and report results in (4.12) [t-ratios in parentheses].

$$DB_t = \underset{(4.890)}{1.282GK_t} - \underset{(-3.598)}{0.253A_t} - \underset{(-7.002)}{0.598TR_t} + \underset{(7.211)}{344.730Trend} \qquad (4.12)$$

Given the results in (4.12) when *GC* is excluded, coefficients are not significantly different from those in (4.11) suggesting *GC* may be ruled out from the long-run relation. So comment is restricted to capital spending coefficient, as the rest of the coefficients are consistent with those in the aggregate model. In the long-run, domestic borrowing is more closely linked to capital spending. We however caution that care should be exercised when interpreting this result. It may be a measurement problem where the aggregation of productive (investment) expenditure includes substantial non-productive (consumption) expenditure (Kweka and Morrissey, 2000). This notwithstanding, we have tested the hypothesis that *GC* and *GK* coefficients in (4.13) are equal (LR test [$\chi^2(5) = 26.774$ (0.000)]. Thus, the hypothesis of equal coefficients is not supported.

Beyond the coefficient signs and magnitudes depicted in Equation (4.11), the same relation is particularly suited for a test of aid fungibility. Aid is said to be fungible if recipients fail to use it in a manner intended by donors (World Bank, 1998; Franco-Rodriguez and Morrissey, 1998). As noted in McGillivray and Morrissey (2004), fungibility falls in three important categories – general fungibility, sector fungibility and additionality (also see Morrissey 2012: 2) but here we concentrate on general fungibility because of the obvious data problems. The assumption underlying general fungibility is that donors grant aid to finance public investment and fungibility arises when recipients divert these funds to finance government consumption spending (Franco-Rodriguez and Morrissey, 1998). This is under the assumption that such diversion reduces the effectiveness of aid (World Bank 1998 in Morrissey 2012). However, consumption spending is a necessary complement to investment spending, so the assumption that general fungibility diminishes the effectiveness of aid may be misleading (Morrissey 2012: 3). Analogously, fungibility is said to occur if aid, tied to a sector is used to finance a project that would otherwise be funded by tax revenue, releasing domestic resources for spending in some other sector. In this case, fungibility arises because donors and recipients have differing expenditure allocation preferences (McGillivray and Morrissey, 2000).

The question of whether aid has been fungible or not, and whether fungibility limits aid effectiveness remains one of the most contentious of the fiscal hypotheses in fiscal literature (see Morrissey, 2012 for an adequate summary on the debate). Unfortunately, data limitations or specifically, lack of appropriate data as one must know how much of the aid the donors intended to be spent on each of the expenditure heading (Morrissey 2012; McGillivray and Morrissey, 2004) largely constrains inference on aid fungibility. Morrissey (2012: 4) terms the evidences in most of (if not all) the previous studies that he adequately reviews as 'imprecise'. Our study is no exception. Not only were we unable to establish (or even claim to know) how much of the aid donors intended to be spent on each expenditure category, but also, current spending (roughly a key variable for fungibility hypothesis) is not a significant element of the long-run fiscal relation.

4.9 Conclusions and Implications for Policy

This paper assesses the dynamic relationship between foreign aid and domestic fiscal variables in Uganda using annual data over the period 1972 to 2008. Alternative measures of aid were explored to ensure a consistent series and measures of government borrowing were collected to identify the fiscal balance. In line with current methods to investigate the fiscal effects of aid, a cointegrated vector autoregressive (CVAR) model is employed. Attention is paid to features of the data over 1972-79 (a decade of economic collapse and social disorder), and effect of ESAP reform from 1988 (adjustment and post adjustment) and the Museveni regime in Uganda. A summary of the key results is as follows:

Aid and fiscal variables form a long-run stationary relation and dummies do not have a long-run effect (as one would expect). Estimates of this relation reveals that domestic borrowing is negatively correlated with aid and tax revenue but positively correlated with government spending (in general and development spending in particular), and tax revenue is the main driver of budgetary spending plans. A test of structural links between aid and fiscal variables reveals that aid is a significant element of long-run fiscal equilibrium, and the hypothesis of aid exogeneity is not statistically supported. This has important implications regarding the treatment given to aid by the Ugandan budget planners. Either they have a target for aid revenue (such that this expected revenue is incorporated into fiscal planning) or donors incorporate government spending in deciding how much aid to allocate to Uganda or both. Either way, government sets her spending targets according to her own development objectives, and then tries to find aid resources to finance those ambitions, but in the order: domestic revenue, aid, and domestic borrowing.

A number of hypotheses of the long-run effect of aid on fiscal behaviour in Uganda have been tested, and these provided interesting insights into fiscal dynamics in Uganda. Existence of a budget constraint and not a balanced budget is supported, suggesting that while aid flows to Uganda have been substantial, the resource gap has remained big and this is often reduced by domestic borrowing (but repaid when revenues are health). Aid induces increased tax effort, reduces domestic borrowing and increases public spending. Although the increase in spending is less than proportional to incremental aid, there is evidence that a budget constraint hangs over the budget implementation. This suggests that aid to government (budget) is likely to be fully additional and it is even possible that total spending increases by more than aid actually delivered through the budget. The DAC measure used overstates significantly the amount of aid to the budget and part of the aid is used to reduce borrowing while some is held in foreign exchange reserves. Moreover common trends analysis reveals the common stochastic trends as shocks to domestic fiscal variables, namely government spending, domestic borrowing and tax revenue. In addition, shocks to tax revenue are the pulling forces, so budget spending plans has been adjusting to, but not pushing tax revenue and empirical shocks to domestic borrowing, government spending and aid are the pushing forces of the system.

In conclusion, a battery of the fiscal hypotheses tests suggest that aid to Uganda has been associated with long-term higher public spending (i.e. spending is more than what it could have been in the absence of aid), increased tax effort and reduced domestic borrowing. As improved public finance management and reduced domestic borrowing are common policy conditions attached to aid, this suggests that aid was either associated with or caused beneficial policy responses in Uganda. Alternatively, it could be the case that in fiscal terms, aid has been utilized sensibly. This is against the backdrop that a distinction between aid as finance from aid as policy condition has not been possible, and we do not know what donors intended the aid to be used for and the fact that we use the DAC measure of aid. This data draw back in our study merits a careful deeper analysis for Uganda. Nonetheless, the long-run estimates give results that are consistent with and the results from common trend analysis and with observing the data, and are plausible in that they are consistent with what is known about the fiscal impact of aid in some of the previous country specific applications summarised in Table 3.1 and Morrissey (2012).

These results suggest some policy implications. Corroborations from the trend analysis and estimates of the long-run coefficients suggest that domestic borrowing remains responsive to the uncertainty associated with aid inflows. It is therefore crucial for the donors to increase the reliability and predictability of aid in order to improve fiscal planning and reduce the need to resort to costly domestic borrowing. In addition, to the extent that financing is in the order domestic revenue, aid and domestic borrowing, countercyclical aid inflows have the potential to compensate for revenue shortfalls, avoid domestic indebtedness and help smooth public spending plans consistent with Uganda's development goals. Moreover as Morrissey (2012) argues, one way to make inference on the relationship between aid and spending more clear is for donors to coordinate aid delivery systems and also make aid more transparent, i.e. recipients need to know what aid is available to finance spending and whether through donor projects or government budgets.

CHAPTER FIVE

AID, PUBLIC SECTOR AND PRIVATE CONSUMPTION

5.1 Motivation

Standard growth theory posits that fiscal policy has an important role in stimulating investment and economic growth. The belief is that given a right mixture of taxation and spending policies as well as other aspects of fiscal policy, the government can increase the quantity and productivity of aggregate investment (human and physical capital, research and technology) and thus, contribute to overall economic growth (Ram, 1986; Barro, 1990, Barro and Sala-i-Martin, 1992, 1995; Easterly and Rebelo, 1993). But not all aspects of fiscal policy are productive. Government operations are inherently bureaucratic and inefficient, and may retard rather than promote growth (Levine and Renelt, 1992; Landau, 1983). In particular, some expenditures are productive although the taxes required to finance them may create distortions, reducing the private returns to accumulation and therefore have a detrimental effect on economic growth. The conventional wisdom is that productive government spending financed by non-distortionary taxation is growth promoting, but unproductive spending (often interpreted as consumption spending) and distortionary taxes are growth retarding (Barro, 1990). This notwithstanding, it is standard in public sector growth models to feature channels that explicitly incorporate government activities (Barro and Sala-i-Martin, 1995). Aid is not an argument in this model and we do not have time series data on capital or labour, so we adopt a more limited approach to investigate relationships of interest.

We have argued previously, following among others, McGillivray and Morrissey (2001) that most of the aid that is spent in the country is given primarily to the government and that any associated effect of aid on the economy is likely to be mediated by the public sector fiscal behaviour. We have also shown empirically in Chapter 4 that aid to Uganda has in the long-run been associated with increased public spending, increased tax revenue (i.e. these have been more than what they could have been otherwise in the absence of aid) and reduced but not eliminated domestic borrowing. Thus, the link between aid and the public sector behaviour, and fiscal policy and public sector growth models (the standard growth theory above) provides a useful framework and allows for assessment of aid effectiveness from a broader fiscal dimension.

As a source of revenue, aid does not have the price distorting effects of taxes that may reduce growth, and that government spending on public goods and services is expected to be more than what it could have been in the absence of aid. In the former, aid would be expected to have a direct contribution to increased growth (Hansen and Tarp, 2001; Lensink and Morrissey, 2000) and may have positive effects on the private sector and hence promote growth through the latter channel (Mosley, Hudson and Verschoor, 2004; Lin, 1994). The understanding that aid's effect on the economy is mediated by the broader fiscal dimension has not been reflected in standard (cross-country) studies of the growth effect of aid whereas studies of the fiscal effects of aid have rarely considered growth. This chapter extends our fiscal analysis to consider the impact of aid, fiscal variables and exports on growth of private consumption to address the growth response to aid in Uganda.

We have chosen to focus on growth of private consumption to measure the macroeconomic effectiveness of aid because as we have shown in Chapter 2, $Y(GDP) = C + I + G + (X - M)$ in macro accounting terms. Many of the key variables of interest are components of GDP, implying there could be a possible identity problem in estimating any long-run relationship in levels. Moreover, as (Hansen and Tarp, 2001: 7) argue, it is difficult to perceive of aid as a lump-sum transfer, independent of the level of income. This suggests a possible simultaneity bias. To circumvent these problems, we place C (in the above identity) on the left hand side (LHS). This can then be interpreted as capturing how aid mediated through fiscal variables affects private sector growth (and the CVAR approach seems appropriate for such an exercise).[37] The alternative approaches to estimating the growth effect of aid, i.e. single equations raises a likelihood that parameters estimates may suffer from endogeneity bias especially when weak instrumental variables are used. CVAR allows the data to speak freely about the empirical content of the model without compromising the high scientific standards. Importantly, instead of assuming aid exogeneity/endogeneity, all variables, including aid are modelled jointly as a system of equations and the question of whether aid is endogenous or exogenous is tested. This makes the use of CVAR all but appropriate for the task at hand.

[37] See Juselius *et al*. (2011: 2) for a detailed justification in favour of the technique and is adopted here on exactly these grounds.

The relation(s) to be investigated assumes that aid and government spending capture the effect of public investment and public wages, taxation captures distortions due to government, and exports capture private sector competitiveness. Imports are omitted because they are financed using foreign exchange from exports and aid which are explicitly modelled. As Morrissey *et al.* (2007); Osei *et al*. (2005); and McGillivray and Morrissey, (2000) have argued, although these channels are important in understanding the growth response to aid, they have too often been ignored and largely overlooked in the literature. Moreover, with particular reference to Uganda, no study to our knowledge has broadened the empirical search for aid effectiveness as in this study.

The rest of the Chapter is organized as follows. Section 5.2 considers and reviews the literature on comparable SSA time series country studies while the determination of the DGP and cointegration analysis is described in Section 5.3. The empirical CVAR model is given in Section 5.4, and estimates of the long-run growth effect of aid is presented in Section 5.5. A disaggregated variant model is discussed in Section 5.6 and finally, Section 5.7 draws the conclusions and implications.

5.2 Literature Review

The literature on aid effectiveness, typically judged in terms of aid's effect on economic growth is largely in cross-country econometric studies (these are reviewed in Chapter one). Approximating cross-country evidence to what is inherently a time series phenomenon is a valuable exercise that allows one to attempt to draw general conclusions (Lloyd *et al.*, 2001: 1). However, countries are heterogeneous and country-specific factors may promote or constrain aid effectiveness. As Doucouliagos and Paldam (2008) argue, aid-growth results are associated with regional differences, and this could be of a serious concern when it comes to country-level differences. Thus, one major limitation of focussing on cross-country regressions is that country-specific questions regarding aid are omitted (Clist, 2010), and Riddell (2007), cited in Juselius *et al.* (2011) argues that country-based evidence provides the only reliable backdrop against which to judge aid effectiveness. Thus, to enhance our understanding of country-specific questions regarding aid effectiveness, it is desirable to conduct studies of the impact of aid on growth in specific countries. There are virtually no country-specific empirical studies on how aid, mediated by fiscal variables impact on private sector growth, but an extensive literature search turned up the following general studies:

Lloyd *et al*. (2001), use an autoregressive distributed lag (ARDL) models approach and find that exports, aid and public investment are (all) positively related to long-run growth in private consumption in Ghana. Studies by Gounder (2001) for Fiji, and Bhattarai (2009) for Napal using respectively the ARDL and the Johansen Maximum Likelihood (ML) approaches show that foreign aid has had a significant positive impact on economic growth. In the only directly comparable study, Morrissey *et al*. (2007) investigate the impact of aid on growth within a fiscal framework and find in Kenya that grants were associated with increased spending and that government spending had a positive effect on growth (grants also had a small positive association with growth). Loans, on the other hand had a negative association with growth.

In some of the most recent applications, Juselius *et al.* (2011) rely on country-based time-series analysis and perform a comprehensive study of the long-run effect of ODA on a set of key macroeconomic variables in 36 SSA from mid-1960s to 2007. Using a statistical benchmark of a CVAR model, they provide broad support for a positive long-run impact of aid on investment in 33 of the 36 countries in the sample, but hardly any evidence that aid has been harmful. Kargbo (2012) uses a triangulation of approaches and specifications on Sierra Leonean data and finds results that are consistent with the view that aid significantly contributes to economic growth. In a sharp contrast, however, Fenny (2005), and Javid and Qayyum (2011) uses a similar ARDL approach on Papua New Guinea and Pakistan respectively, but do not find evidence that aid contributes to economic growth.

This thesis extends the fiscal analysis to consider aid effectiveness within the broader context of the economy, over the period 1970-2008. It draws heavily on the most recent CVAR in Juselius *et al*. (2011) to investigate how aid mediated by fiscal variables, and exports impact on private consumption growth as the context for estimating the growth response to aid in Uganda. Using this approach, we investigate the *ceteris paribus* and the multiplier growth effect of aid mediated by the broader fiscal dimension. With regard to the former effects, Gomanee *et al*. (2005: 356) argue that the aid that generates income-earning opportunities or that provides social services, such as donor funded projects in health or sanitation can directly benefit the private sector in the long-run. The latter arises because aid is directed to the government, and is likely to be associated with incremental public spending which implies that aid indirectly generates positive externalities for the private sector (Mosley, Hudson and Verschoor, 2004).

Following Lloyd *et al*. (2001), we focus on the growth of private consumption rather than growth of investment (as in Morrissey *et al.*, 2007) or GDP. Although one could argue that private consumption is not a measure of growth (usually measured as growth in GDP), our approach is premised on a range of grounds. These include theoretical (following Barro, 1990 and Barro and Sala-I-Martin, 1992, 1995) and conceptual (Lloyd *et al.*, 2001). Barro and Sala-I-Martin (1992) argue that private consumption can be used as a measure of economic growth as the correlation of output and other variables can be modelled from the production or utility side of the household. This is because government activities may indirectly increase the total output of a country through its interaction with the private sector (Lin, 1994). For the data at hand, the correlation between GDP and private consumption is about 0.978, which signals that Uganda's GDP growth has, on average, expanded household living standards.

The other reason is more conceptual. The concern in economic development is more about what is happening to private incomes and consumption levels rather than the overall size of the economy (Lloyd *et al.*, 2001). Note that most of the cross-country and country-specific econometric studies of aid have concentrated on the effectiveness of aid in increasing economic growth. However, in recent years, donors have attached greater importance to the objective of using aid to reduce poverty (World Bank, 2000). It is argued that using aid to guide or influence the allocation of government spending is one important way to increase the leverage of aid on private incomes or poverty alleviation (Gomanee and others, 2005).

Aid to Uganda has increasingly been used to support public spending as part of the PEAP or under HIPC initiative through the PAF spending (Egesa, 2011). Therefore, insofar as there is a strong correlation between levels of poverty and growth in private incomes, then, use of private consumption is consistent with assessing aid effectiveness from the poor's perspective. Note though that incidence of poverty reduction from increased spending due to incremental aid may be un-equally distributed, so that welfare gains for the poor may not be guaranteed (Gomanee *et al.*, 2005: 358). Castro-Leal *et al.* (1999: 54) show that the poorest are the least likely to benefit from pro-poor spending. Nonetheless, it is understood that the poor can still benefit as long as some of the aid financed spending goes to them or get more in aid financed spending than they pay in taxes. In addition, the fact that private consumption expenditure captures non-income dimensions of poverty, it may be more important than economic growth (World Bank, 2001).

So, we do consider the implications of our findings to capture the growth effect of aid in Uganda. This notwithstanding, it is fair to observe that the growth process depends on an intricate range of interacting characteristics and lines of influence (Aghion and Howitt, 1998; Barro and Sala-i-Martin, 1995). Thus, the simple analytical framework adopted here may not fully capture the growth process. Our concern is not with identifying the determinants of growth, but rather how aid and public sector impact on the growth of private income, providing the variables included in the system are cointegrated.

5.3 Determination of the DGP and Cointegration Analysis

Cointegration analysis in this chapter draws on the econometric methodology discussed in Section 3.3, the visual inspection of the data in figure 3.1 and figure 3.2 and exploratory data description, but especially unit-root test results presented in Section 3.5 of Chapter 3. It is shown that macroeconomic variables- tax revenue (*TR*), aid (*A*), domestic borrowing (*DB*), total public spending (*G*), exports (*X*) and private consumption expenditure (*PC*) – are unit root non-stationary, i.e. $I(1)$ in level and $I(0)$ in first difference, so could form (an) equilibrium relation(s) in a 6-variable VAR model. In addition, all series are in non-log specification to preserve the degrees of freedom especially because domestic borrowing series is problematic. Most of the series sample points from the mid-1980s are either negative or very close to zero which jeopardizes the validity of log-transformations.

Although aid effectiveness has typically been judged in terms of its effect on economic growth, this has not been considered within the broader fiscal dimension, i.e. how growth is mediated by the inter-relationship between aid and public sector fiscal behaviour. So, economic theory may be of little guidance for the precise form of the model we should be specifying. However, we have allowed for a complete '*fiscal representation*' (i.e. all budget variables are included, with an omission and aid is based on DAC measures so that there is no estimation of true identity). As we have shown and established in Chapter 4, this '*fiscal representation*' could justify the existence of one cointegrating vector as predicted by the fiscal response theory (McGillivray and Morrissey, 2000, 2004). We go a step further and consider an additional link, i.e. aid, fiscal variables, exports and growth in private consumption because the aid's associated public sector behaviour could have an effect on the economy (McGillivray, 1994; Franco-Rodriguez *et al.*, 1998; McGillivray and Morrissey, 2001). Moreover, through its effect on the public sector, aid may have positive effects on the private sector and hence promote growth (Mosley, Hudson and Verschoor, 2004; Lin, 1994). Hence, this additional link considers aid and the public sector within the broader context of the economy.

Thus, our empirical framework allows for a possibility of two cointegrating vectors because in principle, one relationship is the statistical analogue of the budgetary equilibrium among the core fiscal variables (*DB*, *G*, *A*, *TR*), and a relationship between aid (*A*), public sector (essentially comprising fiscal variables (*G*, *TR*, *DB*) and exports (*X*)) and private consumption (*PC*). If what we find are two cointegrating vectors, their interpretation would be facilitated by the fiscal response and public sector growth theories outlined above, including offering guidance to the specification of each vector. The analysis is executed using *CATS in RATS*, *version 2* (by J.G. Dennis, H. Hansen, S. Johansen and K. Juselius, *Estima* 2005), unless otherwise stated.

The estimation technique employed in the chapter mimics the one we employed in Section 4.2 of Chapter 4, although it is more complex. As in Section 4.2, existence of cointegrating relation(s) among the variables is evaluated using the Johansen (1988) *trace statistic* test. The cointegrating space is specified to include an unrestricted constant and a restricted deterministic trend and *k* is initially set at 2 (to facilitate the search for an appropriate model specification). Thus, we considered a 6-dimensional CVAR model, an unrestricted constant, a restricted trend and let k=2. A VECM similar to one in equation (4.1) is estimated. Based on this model, the appropriate lag-length is determined. A summary of lag-length determination is presented in Appendix B. From the results in Appendix Table B1, we see that *SC* and *HQ* select VAR(1) [because the recommendation is to select the lowest value for the information criteria] and the LM test suggests this model meets the crucial assumption of time independence of the residuals. This DGP nets out the lagged first difference terms stacked in $\mathbf{\Delta y}_{t-1}$ of the general model outlined in equation (3.4), reducing to one similar to that in equation (4.2) in an unrestricted form. We then proceeded to assess the suitability of this model in terms of a battery of residual misspecification tests (see *inter alia* Godfrey, 1988).

First, is the inspection of residual graphs presented in Appendix figure B1. The plots show an outlying observation in the residuals of *G*, *PC* and *X* equations that occurs around 1979/80. The actual and fitted residuals show a slight but detectable change in behaviour in most of the series equations (from about 1988). As already alluded to, the former corresponds to the climax of the decade of economic collapse and social disorder in Uganda and possibly the second oil price shock and the breakdown of the East African Community (EAC) in 1977. The latter could be capturing a change in institutional environment (ESAP reforms) and the Museveni regime from the mid-1980s.

Turning to residual analysis in Appendix Table B2, we cannot reject the null of no first or second order autocorrelation (see LM(1) and LM(2). The multivariate test for ARCH rejects the null of ARCH effects, although univariate ARCH effects are accepted in *PC*, but none of the other variables. Rahbek *et al.* (2002) cited in Juselius (2006) and Dennis (2006) show that the rank tests are robust to moderate ARCH effects, so this may not be a problem here. In the results, both measures of goodness of fit, i.e. the trace correlation and the R^2 for each error correction equation suggest that our model captures, to a reasonable extent, the correlation among the system variables. The hypothesis of multivariate normality is not supported (χ^2 (12) = 22.473 [0.033]). Looking at the univariate statistics, normality of the error term is rejected at the conventional 10 percent level for *PC*, *X* and *G* series. As the standard normal distribution has skewness of 0 and kurtosis of 3, we see from the results that *PC*, *X* and *G* have excess kurtosis (fat tails). In addition, *PC* and *X* have a large degree of skewness which, usually is due to a problem with large outliers. CVAR model is quite robust towards excess kurtosis, but not towards the presence of skewness. We observe non-normality of the error terms in *G*, *X* and *PC* equations, although we do not have autocorrelated residuals, which again is very important.

Using CATSmining procedure, "*Find large residuals*", we estimate extreme values of standardized residuals scaled by the critical value of 3.19341 simulated for T=36. From the results in Appendix Table B3, we see that the largest residuals are in *X* and *PC* equations (3.352 and 3.718 respectively) while in the *G* equation it is borderline so (3.065), in the same period 1979. So as in the previous chapter, we allowed for transitory blip and level shift (on the basis of institutional knowledge) and restricted dum_{79} and D_{88} dummies to lie in the cointegrating space, albeit noting that dum_{79} cancels out as a consequence of cointegration. Residual analysis in Appendix Table B4 considers whether this modification improves the specification of the model. Looking at the univariate series in the table, the errors from *X* and *PC* equations are now normally distributed, although those of *G* are not. In effect, the specification of the model improves, but we still reject multivariate normality (ChiSqr(12) = 19.819 [0.014]) . This suggests that the two variant models, i.e. without (and with dummies) are not statistically different, so dummies may be impotent in the model (i.e. dummies do not correct for the model misspecification problems detected in the basic model). This notwithstanding, the good news is that estimates of the VAR model are robust to deviations from normality assumption providing residuals are not autocorrelated.

Trace Statistics Test for Cointegration

In the following analysis, cointegration rank is determined using *trace statistics* test, but applied on two variants of the model, without (and with dummies) as a sensitivity analysis. Results for the former are in Table 5.1 while those of the latter are in Appendix Table B5. In both of these tables, '*' is the small sample Bartlett correction, which ensures a correct test size (see Johansen, 2002).

Table 5.1: Johansen's Cointegration trace test Results

I(1)-ANALYSIS (without dummies)

p-r	r	Eig.Value	Trace	Trace*	Frac95	P-Value	P-Value*
6	0	0.726	144.194	129.370	117.451	0.000	0.006
5	1	0.695	97.529	89.544	88.554	0.009	0.042
4	2	0.479	54.820	51.426	63.659	0.229	0.356
3	3	0.378	31.327	29.980	42.770	0.432	0.509
2	4	0.219	14.214	13.855	25.731	0.645	0.674
1	5	0.138	5.331	5.285	12.448	0.558	0.564

Notes: Trend assumption: Linear deterministic trend restricted; Frac95: the 5% critical value of the test of H(r) against H(p). The critical values as well as the *p*-values are approximated using the Γ distribution (Doornix, 1998).

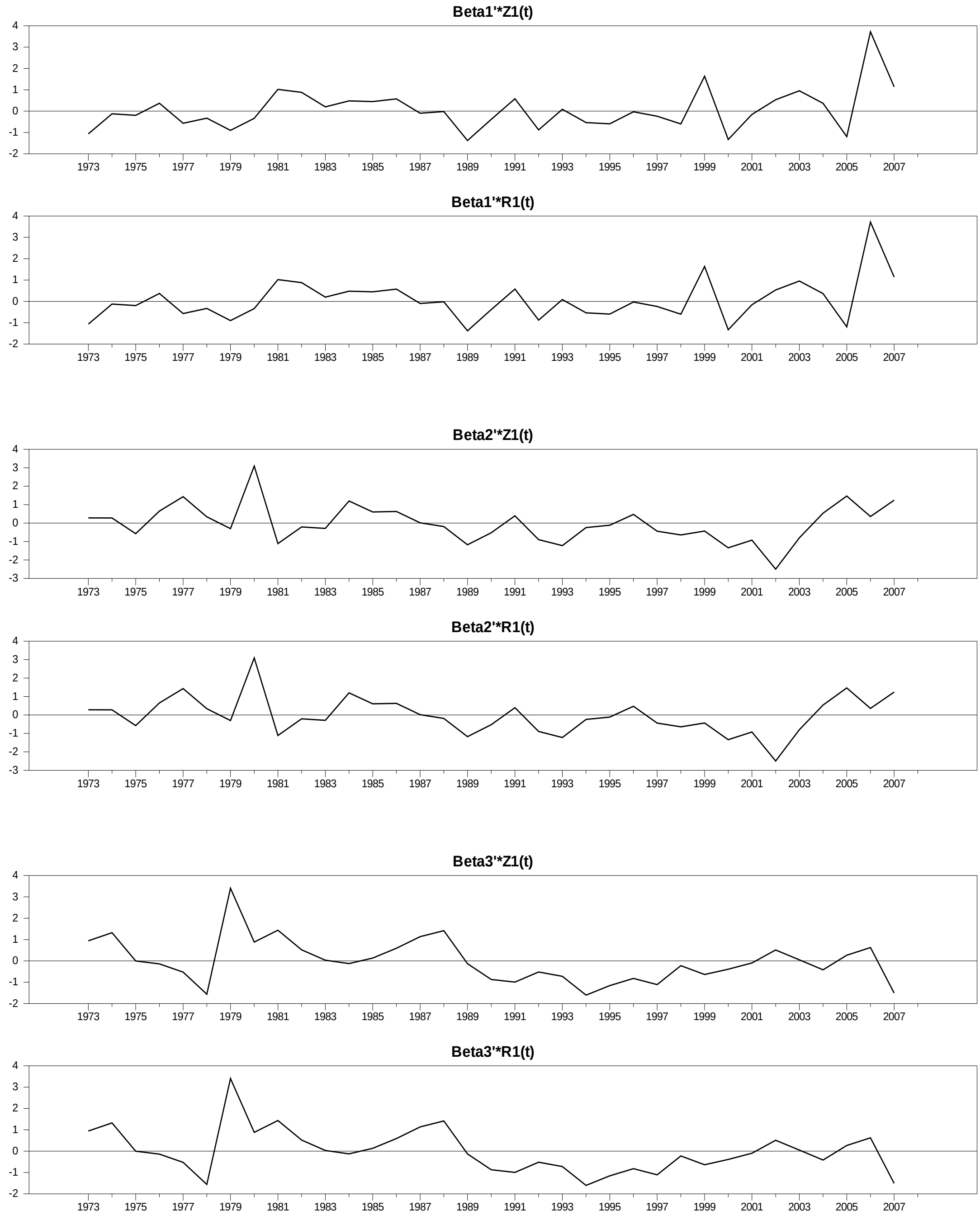
The *trace* test statistic suggests presence of two equilibrium (stationary) relations among the variables and is robust to small sample Bartlett correction in the two variant models. This means that the model has $r = 2$ cointegrating relations and $p - r = 4$ common stochastic trends. Noteworthy is that system variables cointegrate with and (without dummies), implying that dummies appear not to have a long-run effect in the model. To reflect this, a null hypothesis of long-run exclusion of t_{88} shift dummy from the cointegration relations is tested, but cannot be rejected (L.R test: $\chi^2(2) = 0.944\,[0.624]$). To sum up, we have found statistical evidence that inclusion of dummies does not significantly improve multivariate normality of the model. Also, variables in the system cointegrate without having to include dummies and more formally, a test of long-run exclusion of t_{88} shift dummy could not be rejected. Based on this, we conclude as in the previous chapter that inclusion of dummies is not warranted in this case. So the rest of the analysis is based on a model with no dummies without losing the generality of the argument, and it is the model based on which we tested for the presence of unit roots in the multivariate framework given the cointegration space.

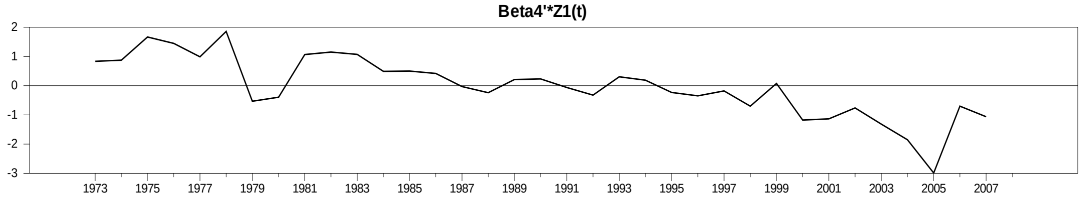
For similar reasons given in Section 4.4, it is a good idea not to exclusively rely on the *trace* test alone. So in the following, the formal (*trace*) test is complemented with a battery of rank condition sensitivity checks, including graphs of the cointegration relations, the characteristic roots of the companion matrix or roots of the characteristic polynomial and then the recursively calculated trace tests.

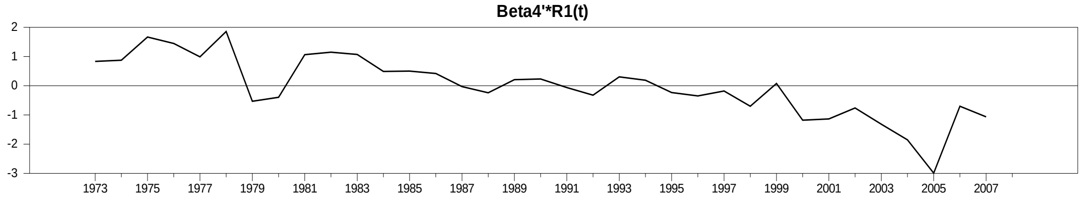
Residuals of Cointegrating Relation

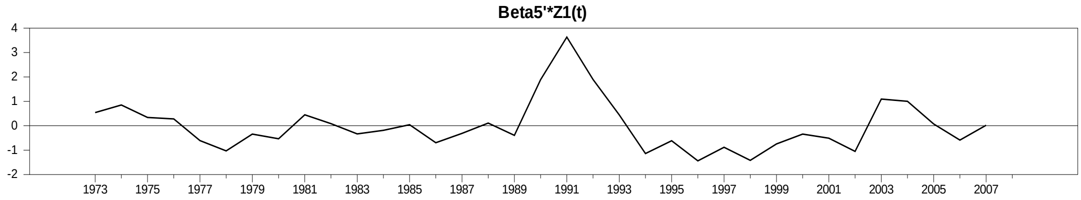
In figure 5.1 are plots of all the six potential cointegrating relations from the model (we assume full rank of the $\mathbf{\Pi}$ matrix). Each of the cointegration relation comprise a pair of residuals, $\hat{\beta}'Z_{1t}$ and $\hat{\beta}'R_{1t}$. The former is the equilibrium error as a function of short run dynamics and deterministic components, while the latter concentrates out the lagged short-run dynamics (i.e. the concentrated model. Given the DGP (i.e. lag-length $k = 1$) in the model, $\hat{\beta}'Z_{1t}$ and $\hat{\beta}'R_{1t}$ are similar as this nullifies the short run adjustment effects embodied in $\hat{\beta}'Z_{1t}$ which $\hat{\beta}'R_{1t}$ corrects for.

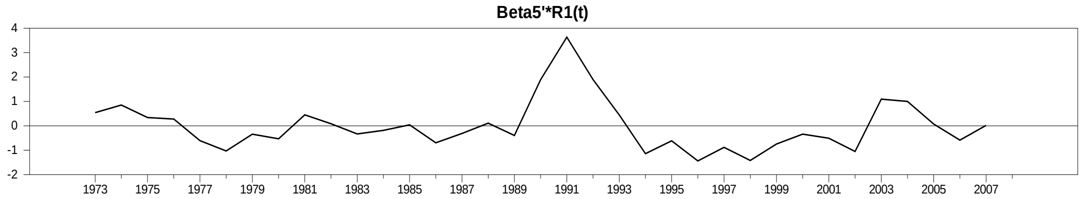
Figure 5.1: Residuals of Cointegrating Relation

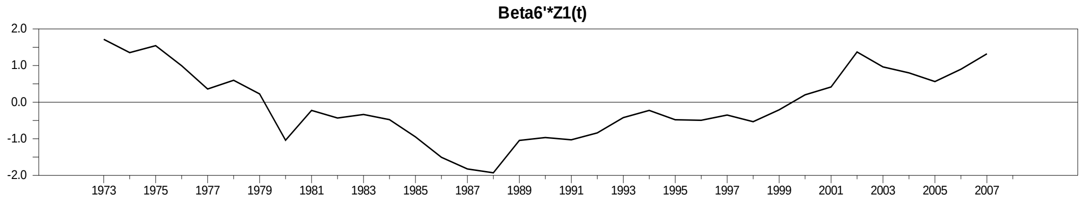


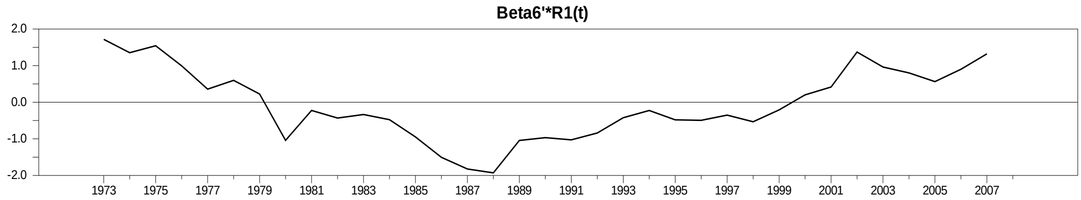












Based on the figure, the first two, i.e. the first and second cointegrating relations appears to be stationary, and may suggest presence of two cointegrating vectors.

Roots of the characteristic polynomial

Under the assumptions of the cointegrated VAR model, the modulus of the root of the companion matrix should be inside the unit circle or equal to 1(because they are equal to the inverse of the roots of the characteristic polynomial (Juselius, 2006: 50-2). Or they correspond to explosive processes if outside the unit circle. In practice, we need to choose the rank so that the largest unrestricted root is far from a unit root, i.e. it has modulus lower than 1. The model here is defined for $p = 6$, $k = 1$ implying $p \times k = 6$ roots in the characteristic polynomial (i.e. we assume full rank of the $\mathbf{\Pi}$ matrix).

Table 5.2: The Roots of the Companion Matrix

The Roots of the COMPANION MATRIX // Model: H(6)

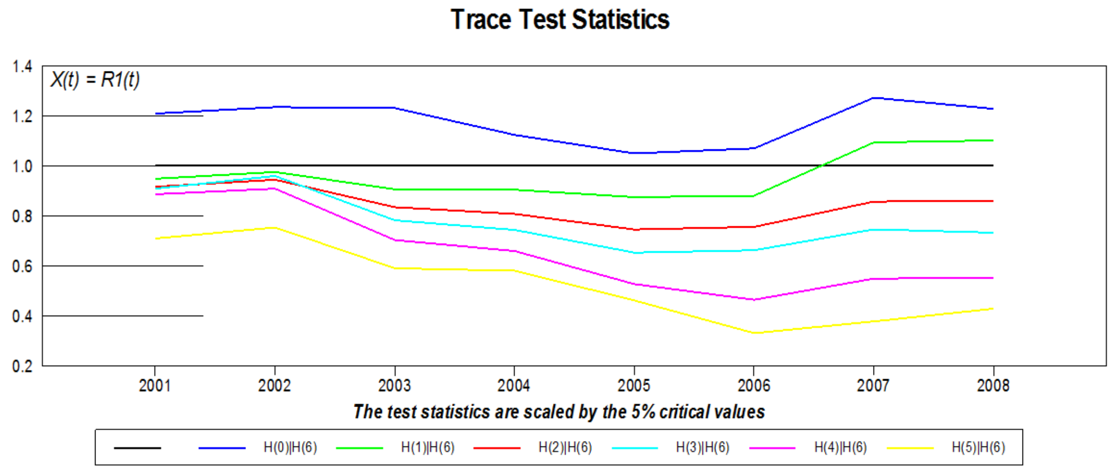
	Real	Imaginary	Modulus	Argument
Root1	0.943	0.052	0.945	0.056
Root2	0.943	-0.052	0.945	-0.056
Root3	0.622	0.000	0.622	0.000
Root4	0.295	0.000	0.295	0.000
Root5	-0.059	-0.047	0.076	-2.469
Root6	-0.059	0.047	0.076	2.469

In the table, we seem to have two complex pairs (roots1+2 and roots5+6) and two real roots. One of the complex pairs (roots1+2) has a modulus close to 1, which we in practice cannot distinguish from unit roots. This indicates that we have 2 potential unit roots.

Recursive graphs of the Trace-Test Statistics

In the figure are recursive graphs of the recursively calculated trace-statistics based on equation (4.2) in Dennis (2006: 100) or equivalently, equation (8.1) in Juselius (2006: 131). These are scaled by the critical value of the trace test distribution derived for a model without exogenous variables, shifts or dummies – ‘basic model’ (Dennis, 2006:100). A baseline line model was estimated for a subsample period, $t_1 = 2001$, and then was recursively extended until the full sample is covered, noting that the **X-** form (full model) and the **R-**form (concentrated) versions of the model are similar. The main point in this graph is to observe the time path of the trace statistics. The visual impression of the graph is that two test statistics are above unity, suggesting $r = 2$, albeit showing the effect of policy regime shift on the eigenvalues.

Figure 5.2: Recursive graphs of the Trace-Test Statistics



In conclusion, the trace statistics test, recursive graphs of the trace-test statistics, roots of the characteristic polynomial and residuals of cointegrating relations together suggest that the preferred rank is $r = 2$. Following the confirmation of the cointegrating rank, we tested for the presence of unit roots within the multivariate framework using the CATS procedure as in Section 4.4 of Chapter 4.

Table 5.3: Test for Stationarity: LR-test, $\chi^2(4)$

DB	G	A	TR	X	PC
22.724 (.000)	22.765 (.000)	22.642 (.000)	22.690 (.000)	21.543 (.000)	22.687 (.000)

Notes: Restricted trend included in the cointegrating relationship(s); 5% C.V = 9.488; *P*-values in parentheses

Results in Table 5.3 clearly show that stationarity of each variable by itself cannot be supported, so the series are unit root non-stationary or $I(1)$.

5.4 The Empirical Specification of Cointegrated VAR(1) Model

From the preceding analysis, we consider a 6-variable CVAR model for $\mathbf{y}_t = \left(DB_t, G_t, A_t, TR_t, X_t, PC_t\right)'$, and structure the restricted empirical error correction specification around $r = 2$ cointegrating relations, an unrestricted constant, $\boldsymbol{\mu}_0$ and a vector of linear trends, $\boldsymbol{\alpha\beta}'\mathbf{t}$ restricted to lie in the cointegrating space. Lag-length $k = 1$ implies $\boldsymbol{\Gamma}_1 = 0$, so the lagged short-run dynamics in (3.4) drops out. The restricted CVAR model for the data becomes

$$\begin{bmatrix} \Delta DB_t \\ \Delta G_t \\ \Delta A_t \\ \Delta TR_t \\ \Delta X_t \\ \Delta PC_t \end{bmatrix} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \\ \alpha_{51} & \alpha_{52} \\ \alpha_{61} & \alpha_{62} \end{bmatrix} \left\{ \begin{pmatrix} \beta_{11}, \beta_{12}, \beta_{13}, \beta_{14}, \beta_{15}, \beta_{16}, \rho_{11} \\ \beta_{21}, \beta_{22}, \beta_{23}, \beta_{24}, \beta_{25}, \beta_{26}, \rho_{21} \end{pmatrix} \begin{bmatrix} DB_{t-1} \\ G_{t-1} \\ A_{t-1} \\ TR_{t-1} \\ X_{t-1} \\ PC_{t-1} \\ t \end{bmatrix} \right\} + \boldsymbol{\mu}_0 + \boldsymbol{\varepsilon}_t \quad \text{..} (5.1)$$

Where $\boldsymbol{\beta}_i'\mathbf{y}_t$ is the equilibrium error, $\boldsymbol{\alpha}_{ij}$ is the adjustment coefficient, $\boldsymbol{\mu}_0$ is a $(p \times 1)$ vector of an unrestricted constant, and $\boldsymbol{\alpha\beta}'\mathbf{t}$ is a $(p \times 1)$ vector of linear trend restricted to lie in the cointegrating space. Δ is the first difference operator and $\boldsymbol{\varepsilon}_{it} \sim N_{\mathrm{P}}\left(0, \boldsymbol{\Lambda}_u\right)$. Given the DGP, the long-run is the same as the short-run and the system, after having been pushed away from equilibrium by an exogenous shock, will adjust back to equilibrium exclusively through $\boldsymbol{\alpha}_{ij}$ so that weak exogeneity is then the same as long-run exogeneity. Although this specification is intuitively similar to (4.3), we have to formerly just-identify the two stationary long-run relations and impose joint restrictions on the long-run parameters (i.e. $\boldsymbol{\beta}_{ij}$ and $\boldsymbol{\alpha}_{ij}$) where permissible. For example, restrictions on $\boldsymbol{\alpha}_{ij}$ coefficient would tell us which variables adjust to maintain equilibrium after the system has been pushed out of its long-run equilibrium.

Long-run Identification Strategy and Structural Analysis

The two joint long-run stationary relationships detected above are unidentified and merely represent statistical rather than meaningful economic relationships. In the following, we wish to uniquely identify (on the basis of the discussion *a priori*) these two relations. We assumed, in the spirit of the fiscal response theory (McGillivray and Morrissey, 2000, 2004) that the first vector links the fiscal variables (DB_t, G_t, A_t & TR_t) only (as has been discussed in Chapter 4). Exports (X_t) and private consumption (PC_t) are set to zero in this relation (because these are not fiscal variables).

The second relation relates to the link between aid, fiscal variables, exports and private consumption. It follows from the recognition that aid is primarily given to the government, and that any impact of aid on the economy is mediated by government fiscal behaviour. This allows us to investigate issues relating to the effect of aid and public sector on the growth of private consumption, i.e. a growth-type relationship (see Barro and Sala-i-Martin, 1995). In this relationship, tax revenue is set to zero due to a number of considerations. First, it measures (in practice) more or less the same thing as government expenditure (Hansson and Henrekson, 1994: 390). Second, in a framework where the government is assumed to be free to borrow (especially that we allow for domestic borrowing in the model), taxes may have zero long-run effect on growth (Milesi-Ferretti and Roubini, 1995). M'Amanja and Morrissey (2005) argue that government effect on long-run growth is through expenditure, and taxes have no or a marginal impact (as tax was found to be insignificant).

We conduct a formal statistical test and complement economic theory in choosing the variables to include in each system. Formally, identification is checked by imposing (over-) identifying restrictions (i.e. imposing at least $r(r-1)$) restrictions on each cointegrating relation or $\boldsymbol{\beta}$ vector (Dennis, 2006: 62). Following the restrictions strategies in Dennis (2006: 60-70), we will require two normalizations and at least one restriction(s) per cointegrating vector, but imposed jointly for just-identifying the system in equation (5.1). We chose to jointly normalize (respectively) on domestic borrowing in the fiscal vector and on private consumption in the second vector. The former (as argued in the previous chapter) is a residual and is incorporated to identify the fiscal balance. The latter is because our focus is on the growth of private consumption.

Using the automated CATSmining procedure, we test first for the theoretical validity (sensitivity analysis) of long-run exclusion of variables from beta1 and from beta2. This is achieved by restricting one cointegrating relation while keeping the others unrestricted and then testing for variable exclusion. In Table 5.4, we report variable exclusion test results for $r = 1$ and $r = 2$ cointegrating vectors.

Table 5.4: Test of Exclusion: LR-test, $\chi^2(r)$

r	DB	G	A	TR	X	PC	Trend
1	3.682 (0.055)	2.682 (0.014)	3.331 (0.068)	3.390 (0.066)	0.525 (0.469)	0.261 (0.609)	3.390 (0.066)
2	22.506 (0.000)	8.403 (0.015)	12.943 (0.002)	1.208 (0.547)	18.721 (0.000)	13.118 (0.001)	20.786 (0.000)

Notes: Null hypothesis: variable is excludable from the respective cointegrating relation(s); *p*-values in parentheses

From the table, the *p*-values corresponding to *X* and *PC* coefficients are insignificant in the first cointegrating vector ($r = 1$), but are significant in the second ($r = 2$) relation. This suggests that exclusion of *X* and *PC* from beta1 cannot be rejected. Similarly, *TR* seems to be unimportant in both cointegrating relations but important in the first. These results reinforce our choice of the variables that we include in the respective cointegrating relations: *X* and *PC* are not fiscal variables and therefore do not need to enter into the first (fiscal) relation but in the second (growth-type) relation. Similarly, it seems clear that tax revenue does not have to enter into the long-run growth-type relation but is important in the fiscal relation. Furthermore, using the same CATSmining, we restricted *X* and *PC* from the first relation and tested for the long-run stationarity of Beta1. Stationarity of Beta1 vector could not be rejected ($\chi^2(2) = 4.309\,[0.116]$). Then, *TR* was restricted in the second relation and stationarity of the second vector (beta2) could not also be rejected ($\chi^2(1) = 0.083\,[0.774]$). Thus, stationarity of each of the restricted vectors could not be rejected, and as the results in Table 5.5 show, the globally loaded model is stationary and this rank condition was just satisfied.

Table 5.5: Test for Stationarity of each Beta Relation

*** MODEL 1: DGF: 3 // P-value: 0.189

BETA(transposed)

	DB	G	A	TR	X	PC	TREND
	0.004	0.001	-0.001	-0.001	0.000	0.000	1.000
Beta(1)	(7.352)	(3.889)	(-4.891)	(-5.327)	(.NA)	(.NA)	(.NA)
	-0.005	-0.001	-0.001	0.000	-0.002	-0.000	1.000
Beta(2)	(-10.547)	(-6.496)	(-7.155)	(.NA)	(-9.304)	(-1.838)	(.NA)

Finally, we jointly exclude PC_t and X_t from beta1 and TR_t from beta2, i.e. we imposed a joint (over-) identifying restrictions using the LR test. The test yielded: $\chi^2(1) = 2.650$ (0.104), albeit noting that the standard errors of $\hat{\beta}_{ij}$ could not be generated as this depends crucially on whether each cointegrating vector has been properly normalized. Nonetheless, the joint test could not be rejected and is consistent with the evidence in Table 5.4. Hence, *X* and *PC* are excludable from the fiscal relation and *TR* is excludable from the growth relation. Equally important is the result that aid is a significant element of both the long-run fiscal and growth equilibria. This mirrors the results we obtained in the fiscal model and may, in the growth relation, capture the effect of aid on private consumption.

With the long-run structure identified and long-run variable exclusion implied, we focus next on the long-run weak exogeneity test (i.e. a zero row in $\boldsymbol{\alpha}$: joint and vector specific) using procedures proposed in Johansen (1996). This has been discussed in detail in Section 4.6.2 of Chapter 4, so we utilize the same here. Testing for example whether aid is weakly exogenous for the long-run system in (5.1) involves imposing joint restrictions on the corresponding $\boldsymbol{\alpha}$ coefficients (i.e. $H_0 : \alpha_{3,1} = \alpha_{3,2} = 0$), whilst other $\boldsymbol{\alpha}$ coefficients are unrestricted. The test results for the joint restrictions are reported in Table 5.6.

Table 5.6: Long-run Weak Exogeneity: LR-test, $\chi^2(2)$

Variable	**Null Hypothesis**	**Statistic**	**p-value**
DB_t	$\alpha_{11} = \alpha_{12} = 0$	8.797	0.012
G_t	$\alpha_{21} = \alpha_{22} = 0$	0.617	0.734
A_t	$\alpha_{31} = \alpha_{32} = 0$	7.945	0.019
TR_t	$\alpha_{41} = \alpha_{42} = 0$	7.060	0.029
X_t	$\alpha_{51} = \alpha_{52} = 0$	10.708	0.005
PC_t	$\alpha_{61} = \alpha_{62} = 0$	1.994	0.369

Notes: Null hypothesis: a variable is weakly exogenous. A large test statistic (small prob.) indicates that the null hypothesis of weak exogeneity is rejected.

The results indicate that jointly, the null hypothesis of weak exogeneity cannot be rejected for total public spending and private consumption. These do not seem to adjust to system disequilibrium, and are as such exogenous to the long-run relations. Conversely, long-run weak exogeneity is firmly rejected for aid, domestic borrowing, tax revenue and exports, suggesting these adjust to maintain equilibrium, and are, as such endogenous to the long-run relations. However, as these results apply to the entire cointegrating system, it is difficult to pin down or even claim to know the role played by aid, fiscal and the other variables in reinstating equilibrium in each of the vector specific relations. Thus, in addition, we tested for long-run weak exogeneity in the fiscal and growth-type relations respectively. Test results are reported in Table 5.7.

Table 5.7: Specific Vector Long-run Weak Exogeneity Tests: LR-test

Identified Relations	DB	G	A	TR	X	PC
Fiscal Relation $\chi^2(3)$	11.546 (0.009)	9.529 (0.023)	10.306 (0.016)	11.677 (0.009)	---	---
Growth Relation $\chi^2(2)$	6.313 (0.043)	4.452 (0.108)	5.588 (0.014)	---	6.348 (0.042)	5.045 (0.080)

Notes: *p*-values in parentheses

While the results in Table 5.6 suggest *G* and *PC* are weakly exogenous to the system, the results in Table 5.7 suggest that *G* and *PC* are in the margins of significance. The result for long-run weak-exogeneity of aid is consistent with test evidence we obtained in the fiscal response model, and is also consistent with the evidence in Juselius *et al.* (2011). Strong exogeneity of aid received little support in the majority of the SSA countries in their sample (25 (including Uganda) of the 33 countries). Also worth noting is the behaviour of the domestic borrowing variable. Although it happens to be weakly exogenous in the fiscal response model, it is endogenous in the macroeconomic set-up, corroborating our earlier conjecture that it may be influenced by factors other than domestic fiscal variables (say factors in the macro economy).

5.5 Long-Run Growth Effect of Aid

Section 5.4 shows the links between aid and the macrovariables in Uganda but these are uninformative about the signs and magnitude of the individual effects of aid on individual macrovariables. In this section, we investigate the signs and significance of the direct and multiplier effect associated with aid, fiscal variables and exports on the growth of private consumption. For example, a significant positive association of aid with private consumption could imply that aid contributes to private sector growth. Furthermore, allowing for the fact that aid itself is included in government spending, then, a positive significant correlation of public spending with private consumption may capture, in part, the multiplier effect associated with aid. Due to the difficulties implementing routines in CATS in RATS, the calculation of 'standard errors' for beta was invalidated when we normalized on *PC*[38] , but as this is a variable of interest, we had to switch to E-views 7.2 to analyse the long-run estimates. Estimates of the long-run growth-type relation as set in Table 5.8 are obtained (t-ratios in parentheses):

From the table, we see that results in the first column (fiscal relation) are consistent with what we obtain in equation (4.4) of Chapter 4 and would be consistent if normalized on G and TR or A (as in equation (4.5) and equation (4.6a, b) respectively). So a similar interpretation of the long-run effect of aid on individual fiscal variables (i.e. the fiscal effects of aid) as in section 4.6 applies. Thus, it is fair to argue that results in the first column of Table 5.8 imply that in the long-run, aid is associated with: (i) increased public spending, albeit noting that spending is less than proportional to aid increment, but it is

[38] When identifying restrictions have been imposed on the long-run structure, it is only possible to get standard errors of $\widehat{\beta}_{ij}$ when each cointegrating vector has been properly normalized.

more than what it could have been in the absence of aid and it is possible that total spending increases by more than aid actually delivered through the budget; (ii) Increased tax effort; and (iii) reduced domestic borrowing.

Table 5.8: Vector Error Correction Estimates (Aggregate model)

Cointegrating Eq:	Fiscal Relation	Growth Relation
DB(-1)	-1.000	6.988
		[7.284]
G(-1)	0.223	1.392
	[6.506]	[5.007]
A(-1)	-0.345	0.431
	[-9.087]	[1.503]
TR(-1)	-0.391	0.000
	[-8.423]	
X(-1)	0.000	2.030
		[3.377]
PC(-1)	0.000	-1.000
@T(72)	207.448	1567.252
	[7.081]	[5.563]
C	-3803.436	-993.795

Notes: Normalization is on DB in the fiscal relation and on PC in the growth relation. X and PC are restricted to zero in the fiscal relation, and so is TR in the growth relation. In parantheses are *t*-ratios.

In the second column of the table is the growth in private consumption relation. In the relation, all variables have expected signs. *Ceteris paribus,* public spending, exports and domestic borrowing positively contribute to private sector growth in Uganda. In the fiscal relation, aid is associated with incremental spending, and spending has a significant positive effect on private sector growth. This confirms the view that incremental expenditure on public goods and service due to incremental aid generates positive externalities for the private sector. From this angle, aid appears to have an indirect (positive and significant) multiplier effect on private consumption, and presumably through this on growth. Aid itself has a positive albeit insignificant coefficient, suggesting '*absence of evidence and not evidence of absence'* (see Temple, 2010 cited in Juselius *et al*., 2011: 2) that aid has had a direct beneficial association with private sector growth in

Uganda. Hence, even though aid may plausibly have no direct effect on private consumption, it does conditional on government expenditure.

The result for a rise in government bond issuance may appear counter intuitive. However, as estimates of the disaggregated variate model will show (and consistent with estimates of the disaggregated variate of the fiscal relation in Section (4.8) of the previous Chapter) domestic borrowing is linked to public investment spending. Given this, the result may imply that domestic borrowing is associated with a 'crowding in' effect linked to public investment spending, which has a complementary relationship with private sector growth. In this regard, deficit financing raises wealth and stimulates household consumption demand. Overall, it is quite remarkable from the results that public spending, exports and even domestic financing have coefficients well above unit, implying that increase in either of this may increase private consumption more than one-for-one.

The trend term has a positive association with private income and is significantly different from zero suggesting that private income has been increasing with time. This mirrors the remarkable declines in income poverty or a rise in household living standards in Uganda over the past two decades. Income poverty has declined from 44% in 1997/98 (Appleton *et al.*, 1999) to 38.4% in 2002/03 and further to 31.3% in 2005/06 (UBOS, 2006; Appleton, 2001). Since this period coincides with large increases in aid inflows on a scale that Uganda had never previously received (Egesa, 2011; Mugume, 2008), it could be case that the rising private income trend has a bearing on the aid inflows.

5.6 A disaggregated Variant Model

Kweka and Morrissey (2000) argue that the nature of the impact of increased government spending due to incremental aid on growth depends very much on its form. Verschoor (2002) cited in Gomanee *et al.* (2005: 357-58) argues that some categories of public spending are recognized as being pro-public and tends to do so in a manner that is pro-poor especially as the level of spending increases. Specifically, social sector spending and expenditures on rural roads, microcredit, agricultural extension etc. may be as beneficial to the poor as it could be to the public at large (Morrissey, 2004).[39] So we considered disaggregating *G* into current consumption (*GC*) and development (*GK*) spending. Thus, a refinement of the results in Table 5.8 is considered and estimated to reveal the overall importance of the form of spending in Uganda's growth record. Results are set out in Table 5.9 [t-ratios in parentheses][40]

Table 5.9: Vector Error Correction Estimates (Disaggregated variant model)

Cointegrating Eq:	Fiscal Relation	Growth Relation
DB(-1)	-1.000	9.467
		[8.119]
GC(-1)	0.056	1.399
	[0.306]	[2.606]
GK(-1)	0.245	1.974
	[4.401]	[1.317]
A(-1)	-0.379	0.732
	[-7.491]	[1.533]
TR(-1)	-0.337	0.000
	[-6.578]	
X(-1)	0.000	1.326
		[1.781]
PC(-1)	0.000	-1.000
@T(72)	198.273	1862.173
	[5.432]	[4.817]
C	-3361.828	-8885.767

Notes: Normalization is on DB in the fiscal relation and on PC in the growth relation. *X* and *PC* are restricted to zero in the fiscal relation, and so is *TR* in the growth relation. In parantheses are *t*-ratios.

Save for the *GC* and *GK* coefficients in the fiscal relation shown in the first column in the table, the rest of the coefficients are consistent with those in the aggregate model. In addition, current spending coefficient is insignificant, so comment is restricted to capital spending coefficient. Results suggest that in the long-run, domestic borrowing is more closely linked to capital spending. We however caution that care should be exercised when

[39] While one may discredit this argument on grounds that there could be limited efficiency of service delivery especially to the poor, Devarajan and Reinikka (2004), and Reinikka and Svensson (2004) (in Gomanee *et al.*, 2005) argue that new techniques for monitoring expenditure and delivering services offer potential for improvement.
[40] Estimates obtained using E-views 7.2 software

interpreting this result. It may be a measurement problem where the aggregation of productive (investment) expenditure includes substantial non-productive (consumption) expenditure (Kweka and Morrissey, 2000)

The decomposition results in the second column in the table (growth relation) suggest, *ceteris paribus*, current spending and domestic borrowing positively contribute to private sector growth. The fact that aid is associated with increased spending, the significance of current spending suggests that some aid finances government consumption spending via probably public sector wages and services, which contribute to aggregate demand. Egesa (2011) observes that donor funding has been characterized by an adjustment from heavy capital expenditures in the early 1990s to social programs spending enshrined in the PEAP (and specifically the PAF). Egesa's observation corroborates the available statistics with UBOS and MoFPED. Government consumption spending has averaged about 14.5% of GDP over 2001/02 – 2007/08 period, while investment spending over the same period has been about 5.2% of GDP on average. So the above results are not entirely surprising as they could be driven by the spending patterns.

Results in the fiscal relation (see column 1 in the table) show that domestic borrowing is associated with a 'crowding in' effect linked to investment spending, which has a complementary relationship with private sector growth. However, investment spending itself is insignificant in the growth relation. This could be because investment (even when it was actually under taken) was in unproductive state owned enterprises (SOEs) (Collier and Reinikka, 2001). Lloyd *et al*. (2001) finds a similar result for Ghana: investment spending is not significant in their solved long-run relationship, and (in addition to investment itself being unproductive), they argue that in the pre-ESAP period, much of the money designated as government investment ended up in private accounts. This granted, it may be the case that a similar situation potentially reduced long-run capital accumulation in Uganda.

5.7 Conclusions and Implications

This study adopted CVAR and investigated the impact of aid on growth of private consumption but mediated by the broader fiscal dimension in Uganda over the period 1972 to 2008. Attention is paid to the differential impact of aid and the overall importance of the form of spending in Uganda's growth record. We also incorporated dummies for the effect of political and economic instability over 1972-79 period and the possibility that policy reform following structural adjustment (initiated with the ESAP in the late 1980s) and the Museveni regime created a more favourable environment for growth in private incomes.

Aid and the Ugandan macrovariables are significantly cointegrated, and a battery of sensitivity and robust checks demonstrate that the cointegration rank is 2. We use this rank condition to test for causal links of interest between aid and macrovariables in Uganda. We find that aid is a significant part of the long-run equilibria, and this is separately robust to the fiscal and growth-type relations. The hypothesis of aid exogeneity is optimally tested within a system of equations, and separately in the fiscal and growth-type relations, but this is not statistically supported.

There is broad support that aid has had a positive impact on the private sector, albeit indirectly through public spending. Deficit financing is associated with 'crowding in' linked to public investment spending, which has a complementary relationship with private sector growth. To the extent that investment spending itself is insignificant in the solved long-run growth relation implies that it is the productivity, not the level of investment that clearly matter. With particular reference to aid, Berg *et al.*, (2010: 27) make a similar assertion in their calibrated model to Uganda arguing that it is the efficiency of aid-related public investment *relative* to stead-state investment efficiency that determines the growth impact of aid-financed public investment. Thus, in agreement with a conclusion in Kweka and Morrissey (2000), the wide-spread recommendation to increase public investment's share of the national budget in developing countries could be misleading. Similarly, the beneficial effects of 'earmarking' aid to investment spending may be exaggerated. Actually, what we find is that aid may have an important role in supporting consumption spending, and this may have more beneficial effects than is commonly acknowledged. This counters the widely held view that aid diverted to consumption spending reduces effectiveness of aid (World Bank 1998) or is growth reducing. In contrast to our expectations, we do not find evidence in support of the view that political and economic instability and policy reform effects are significant in the long-run.

CHAPTER SIX

BRIEF CONCLUSION, STUDY LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

While confronting the question of aid effectiveness, an important issue (but often ignored) in the context of a developing country like Uganda was which GDP measure would be most reliable as this is crucial for measuring the macroeconomic impact of aid. The most commonly used GDP measure in the aid-growth literature is typically from World Development Indicators (WDI) or Penn World Tables (PWT) (being considered the most reliable or the easiest to obtain). However, disparities in GDP from alternative sources are common and in practice one has different estimates of the level, change and growth of GDP for the same country over the same period. This is of a particular concern especially in developing countries (without exception) where the informal and subsistence sectors are a large share of the economy (Jerven, 2010) and where not all transactions in the formal sector are recorded (MacGaffey, 1991), and the quality of data is still very poor and measurement perceptions of macroeconomic aggregates are varied and weak (Mukherjee, White and Wuyts, 1998). Because the source chosen for GDP may affect inferences on growth and economic performance for African countries, the thesis entry point was an analysis of alternative sources of GDP, and aimed to construct a consistent GDP series for Uganda. The extent of discrepancy in GDP estimates was investigated, and the year on year percentage GDP growth rates, including percentage and average growth rate discrepancies were derived, with a particular focus on sub-periods when GDP from alternative sources diverge most.

Although UBOS and WDI real UGX GDP year on year growth rate estimates had a 3.6 percentage point average absolute discrepancy per year, they are consistent, similar and cointegrated. In fact, over 1970-76 and 2000-08 the two series are very close, and they are quite close for 1978-83 and 1993-99. Therefore, either series can be considered to represent trends in the size of the macroeconomy. However, the UBOS real series is smoother and produces a more stable measure of GDP than does the WDI series and it is the underlying source from which macroeconomic data is sought by the international agencies, including WDI. Given this, the less volatile UBOS real series (real UGX GDP/U) was preferred especially as there was less need to incorporate dummies in the rest of the thesis. Fiscal data and private consumption (our preferred measure of growth) in the thesis were derived from this same source. A powerful and scientifically strict CVAR model was employed and was executed using *CATS in RATS, version 2* and E-views 7.2, while paying specific attention to the effect of political and economic instability over 1972-79 period and policy reform following structural adjustment (initiated with the ESAP in the late 1980s) and the Museveni regime in Uganda.

Considering first the core fiscal variables, we find that aid and fiscal variables form a long-run stationary relation. Estimates of this relation reveal that about 61 per cent of incremental aid is spent, and suggests *prima facie* that spending is less than proportional to aid increment. However, this remains inconclusive considering that the DAC measure of aid used is an overestimate of the amount of the aid that goes to and through the budget, while part of the aid is used to reduce borrowing and some is held in foreign exchange reserves. A test of structural links between aid and fiscal variables reveals that aid is a significant element of long-run fiscal equilibrium, so aid may have been effective atleast in fiscal terms. Moreover, the hypothesis of aid exogeneity is not statistically supported, suggesting that Ugandan fiscal planners have a target for aid revenue and incorporate this in their budget planning process. Alternatively, it may be that donors incorporate public spending in deciding how much aid to allocate to Uganda.

In the long-run, aid is associated with increased tax effort, reduced domestic borrowing and increased public spending. Although, as shown above, the increase in spending is less than proportional to incremental aid, it is also clear that a budget constraint hangs over the budget implementation despite aid flows being substantial. This suggests that the actual aid to government (budget) is likely to be fully additional and it is even possible that total spending increases by more than aid actually delivered through the budget, i.e. aid illusion. The common stochastic trends are identified and these are shocks to the domestic fiscal variables (government spending, domestic borrowing and tax revenue). A decomposition of the common trends shows that shocks to tax revenue are the pulling forces, a result that is broadly consistent with the long-run estimates and suggests that budget spending plans have been adjusting to, but not pushing tax revenue, while empirical shocks to domestic borrowing, government spending and aid are the pushing forces of the fiscal system.

Finally, we extended the fiscal analysis and also considered how aid, mediated by the fiscal variables, and exports impact on the growth of the private sector- a relationship a kin to the growth response to aid in Uganda. Aid and the Ugandan macrovariables are significantly cointegrated, and a battery of sensitivity and robust checks demonstrate that the cointegration rank is 2. These are formally identified as representing respectively the statistical analogue of the budgetary equilibrium among the core fiscal variables and the link between aid, fiscal variables, exports and growth in private consumption. Using this rank condition, the hypotheses of long-run exclusion of aid and aid exogeneity are optimally tested within a system of equations, but these are not statistically supported. Based on the former test, one can argue that aid or policy conditions linked to aid seem to have been beneficial to the Ugandan economy, while on the basis of the latter, similar implications (as in the fiscal case above) may seem reasonable.

We find statistical support that aid has had, in the long-run, a positive impact on the private sector, albeit indirectly through public spending, and deficit financing is associated with ‘crowding in’ linked to public investment spending. Theory would suggest that public investment is growth-promoting while current spending is unproductive. In contrast, our evidence for the sample analyzed here shows it is current spending not investment spending that is beneficial to growth in Uganda because it contributes to private incomes and consumption. This is consistent with what Kweka and Morrissey (2000) find for Tanzania - another low income country. This has implications especially if we consider the emphasis put on investment spending (i.e. the overt recommendation to increase public investment’s share of the national budget, and so is the preference of donors to earmark aid to investment spending in developing countries). Our evidence suggests that the argument that tagging aid to investment spending contributes to achieving target growth rates may be exaggerated. Clearly, it may be the productivity, not the level of investment that matter. Similarly, the widely held view that aid allocated to consumption spending is growth reducing may be misleading. Instead, aid may have an important role in supporting consumption spending, and this happens to be more beneficial to growth in Uganda than may be commonly acknowledged. The role of structural changes remains unclear as the policy shift dummy seems unimportant for the long-run fiscal and growth relations, but may matter for the short-run.

While our empirical estimates give results that are consistent with observing the data, and are plausible in that they are consistent with what is known about the fiscal and macroeconomic impact of aid in some of the previous country specific applications summarised in Table 3.1, Morrissey (2012) and Juselius *et al.*, (2011), it is important to acknowledge the caveats that accompany the results that have been generated. VARs are inherently over parameterized and thus results tend to be sensitive to model specification, sample size and lag-length, particularly in small samples. Therefore, our results should be considered as no more than indicative. A more serious limitation of the study is that we could not legitimately draw inference on the effectiveness of aid, policy and public spending. A distinction between aid as finance from aid as policy condition has not been possible, and we do not know what donors intended the aid to be used for and the fact that DAC measure of aid is used. Moreover, the classification of expenditure categories is problematic, making it difficult to draw firm conclusions regarding the impact of government spending due to incremental aid on growth. This data draw back in our study merits a careful deeper analysis for Uganda.

Besides, aid surges carry with them an expectation of macroeconomic repercussions and potential macroeconomic management problems. These are subjects beyond the scope of this study but appropriate for further research. Even more, the data generating process based on the present sample could not support the analysis of the important current contemporaneous dynamic effect of aid on the rest of the variables in the systems analysed here. Thus, an expansion in the information set (especially a longer time series) that would accommodate a VAR of order higher than the one analyzed here (say VAR(2)) is very much desired. To this end, there is considerable scope in Uganda. This notwithstanding, it is fair to observe that if the stories in this study are put together, i.e. the derivation of a most reliable GDP measure for Uganda (as this is crucial for measuring how aid may have related to growth); the fiscal response to aid receipts; and the consideration of how aid mediated through fiscal variables affect growth (measured by growth in private incomes) a representative picture of the effect of aid in Uganda is gained.

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LIST OF APPENDENCIES

Appendix A: Sector Disaggregation of GDP

This section draws on both GDP aggregates, and sector value added and expenditure GDP disaggregates data (in current prices of local currency (LCU), hereafter UGX) from the two primary sources of GDP (i.e. WDI and UBOS). We use these data sets to: (i) reconstruct GDP by the two commonly used approaches (the expenditure and value added approach); (ii) establish if there are measurement inconsistencies in the components of each of the approaches across the two sources (as one could suspect this to be one possible cause of discrepancy across the two sources); and (iii) establish which of the two reconstructed series replicates the aggregate GDP series reported by each source, and if this is similar for the two sources.

1.1 Sector Expenditure Approach

GDP reconstruction using WDI's current price expenditure disaggregated data

Commentaries available from the source (WDI) shows that GDP by expenditure approach is an aggregation of two major components: the gross national expenditure (GNE), and external balances on goods and services. The former constitutes household final consumption expenditure (private consumption, C) and general government final consumption expenditure (government consumption, G), including any statistical discrepancy in the use of resources relative to the supply of resources, and gross capital formation (gross domestic investment, I). Thus,

$$GNE = C + G + I \qquad \text{(A1)}$$

In (A1), *C is the market value of all goods and services purchased by households, payments and fees to governments to obtain permits and licenses and includes the expenditures of non-profit institutions serving households, even when reported separately by the country. The estimation of* C *excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. G sums up expenditures by all government bodies on general public administration, defence, public order and safety affairs, education, health,* *community, social and economic services, agriculture, roads, water, loans repayment and pensions, among others. The measurement of I consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress". According to the 1993 SNA, net acquisitions of valuables are also considered capital formation*

Source: **World Bank national accounts data, and OECD National Accounts data files, 2009**).

External balances on goods and services is given as exports of goods and services (X) minus imports of goods and services (M), and is expressed as

$$X\text{-}M \qquad \text{(A2)}$$

Summing up Equations (A1) and (A2) gives the GDP identity by the expenditure approach in Equation (A3)

$$GDP = C + G + I + (X - M) \qquad \text{(A3)}$$

GDP reconstruction using UBOS's current price expenditure disaggregated data

This sums household final consumption expenditure (C), general government final consumption expenditure (G), Capital formation (I), and the trade balance $(X - M)$ as in Equation (A3), but with only one exception: the treatment given to statistical discrepancy. WDI incorporates this explicitly in the final consumption spending, but UBOS considers it as a separate item in the identity (UBOS and Back Ground to the Budget, *various issues*, Ministry of Finance, Planning and Economic Development, MoFPED). In this regard, we denote it separately and enter it as (Ω) in (A4).

$$GDP = C + G + I + (X - M) + \Omega \qquad \text{(A4)}$$

1.2 Sector Value Added Approach

GDP reconstruction using WDI's current price sector value added disaggregated data

In terms of sector value added, the World Bank and OECD (2009) National Accounts data files define GDP at purchaser prices as the sum of gross value added by all resident producers in the economy plus any product taxes, and minus any subsidies not included in the value of the products. It is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources, and the source uses it as determined by the International Standard Industrial Classification (ISIC), revision 3. In Uganda's GDP accounts, this approach sums up value added in the three sectors of agriculture (A), industry (N) and services (S) that make up the economy. The GDP identity by value added is represented in Equation (A5).

$$\text{GDP by sector value added} = \mathrm{A} + N + \mathrm{S} \qquad \text{(A5)}$$

In (A5), *A corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production; N corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37), which comprises value added in mining, manufacturing (also reported as a separate subgroup by national compilers), construction, electricity, water, and gas. S corresponds to ISIC divisions 50-99 that include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling*

Source: **World Bank national accounts data, and OECD National Accounts data files (2009).**

GDP reconstruction using UBOS's current price sector value added disaggregated data

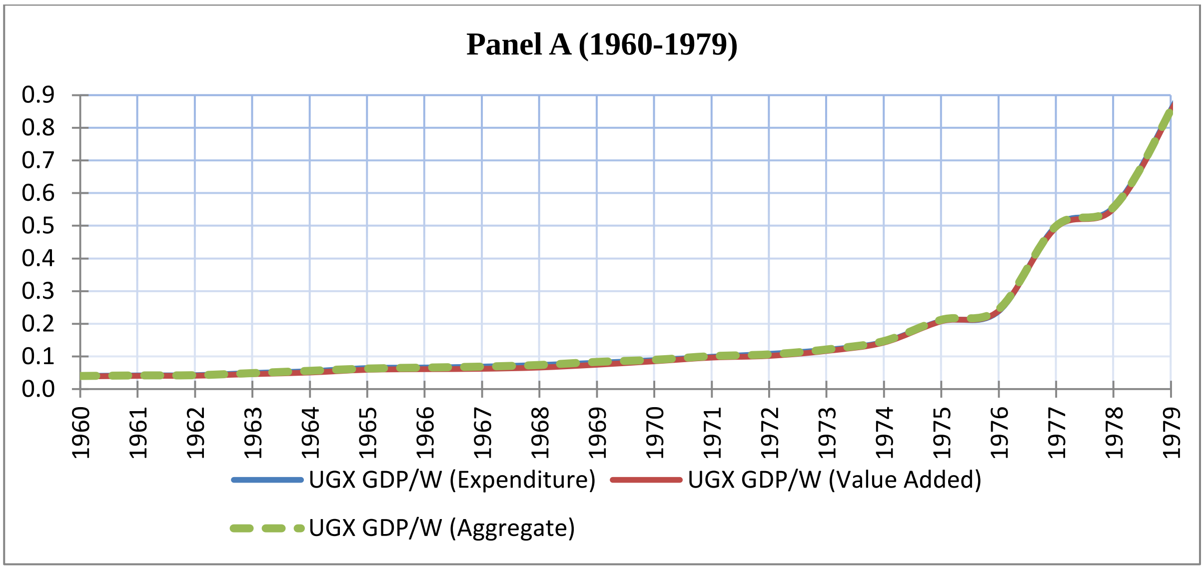
GDP by value added approach is the net monetary value of the output of the agriculture (A), industry (N), services (S) sectors as above and other activities (Ψ) after adding up all outputs and subtracting intermediate inputs. Its calculation does not incorporate deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. The ''other activities'' (Ψ) include imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling (UBOS and Back Ground to the Budget, *various issues*, MoFPED). The GDP identity by value added is represented as:

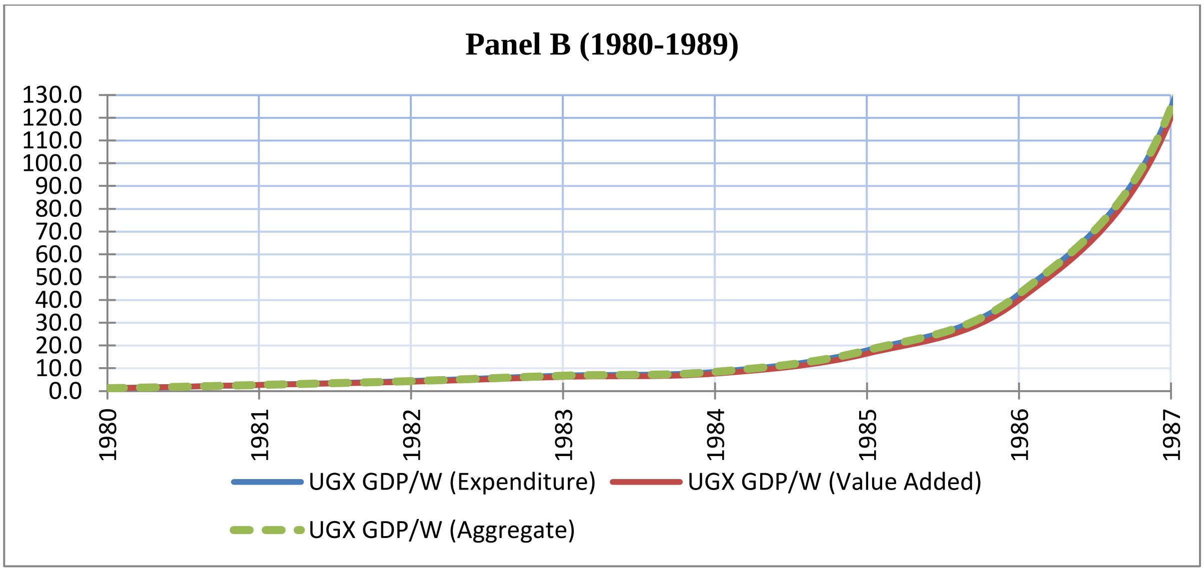
$$\text{GDP by sector value added} = \mathrm{A} + N + \mathrm{S} + \Psi \qquad \text{(A6)}$$

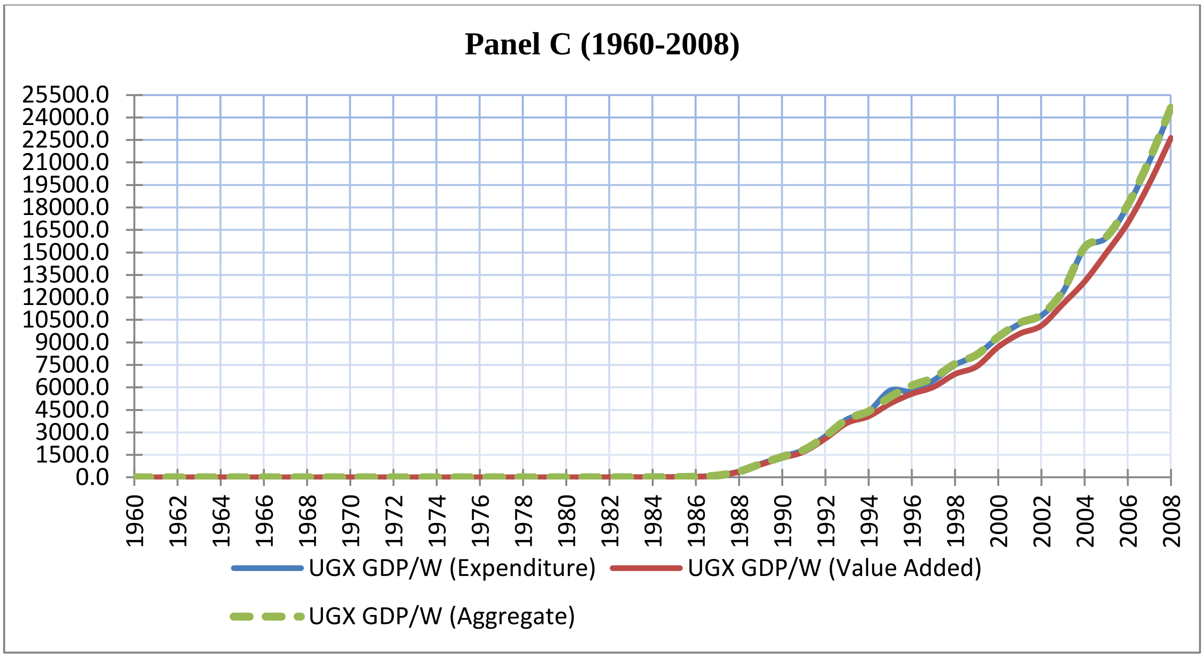
Considering the corresponding entries in (A3) and (A4) (GDP by sector expenditure approach), and (A5) and (A6) (GDP by sector value added approach), there is no evidence of material inconsistencies in the measurement of the components of each of the approaches across the two sources. What we find, but immaterial, are minor differences in activity aggregations. As noted above, the estimates for final consumption expenditure in (A3) for example includes any statistical discrepancy, but this is considered separately in (A4). Also, UBOS separates '*other activities*' as defined in (A6) from the services while WDI incorporates this explicitly in the mainstream services sector. Thus, WDI and UBOS consider the same components in their respective GDP identity approach. Based on this, we use data on GDP disaggregates to reconstruct GDP by sector expenditure and sector value added identities, which we then compare with the aggregate GDP series reported by each source. As set out earlier, the comparison aims to investigate whether it is GDP by sector expenditure or GDP by sector value added that is used to derive aggregate GDP as is reported by the respective sources.

Aggregate and 'authors' reconstructed GDP series are given in Figure (A1) for WDI and Figure (A2) for UBOS, while Figure (A3) compares the aggregate GDP series across the two sources. Given large changes in scale, each of this is conveniently split into three panels: panels A (covering the period until 1979); panel B (early to mid-1980s period); and panel C (which covers the entire sample period). In Figure (A1), UGX GDP (value added) and UGX GDP (aggregate) are clearly distinguishable, but UGX GDP (aggregate) and UGX GDP (expenditure) are identical, i.e. GDP by sector expenditure replicates the aggregate GDP that WDI reports. Also, UGX GDP (aggregate) and UGX GDP (expenditure) (as one) is systematically higher than UGX GDP (value added) at almost all data points.

Figure A1: Aggregate and Reconstructed GDP from Sector Expenditure and Value Added Disaggregated Data: WDI





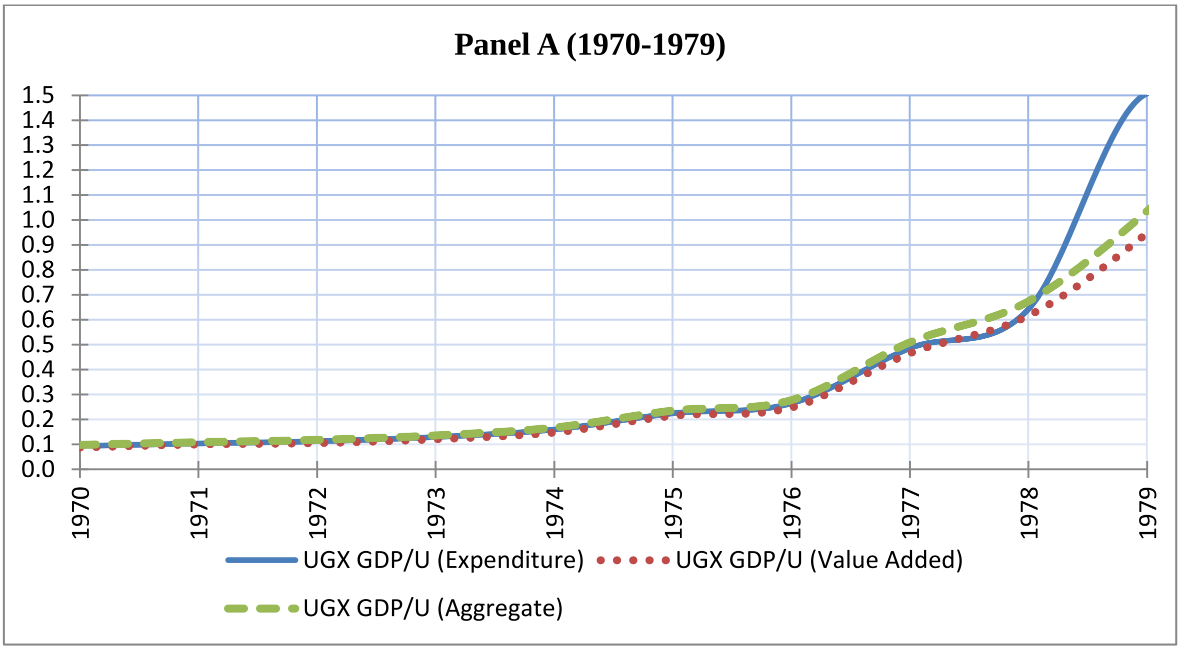


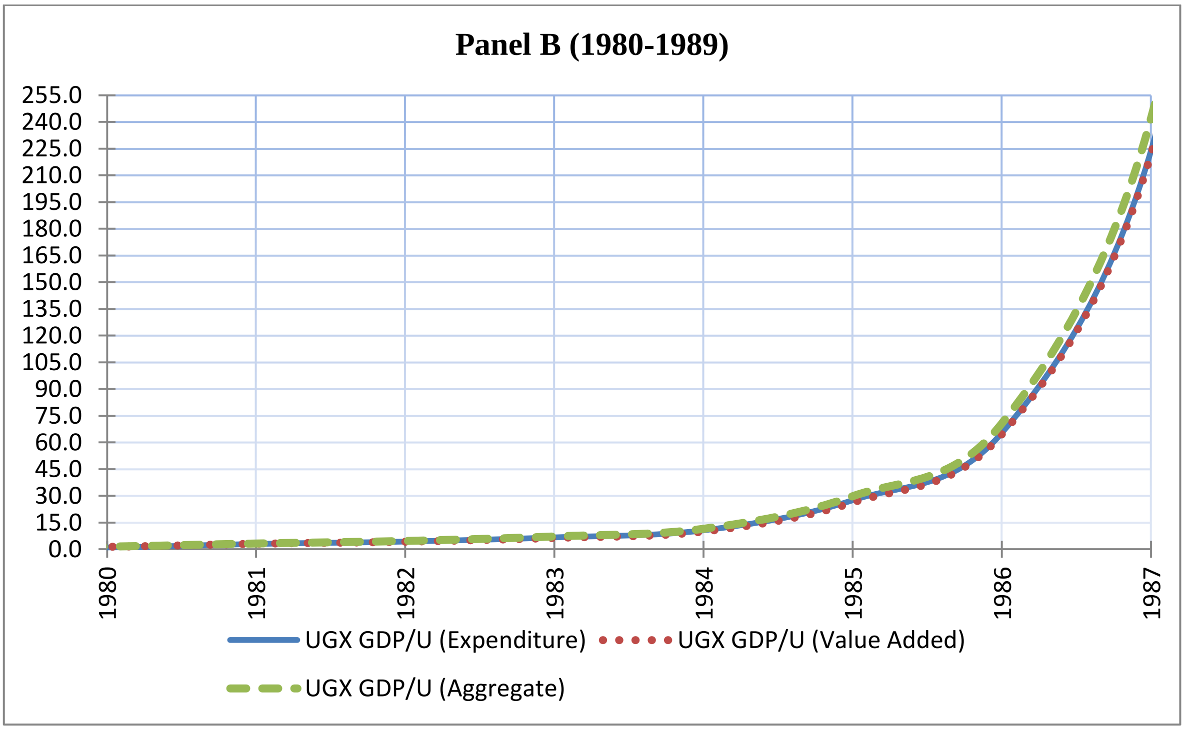
Notes: On the vertical axis is GDP in billions of current UGX

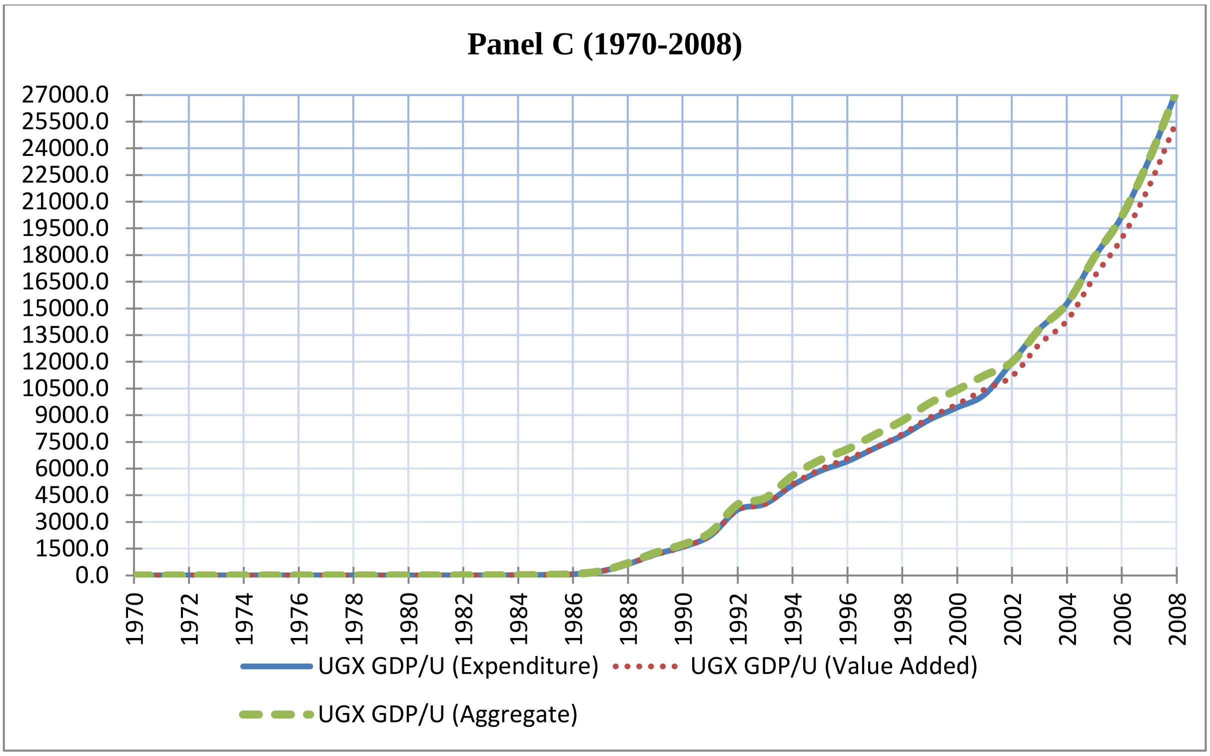
Source: World Bank national accounts data and OECD National Accounts data files (2009) and Author's own calculations

The story in Figure (A2) is mixed. UGX GDP (expenditure) appears to replicate UGX GDP (aggregate) at least initially over the period 1970-77. Between 1978 and mid-1979, UGX GDP (expenditure) rises sharply over and above the other two measures (aggregate and value added GDP) and falls significantly below both aggregate and value added GDP between mid-1979 and mid-1980. Over the period 1978-2001, neither UGX GDP (expenditure) nor UGX GDP (value added) replicates UGX GDP (aggregate), suggesting that the latter may have been derived in a way that approximated data and/or taken as a proxy economic indicator from international sources. Effective 2002 however, UGX GDP (expenditure) replicates the aggregate GDP, and the two (combined into one) are systematically higher than UGX GDP (value added).

Figure A2: Aggregate and Reconstructed GDP from Sector Expenditure and Value Added Disaggregated Data: UBOS







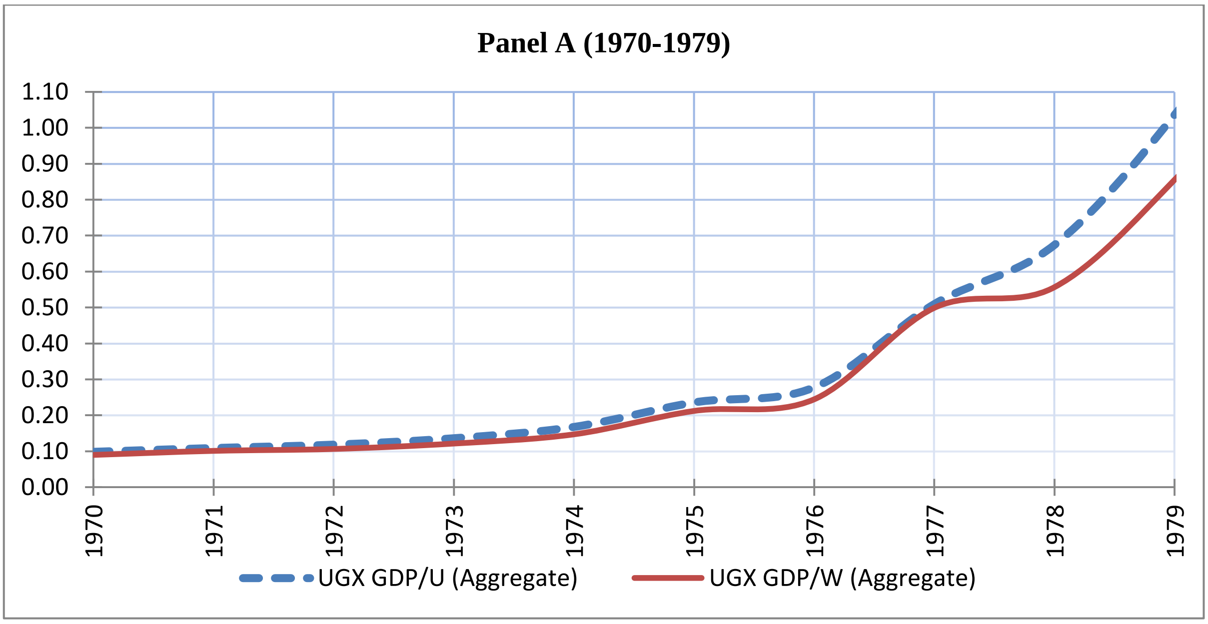
Notes: On the vertical axis is GDP in billions of current UGX

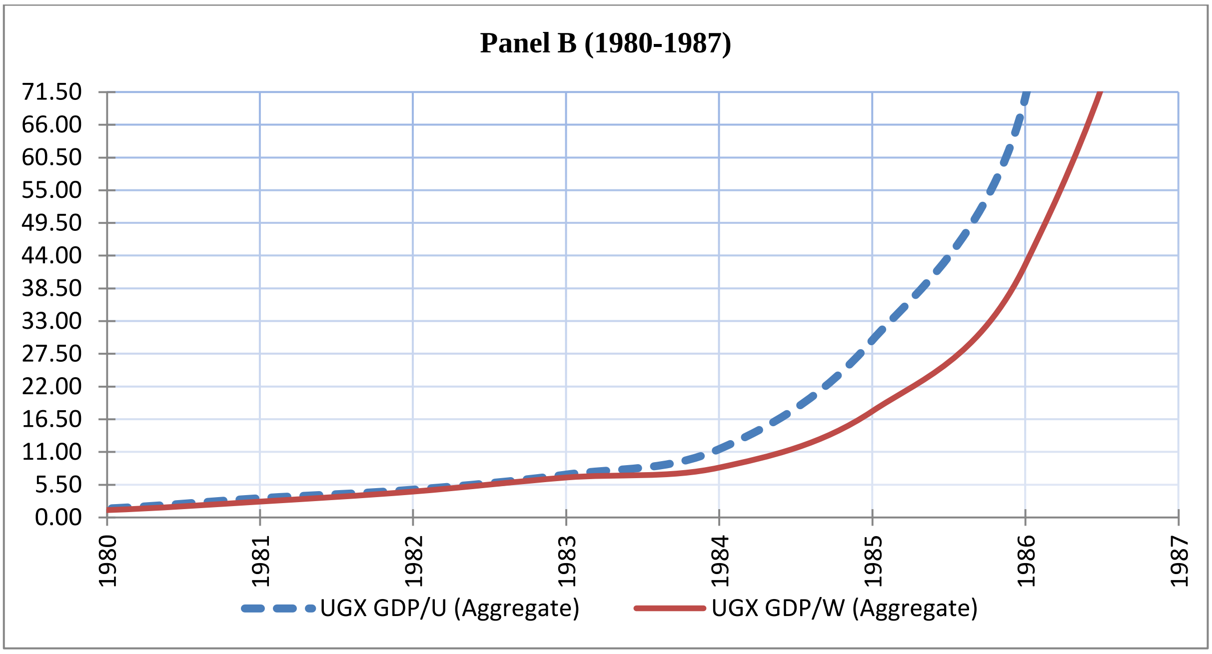
Source: UBOS National Accounts Estimates of main Aggregates and Author's own calculations

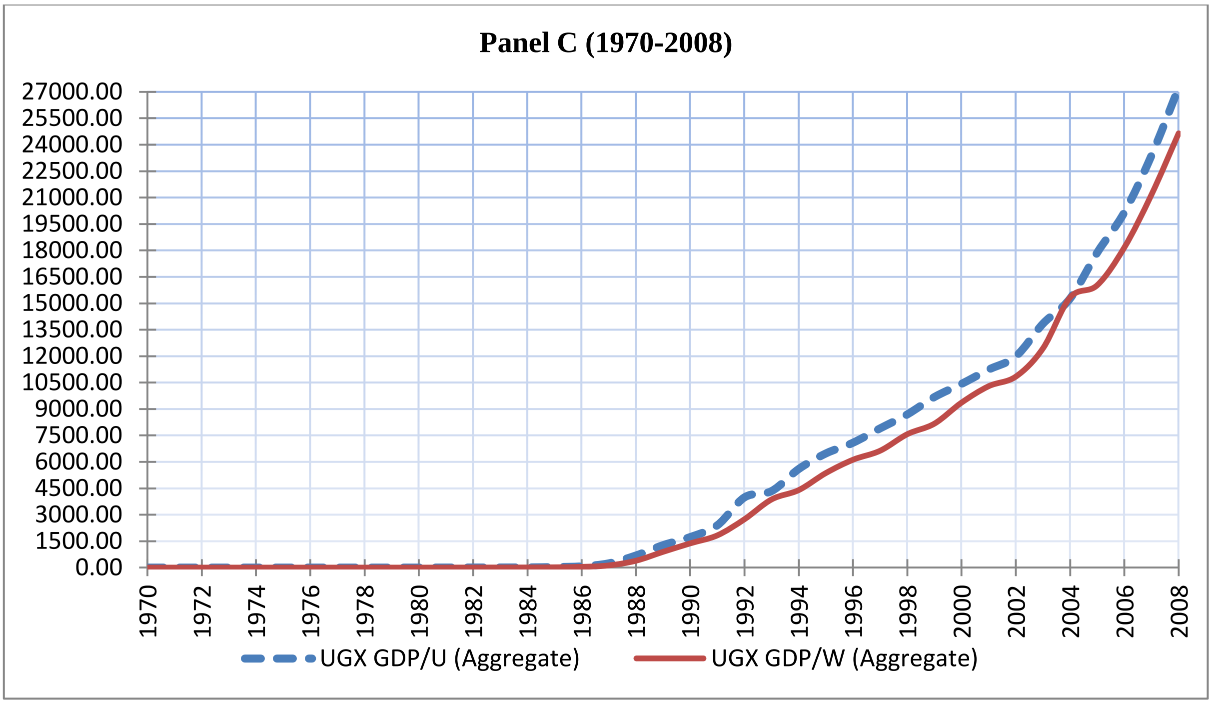
Overall, it appears that sector value added and expenditure approaches yield similar but not identical estimates of level GDP. Expenditure and aggregate GDP are identical, at least for the greater part of the series sample periods, suggesting that both sources compile Uganda's GDP by expenditure approach. Following from this, subsequent comparisons and analysis are based on aggregate UGX GDP estimates.

Finally, Figure (A3) compares aggregate UGX GDP estimates across the two sources. Although these move together in nominal terms, they are inconsistent (UGX GDP/U is consistently higher than UGX GDP/W) and converge in 2004. The series look similar because alternative sources use a similar fixed-base Laspeyres index splicing/linking technique to construct continuous time series. The procedure requires several heterogeneous shorter series to be pieced together (Fuente, 2009), because as (Brueton, 1999) notes, over time relative prices and volumes of goods and services change; some products disappear from the market place and new products appear. Thus, in order to ensure that the price structure reflected in the index construction remains representative, it is a common practice to link the national accounts data at regular intervals.

Figure A3: Aggregate UGX GDP (current prices) Comparison: WDI and UBOS







Notes:	On the vertical axis is GDP in billions of current UGX; U denotes UBOS and W stands for WDI.
Sources:	World Bank national accounts data and OECD National Accounts data files (2009) and UBOS National Accounts Estimates of main Aggregates

The series are inconsistent because of differences in regularity of the time intervals at which alternative sources pieced together several heterogeneous shorter series. Commentaries with WDI show that the series was linked by butt splicing in 1972 while 1979, 1986, and 2002 corresponds to a break in analytical comparability data or change of magnitude. It is also shown that multiple time series versions were linked by ratio splicing using the first annual overlap in 1991 and 2004. No such commentaries about the series linking points are available with UBOS except for one point, 2004 when multiple time series versions were linked by ratio splicing as in WDI. So, it appears 2004 corresponds to a harmonized series linking point. Another plausible explanation for the observed inconsistencies may relate to whether the series is spliced at the aggregate or disaggregates level. It is worth noting that while the individual expenditure components of WDI add up to aggregate GDP, those of UBOS do so only for the period 2002-2008. It is therefore possible that UBOS series may have been spliced at the aggregate level and that of WDI at the components level. Romer (1987) shows that aggregate level splicing does not genuinely convert the revised series, suggesting that components and aggregate level spliced series tend to differ.

Appendix Table A1: Selected WDI Data Set

Year	Population (Millions)	End of year nominal exchange rate (UGX per USD)	USD Denominated: USD GDP (Billions of current prices)	USD GDP Index (1970=100)	USD GDP per capita	USD GDP per capita index (1970=100)	UGX Denominated: UGX GDP (Billions of current prices)	Real UGX GDP (Billions of constant 2005 prices)	Real UGX GDP index (1970=100)	Real UGX GDP per capita	Real UGX GDP per capita index (1970=100)
1970	9,443,100	0.0714	1.26	100	133.4	100	0.08997	48.21	100	5,105.27	100
1971	9,727,225	0.0714	1.42	112	145.7	110	0.10123	50.37	105	5,178.32	101
1972	10,009,099	0.0714	1.49	118	149.0	112	0.1065	48.77	101	4,872.80	95
1973	10,293,317	0.0690	1.70	135	165.3	124	0.12156	48.39	100	4,701.04	92
1974	10,586,431	0.0714	2.10	167	198.3	149	0.14722	47.62	99	4,497.79	88
1975	10,893,437	0.0826	2.36	187	216.6	163	0.21236	48.19	100	4,423.83	87
1976	11,217,082	0.0831	2.45	194	218.2	164	0.24473	47.15	98	4,203.72	82
1977	11,557,069	0.0795	2.94	233	254.1	191	0.4992	53.15	110	4,599.31	90
1978	11,911,811	0.0742	2.42	192	203.2	153	0.55666	43.01	89	3,610.56	71
1979	12,278,381	0.0733	2.14	170	174.2	131	0.85561	37.63	78	3,064.92	60
1980	12,655,396	0.0757	1.24	99	98.3	74	1.24461	36.68	76	2,898.02	57
1981	13,041,409	0.8515	1.34	106	102.5	77	2.6746	38.09	79	2,920.77	57
1982	13,439,426	1.0582	2.18	173	162.0	122	4.355	46.33	96	3,447.61	68
1983	13,857,714	2.4000	2.24	178	161.7	122	6.721	49.29	102	3,557.09	70
1984	14,307,266	5.2000	3.62	287	252.7	190	8.390833	36.78	76	2,570.49	50
1985	14,795,432	14.0000	3.52	279	237.9	179	17.87674	30.15	63	2,037.47	40
1986	15,325,608	14.0000	3.92	311	256.0	192	42.58355	30.72	64	2,004.48	39
1987	15,894,088	60.0000	6.27	498	394.5	297	124.3953	27.89	58	1,754.77	34
1988	16,492,254	165.0000	6.51	517	394.7	297	390.5359	33.33	69	2,020.71	40
1989	17,107,626	370.0000	5.28	419	308.4	232	894.926	43.97	91	2,570.42	50
1990	17,730,869	540.0000	4.30	342	242.8	183	1,375.747	52.79	110	2,977.15	58
1991	18,360,515	915.0000	3.32	264	180.9	136	1,829.999	53.39	111	2,908.10	57

1992	18,998,629	1217.1500	2.86	227	150.4	113	2,745.492	50.52	105	2,659.26	52
1993	19,643,839	1130.1500	3.22	256	163.9	123	3,870.387	70.00	145	3,563.34	70
1994	20,295,395	926.7700	3.99	317	196.6	148	4,400.27	68.41	142	3,370.92	66
1995	20,953,589	1009.4500	5.76	457	274.7	207	5,367.456	78.87	164	3,764.23	74
1996	21,617,190	1029.5900	6.04	480	279.6	210	6,122.089	87.34	181	4,040.53	79
1997	22,288,245	1140.1100	6.27	498	281.3	211	6,633.475	89.38	185	4,010.33	79
1998	22,974,610	1362.6900	6.58	523	286.6	215	7,570.25	101.74	211	4,428.54	87
1999	23,686,817	1506.0400	6.00	476	253.2	190	8,170.7	105.05	218	4,435.10	87
2000	24,432,843	1766.6800	6.19	492	253.5	191	9,364.317	116.67	242	4,775.06	94
2001	25,215,902	1727.4000	5.84	464	231.6	174	10,296.37	126.56	263	5,018.88	98
2002	26,035,327	1852.5700	6.18	490	237.3	178	10,840.67	130.82	271	5,024.85	98
2003	26,890,404	1935.3200	6.61	524	245.7	185	12,443.5	138.07	286	5,134.52	101
2004	27,778,909	1738.5900	7.92	629	285.2	214	15,331.31	163.15	338	5,873.27	115
2005	28,699,255	1816.8600	9.23	732	321.4	242	16,026	160.26	332	5,584.07	109
2006	29,651,734	1741.4400	9.96	790	335.8	252	18,172	172.46	358	5,816.03	114
2007	30,637,544	1697.3400	11.89	944	388.2	292	21,168.4	188.16	390	6,141.49	120
2008	31,656,865	1949.1800	14.53	1153	458.9	345	24,647.53	206.10	428	6,510.41	128

Source: World Bank national accounts data and OECD National Accounts data files (2009) and Author's own computations

Appendix Table A2: Selected UBOS Data Set

				USD Denomination				UGX Denomination				
Year	Population (Millions)	End of year nominal exchange rate (UGX per USD)	UGX GDP Implicit Price Deflator, (2005=100)	USD GDP (Billions of current prices)	USD GDP Index (1970=100)	USD GDP per capita	USD GDP per capita index (1970=100)	UGX GDP (Billions of current prices)	Real UGX GDP (Billions of constant 2005 prices)	Real UGX GDP index (1970=100)	Real UGX GDP per capita	Real UGX GDP per capita index (1970=100)
1970	9,443,100	0.0714	0.00	1.38	100	146.1	100	0.098558	52.81	100	5592.60	100
1971	9,727,225	0.0714	0.00	1.53	111	156.9	107	0.109043	54.26	103	5577.99	100
1972	10,009,099	0.0714	0.00	1.66	120	165.7	114	0.11848	54.26	103	5420.91	97
1973	10,293,317	0.0702	0.00	1.94	141	188.6	129	0.136304	54.26	103	5271.23	94
1974	10,586,431	0.0714	0.00	2.35	170	222.1	152	0.167759	54.26	103	5125.28	92
1975	10,893,437	0.0916	0.00	2.57	187	236.4	162	0.235911	53.53	101	4914.42	88
1976	11,217,082	0.1020	0.01	2.72	197	242.8	166	0.27785	53.53	101	4772.63	85
1977	11,557,069	0.1736	0.01	2.93	213	254.0	174	0.509567	54.26	103	4694.82	84
1978	11,911,811	0.2236	0.01	3.02	219	253.2	173	0.67418	52.09	99	4372.81	78
1979	12,278,381	0.3626	0.02	2.86	207	232.8	159	1.036243	45.58	86	3711.98	66
1980	12,655,396	0.4962	0.03	3.04	220	240.1	164	1.507367	44.42	84	3509.83	63
1981	13,041,409	0.9384	0.07	3.45	250	264.7	181	3.239251	46.13	87	3537.39	63
1982	13,439,426	1.1841	0.09	3.95	286	293.7	201	4.673993	49.73	94	3700.14	66
1983	13,857,714	1.6523	0.14	4.36	316	314.9	216	7.21047	52.88	100	3816.14	68
1984	14,307,266	2.6649	0.23	4.32	313	301.8	207	11.50821	50.44	96	3525.48	63
1985	14,795,432	6.7202	0.59	4.44	322	299.9	205	29.81711	50.28	95	3398.35	61
1986	15,325,608	14.0000	1.39	5.05	366	329.8	226	70.75753	51.04	97	3330.67	60
1987	15,894,088	42.8413	4.46	5.65	410	355.7	244	242.2313	54.31	103	3417.01	61
1988	16,492,254	106.1358	11.72	6.46	468	392.0	268	686.1612	58.55	111	3550.34	63
1989	17,107,626	223.0916	20.35	5.71	414	333.8	229	1273.844	62.59	119	3658.75	65
1990	17,730,869	428.8547	26.06	4.04	293	227.8	156	1732.171	66.46	126	3748.46	67
1991	18,360,515	734.0099	34.27	3.27	237	178.3	122	2403.339	70.12	133	3819.21	68

1992	18,998,629	1133.8343	54.34	3.52	255	185.1	127	3987.053	73.37	139	3861.83	69
1993	19,643,839	1195.0168	55.29	3.63	263	185.0	127	4343.127	78.55	149	3998.57	71
1994	20,295,395	979.4454	64.32	5.72	414	281.6	193	5597.813	87.03	165	4288.32	77
1995	20,953,589	968.9167	68.05	6.69	485	319.1	219	6478.947	95.21	180	4543.72	81
1996	21,617,190	1046.0848	70.09	6.78	491	313.5	215	7088.54	101.13	192	4678.37	84
1997	22,288,245	1083.0087	74.21	7.30	529	327.4	224	7903.363	106.49	202	4778.06	85
1998	22,974,610	1240.3058	74.40	7.01	508	305.1	209	8693.913	116.85	221	5085.88	91
1999	23,686,817	1454.8272	77.78	6.65	482	280.9	192	9681.518	124.48	236	5255.18	94
2000	24,432,843	1644.4753	80.26	6.34	459	259.5	178	10427.61	129.92	246	5317.25	95
2001	25,215,902	1755.6588	81.36	6.40	464	253.9	174	11238.47	138.14	262	5478.10	98
2002	26,035,327	1797.5505	82.86	6.67	483	256.2	175	11989.65	144.69	274	5557.42	99
2003	26,890,404	1963.7201	90.13	7.05	511	262.2	180	13843.25	153.60	291	5712.10	102
2004	27,778,909	1810.3047	93.97	8.44	611	303.7	208	15271.32	162.51	308	5850.28	105
2005	28,699,255	1780.6658	100.00	10.04	728	349.8	240	17877.94	178.78	339	6229.36	111
2006	29,651,734	1831.4534	105.37	11.01	798	371.3	254	20166.19	191.38	362	6454.28	115
2007	30,637,544	1723.4918	112.50	13.57	984	443.0	303	23391.98	207.92	394	6786.60	121
2008	31,656,865	1720.7001	119.59	15.83	1147	500.0	342	27236.57	227.75	431	7194.28	129

Source: Uganda Bureau of Statistics: National Accounts Estimates of main Aggregates and Author's own computations

Appendix Table A3: GDP PPP per capita Data Set

	PWT6.3		WDI	
Year	CGDP (1996=100)	CGDP index (1982=100)	GDP PPP per capita (2005=100)	GDP PPP per capita index (1982=100)
1982	452.10	100	567.44	100
1983	510.58	113	581.93	103
1984	532.66	118	561.70	99
1985	499.93	111	525.21	93
1986	493.77	109	509.02	90
1987	498.06	110	510.26	90
1988	507.44	112	532.40	94
1989	534.77	118	545.91	96
1990	570.11	126	560.82	99
1991	589.47	130	571.67	101
1992	599.44	133	571.35	101
1993	632.73	140	598.59	105
1994	767.40	170	616.48	109
1995	794.09	176	665.92	117
1996	796.57	176	704.04	124
1997	870.17	192	717.66	126
1998	894.78	198	730.37	129
1999	939.38	208	765.47	135
2000	962.92	213	783.94	138
2001	1000.83	221	797.15	140
2002	1034.57	229	821.51	145
2003	1069.47	237	846.88	149
2004	1109.95	246	875.60	154
2005	1167.26	258	901.19	159
2006	1224.15	271	966.31	170
2007	1298.83	287	1015.53	179

Sources: World Bank; International Comparison Program database; & Alan Heston ,Robert Summers and Bettina Aten, Penn World Table Version 6.3, Centre for international Comparisons of Production, Income and Prices at the University of Pennsylvania, August 2009; and Author’s own computations.

Appendix B: Determination of the Lag Length and Misspecification Tests

The SC and HQ information criteria are used. With several regressors and a relatively small sample, it is not possible to test long lag-lengths.[41] We started with lag 2 and employed a general-to-specific modelling approach. Test results for minimising the information criteria are given in Appendix Table B1

Appendix Table B1: Lag Length Determination

```
LAG LENGTH DETERMINATION
Effective Sample: 1974:01 to 2008:01

MODEL SUMMARY
Model  k T  Regr  Log-Lik    SC    H-Q   LM(1) LM(k)
VAR(2) 2 35   14 -1493.863 93.896 91.452 0.363 0.101
VAR(1) 1 35    8 -1538.639 92.798 91.401 0.611 0.611
```

Notes: SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion; LM (k): LM order autocorrelation test at lag k.

As the recommendation is to select the lowest value for the information criteria, both *SC* and *HQ* suggest VAR(1) could be a reasonable approximation of the DGP. The LM test further shows the model meets the crucial assumption of uncorrelated residuals. So, we adopted VAR(1) and subjected it to residual misspecification tests. Results of model suitability tests, including the residuals plots and residual analysis (normality, Heteroskedasticity, and the models goodness of fit) are reported in Appendix figure B1 and Appendix Table B2.

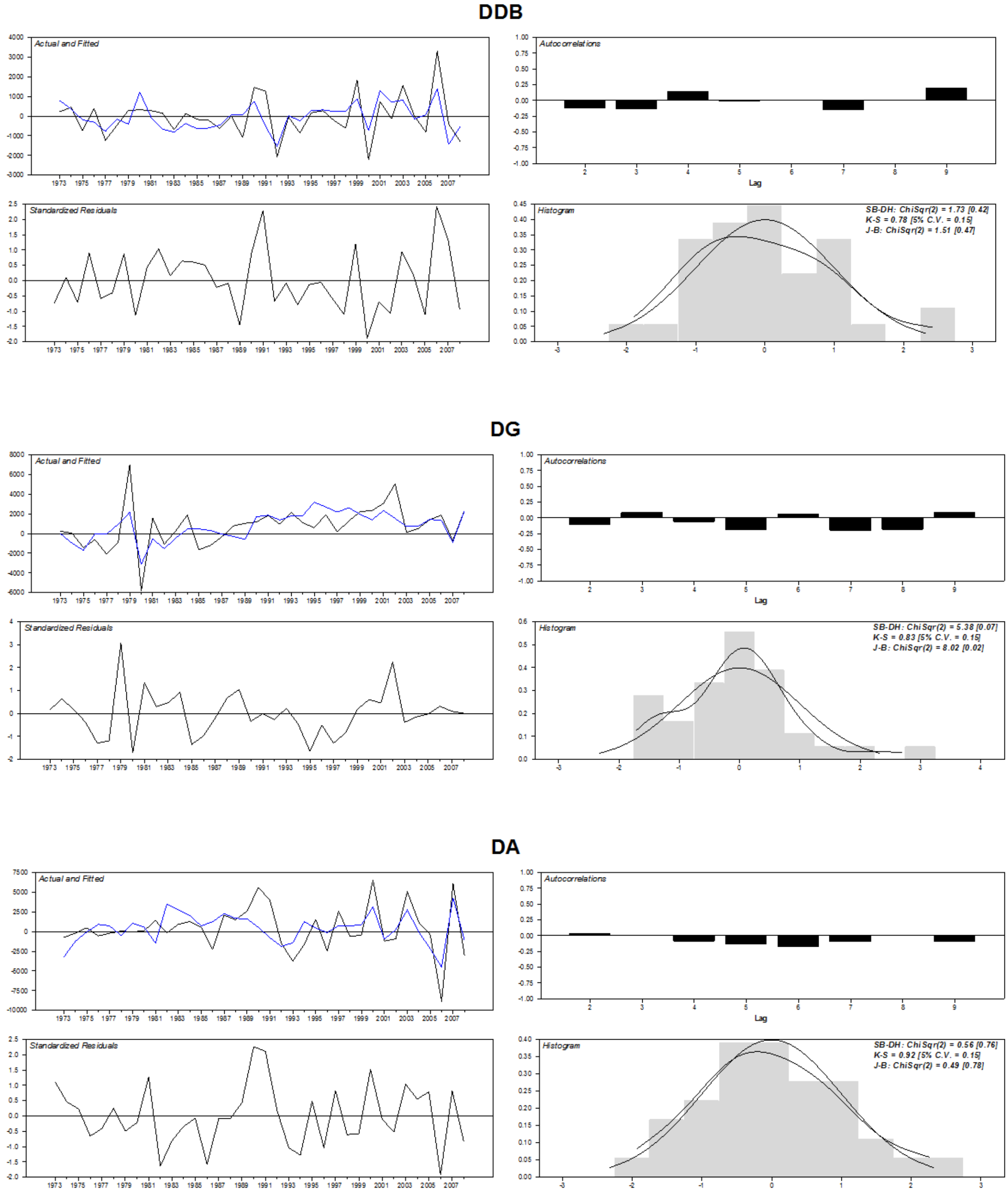
Residuals Plots

In the figure below, each error correction model equation consists of a panel of 4 plots: (a) Actual and fitted values (top left); (b) standardized residuals (bottom left); (c) autocorrelations (top right); and (d) histogram (bottom right). Also, overlaid on the histogram is the estimated density function of the standardized residuals (appears as a dotted line in print) and the density of the standard normal distribution. It also contains some statistics: the univariate normality test by Doornik and Hansen-DH (2008) and

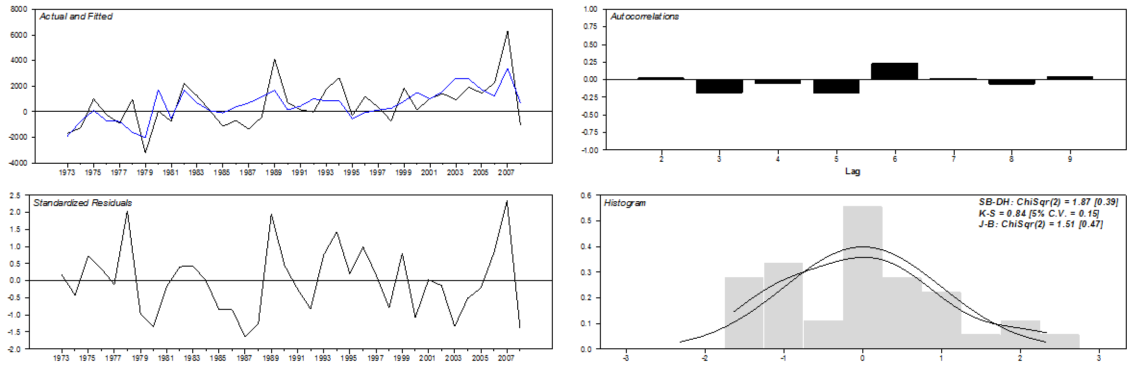
[41] Lütkepohl and Krätzig (2004) suggest that an "excessively large value of $p_{\max}$ [maximum lags for test] may be problematic" since it affects the overall Type I error of the testing sequence.

Kolmogorov-Smirnov-K-S (Lilliefors, 1967) test for normality, and the Jarque-Bera test computed by the RATS' statistics instruction (Dennis, 2006).

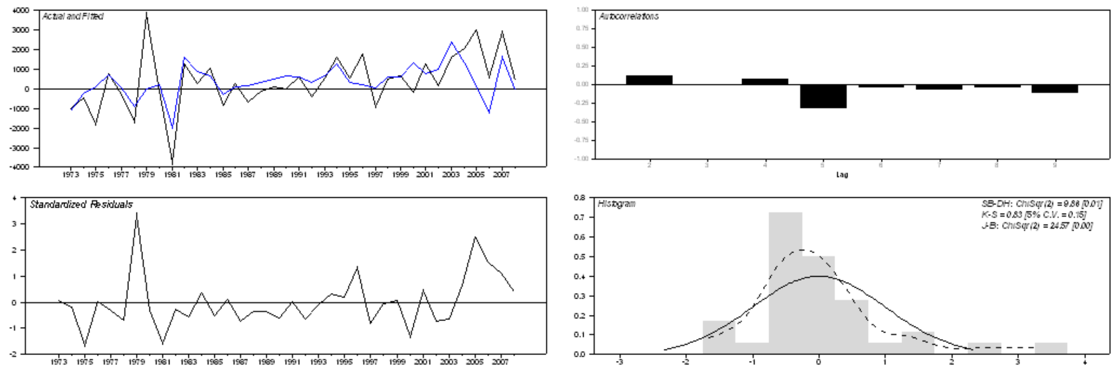
Appendix Figure B1: Actual, Fitted and Standardized Residuals, Autocorrelations and Histograms



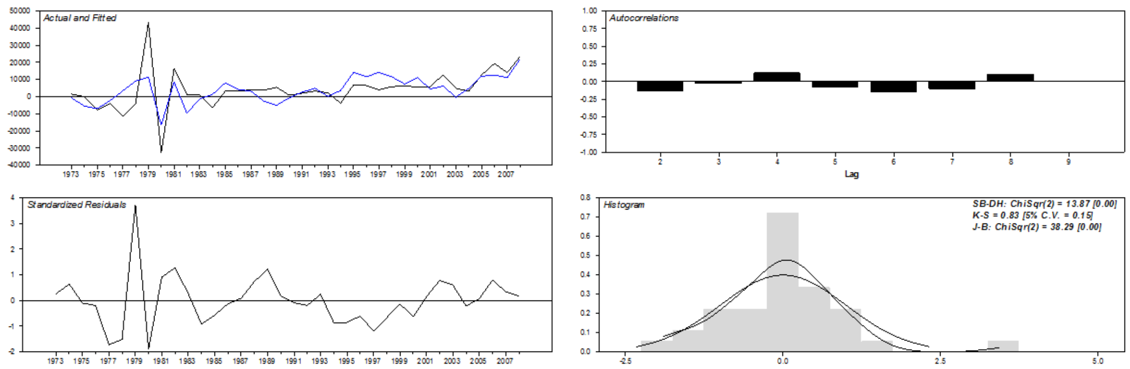
DR



DX



DPC



The plots do not suggest any significant problem except some outlier observation in the residuals for *G*, *X* and *PC* that occurs around 1979. The actual and fitted residuals show a slight but detectable change in behaviour from about 1988. This notwithstanding, the histograms portray reasonably normal distribution behaviour.

Residual Analysis

Appendix Table B2: Residual Analysis

Residual S.E. and Cross-Correlations

	DDB	DG	DA	DTR	DX	DPC
	775.1173	1548.3985	2218.4111	1234.6740	1003.8957	8454.8802
DDB	1.000					
DG	0.088	1.000				
DA	-0.059	-0.009	1.000			
DTR	0.143	-0.007	-0.068	1.000		
DX	0.299	0.265	-0.308	0.087	1.000	
DPC	0.308	0.813	-0.057	-0.064	0.424	1.000

```
LOG(|Sigma|)                     =  87.858
Information Criteria: SC         =  92.636
                      H-Q        =  91.261
Trace Correlation                =   0.439

Tests for Autocorrelation
Ljung-Box(9):         ChiSqr(288) = 672.615 [0.000]
LM(1):                ChiSqr(36)  =  34.161 [0.556]
LM(2):                ChiSqr(36)  =  53.704 [0.129]

Test for Normality:   ChiSqr(12)  =  22.473 [0.033]

Test for ARCH:
LM(1):                ChiSqr(441) = 442.955 [0.465]
LM(2):                ChiSqr(882) = 756.000 [0.999]
```

Univariate Statistics

	Mean	Std.Dev	Skewness	Kurtosis	Maximum	Minimum
DDB	-0.000	775.117	0.480	2.875	1910.088	-1491.420
DG	0.000	1548.398	0.740	4.328	4812.824	-2692.423
DA	-0.000	2218.411	0.265	2.714	5091.461	-4345.092
DTR	-0.000	1234.674	0.477	2.734	2926.464	-2044.831
DX	-0.000	1003.896	1.004	5.063	3412.345	-1702.573
DPC	0.000	8454.880	1.099	6.738	31877.318	-16252.478

	ARCH(1)		Normality		R-Squared
DDB	0.449	[0.503]	1.732	[0.421]	0.447
DG	1.510	[0.219]	5.375	[0.068]	0.452
DA	0.683	[0.409]	0.557	[0.757]	0.406
DTR	0.198	[0.657]	1.868	[0.393]	0.483
DX	0.094	[0.759]	7.398	[0.025]	0.488
DPC	3.576	[0.059]	13.869	[0.001]	0.452

Notes: The multivariate diagnostic test is the chi-square for the joint significance of the variables. Null hypothesis is: VEC residuals are Gaussian errors.

Appendix Table B3: Extreme values of Standardized Residuals

Date	Entry	SRes_DB	SRes_G	SRes_A	SRes_TR	SRes_X	SRes_PC
1973:01	1	-0.721	0.167	1.111	0.169	-0.163	0.259
1974:01	2	0.100	0.640	0.459	-0.417	-0.104	0.642
1975:01	3	-0.710	0.178	0.234	0.728	-1.522	-0.099
1976:01	4	0.897	-0.374	-0.657	0.359	0.017	-0.192
1977:01	5	-0.579	-1.287	-0.407	-0.109	-0.315	-1.725
1978:01	6	-0.403	-1.191	0.254	2.049	-0.880	-1.511
1979:01	7	0.872	3.065	-0.497	-0.969	3.352 *	3.718 *
1980:01	8	-1.142	-1.715	-0.216	-1.340	0.748	-1.895
1981:01	9	0.439	1.351	1.272	-0.175	-1.250	0.914
1982:01	10	1.034	0.294	-1.635	0.412	0.562	1.273
1983:01	11	0.157	0.467	-0.810	0.441	-0.051	0.268
1984:01	12	0.639	0.919	-0.339	0.004	0.735	-0.917
1985:01	13	0.601	-1.347	-0.076	-0.838	-0.388	-0.570
1986:01	14	0.504	-0.968	-1.584	-0.849	0.551	-0.125
1987:01	15	-0.215	-0.180	-0.088	-1.633	-0.105	0.089
1988:01	16	-0.090	0.681	-0.084	-1.269	0.487	0.741
1989:01	17	-1.456	1.047	0.443	1.957	0.610	1.220
1990:01	18	0.875	-0.340	2.263	0.458	-0.398	0.175
1991:01	19	2.296	-0.005	2.113	-0.242	0.046	-0.082
1992:01	20	-0.676	-0.260	0.174	-0.828	-0.778	-0.190
1993:01	21	-0.086	0.230	-1.040	0.762	-0.140	0.245
1994:01	22	-0.790	-0.456	-1.278	1.436	0.252	-0.862
1995:01	23	-0.130	-1.648	0.478	0.202	-0.311	-0.853
1996:01	24	-0.053	-0.502	-1.034	0.993	1.133	-0.601
1997:01	25	-0.589	-1.292	0.823	0.175	-1.216	-1.185
1998:01	26	-1.101	-0.844	-0.610	-0.792	-0.463	-0.668
1999:01	27	1.196	0.187	-0.581	0.810	-0.061	-0.132
2000:01	28	-1.897	0.604	1.529	-1.078	-1.672	-0.630
2001:01	29	-0.701	0.461	-0.105	0.028	0.007	0.146
2002:01	30	-1.072	2.231	-0.523	-0.139	-1.242	0.780
2003:01	31	0.942	-0.383	1.040	-1.336	-1.112	0.603
2004:01	32	0.186	-0.145	0.549	-0.514	0.208	-0.212
2005:01	33	-1.113	-0.020	0.790	-0.214	2.058	0.076
2006:01	34	2.430	0.322	-1.931	0.812	1.020	0.793
2007:01	35	1.321	0.098	0.813	2.337	1.084	0.339
2008:01	36	-0.965	0.014	-0.849	-1.391	-0.698	0.169

Notes: * Maximum Value occurring at 1979:01; 5% C.V = 3.1934

Appendix Table B4: Residual Analysis with Modification

Residual S.E. and Cross-Correlations

	DDB	DG	DA	DTR	DX	DPC
	680.9422	867.7248	1999.7439	1114.7484	867.6104	3344.0263
DDB	1.000					
DG	-0.276	1.000				
DA	0.088	0.140	1.000			
DTR	0.293	-0.313	-0.110	1.000		
DX	0.087	-0.095	-0.251	0.181	1.000	
DPC	-0.032	0.406	0.050	-0.332	0.058	1.000

```
LOG(|Sigma|)                      =  84.912
Information Criteria: SC          =  91.482
                      H-Q         =  89.592
Trace Correlation                 =   0.602

Tests for Autocorrelation
Ljung-Box(9):         ChiSqr(288) = 452.633 [0.000]
LM(1):                ChiSqr(36)  =  30.485 [0.728]
LM(2):                ChiSqr(36)  =  40.893 [0.264]

Test for Normality:   ChiSqr(12)  =  25.152 [0.014]

Test for ARCH:
LM(1):                ChiSqr(441) = 460.556 [0.251]
LM(2):                ChiSqr(882) = 791.187 [0.987]
```

Univariate Statistics

	Mean	Std.Dev	Skewness	Kurtosis	Maximum	Minimum
DDB	-0.000	680.942	0.743	3.427	1895.180	-1192.224
DG	-0.000	867.725	1.382	5.867	3146.004	-1124.920
DA	-0.000	1999.744	0.489	3.038	5050.911	-3526.707
DTR	-0.000	1114.748	0.233	2.611	2517.336	-2303.465
DX	-0.000	867.610	0.434	3.109	1981.644	-1581.349
DPC	0.000	3344.026	-0.376	2.488	5402.220	-7381.602

	ARCH(1)		Normality		R-Squared
DDB	0.399	[0.528]	3.841	[0.147]	0.573
DG	0.492	[0.483]	10.478	[0.005]	0.828
DA	0.834	[0.361]	1.794	[0.408]	0.517
DTR	0.060	[0.807]	0.424	[0.809]	0.579
DX	0.086	[0.770]	1.611	[0.447]	0.617
DPC	0.128	[0.721]	1.456	[0.483]	0.914

Appendix Table B5: Johansen's Cointegration trace test Results (Model with Dummies)

I(1)-ANALYSIS

p-r	r	Eig.Value	Trace	Trace*	Frac95	P-Value	P-Value*
6	0	0.796	180.924	162.324	146.478	0.000	0.004
5	1	0.770	123.640	113.517	113.492	0.009	0.050
4	2	0.601	70.732	66.353	84.328	0.330	0.492
3	3	0.454	37.659	36.040	59.025	0.779	0.838
2	4	0.288	15.897	15.496	37.361	0.953	0.961
1	5	0.097	3.691	3.659	18.911	0.987	0.988

WARNING: Critical/P-values correspond to a model with no dummies.
WARNING: The Bartlett Corrections correspond to the 'Basic Model'.

Notes: Trend assumption: Linear deterministic trend restricted; Frac95: the 5% critical value of the test of H(r) against H(p). The critical values as well as the *p*-values are approximated using the Γ - distribution (Doornix, 1998).

Appendix Table D1: Data used in the Analysis

Year	A	Dum79	D87	DB	X	G	GC	GK	PC	TR	GC	GK
1972	1335.62	0	0	1934.493	5671.81	9749.68	6757.16	2992.53	39356.77	6420.543	6757.16	2992.53
1973	608.39	0	0	2157.536	4656.97	9993.82	7011.72	2982.1	40839.47	4741.007	7011.72	2982.1
1974	405.04	0	0	2603.623	4188.56	10022.19	7019.2	3002.99	40883.04	3476.888	7019.2	3002.99
1975	890.1	0	0	1854.011	2398.97	8595.89	5674.02	2921.87	33048.08	4486.388	5674.02	2921.87
1976	335.44	0	0	2252.378	3151.23	7980.12	4975.5	3004.62	28979.58	4238.864	4975.5	3004.62
1977	141.62	0	0	1020.073	2871.6	5887.45	3007.66	2879.79	17517.99	3340.261	3007.66	2879.79
1978	198.29	0	0	541.6023	1180.85	4948.45	2334.04	2614.41	13594.49	4297.278	2334.04	2614.41
1979	149.32	1	0	826.8801	4952.38	11920.33	9756.99	2163.34	56829.17	1068.347	9756.99	2163.34
1980	252.8	-1	0	1148.643	4809.41	6090.13	4096.33	1993.8	23858.88	1120.649	4096.33	1993.8
1981	1645.13	0	0	1426.454	1036.29	7654.96	5696.7	1958.26	40318.39	377.1215	5696.7	1958.26
1982	1478.8	0	0	1573.118	2319.21	6571.06	4574.87	1996.19	41610.06	2558.95	4574.87	1996.19
1983	2406.38	0	0	880.6161	2562.19	6848.09	4840.56	2007.53	42552.96	3795.956	4840.56	2007.53
1984	3693.8	0	0	1004.663	3630.11	8740.23	6929.46	1810.77	35992.89	3875.591	6929.46	1810.77
1985	4237.16	0	0	836.5146	2757.45	7091.27	5384.3	1706.97	39147.07	2733.33	5384.3	1706.97
1986	1934.68	0	0	625.1017	3015.21	5884.81	4145.89	1738.92	42238.78	2051.478	4145.89	1738.92
1987	4021.62	0	1	0	2344.68	5549.12	3796.74	1752.37	46230.61	690.3083	3796.74	1752.37
1988	5513.66	0	1	0	2241.02	6326.08	3781.93	2544.15	49990.42	282.7985	3781.93	2544.15
1989	8117.64	0	1	-1094.18	2343.01	7364.57	3886.47	3478.1	55399.02	4400.493	3886.47	3478.1
1990	13739.3	0	1	359.6036	2321.61	8543.33	4921.11	3622.22	56239.6	5117.215	4921.11	3622.22
1991	17707.68	0	1	1634.711	2946.26	10387.18	6013.74	4373.43	58211.94	5261.467	6013.74	4373.43
1992	16209.81	0	1	-438.444	2525.66	11356.8	5918.11	5438.68	61438.81	5239.507	5918.11	5438.68
1993	12447.71	0	1	-487.62	3048.79	13496.8	7684.45	5812.35	63686.65	7020.768	7684.45	5812.35
1994	10818.25	0	1	-1348	4678.73	14597.47	8745.44	5852.03	59852.45	9674.243	8745.44	5852.03
1995	12354.57	0	1	-1179.44	5237.55	15187.29	10010.32	5176.97	66657.55	9385.876	10010.32	5176.97
1996	9895.76	0	1	-904.852	6995.47	17098.06	12499.68	4598.38	73134.32	10570.32	12499.68	4598.38
1997	12489.26	0	1	-1140.22	6080.69	17248.82	12599.27	4649.54	77131.53	10921.46	12599.27	4649.54

1998	11850.23	0	1	-1749.89	6599.96	18543.57	13886.09	4657.48	82911.65	10199.6	13886.09	4657.48
1999	11423.39	0	1	69.55812	7266.37	20769.58	14970.26	5799.32	89138.17	12028.77	14970.26	5799.32
2000	17984.74	0	1	-2165.34	7104.42	23107.29	16061.92	7045.37	94726.68	12184.77	16061.92	7045.37
2001	16780.7	0	1	-1424.56	8396.24	26166.04	17797.09	8368.95	100447.5	13211.91	17797.09	8368.95
2002	15865.32	0	1	-1549.51	8533.02	31212.08	22596.14	8615.94	113296.7	14626.12	22596.14	8615.94
2003	20961.37	0	1	0	10157.39	31319.12	22755.55	8563.57	118162.3	15548.18	22755.55	8563.57
2004	22157.33	0	1	0	12230.91	31819.89	23577.6	8242.29	121254.4	17474.5	23577.6	8242.29
2005	21766.54	0	1	-812.694	15256.07	33215.53	24408.4	8807.13	133869.6	18930.45	24408.4	8807.13
2006	12923.72	0	1	2484.529	15879.2	35080.33	25552.16	9528.17	153190.5	21172.68	25552.16	9528.17
2007	19012.09	0	1	2084.851	18792.49	34341.31	24754.36	9586.94	167248.8	27494.23	24754.36	9586.94
2008	15990.39	0	1	786.3493	19224.58	36633.31	25381.52	11251.79	190606.8	26432.68	25381.52	11251.79

Notes: All the data (except dummies) are in millions of constant 2005 UGX prices.

Source: Uganda Bureau of Statistics: National Accounts Estimates of main Aggregates; *Geographical Distribution of Financial Flows* (OECD-DAC, 2009) databases, and Author's own computations