Assessing Growth Performance in Uganda: A contest between Data Sources and Data Type

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Abstract

The paper examines national income for Uganda from the two primary sources, the Uganda Bureau of Statistics (UBOS) and World Development Indicators (WDI) and constructs a consistent GDP series over the period 1970-2008, with a particular focus on sub-periods when there are notable divergences. Although results show these are consistent, similar and cointegrated, the UBOS series is smoother and produces a more stable measure of GDP than does the WDI series, making the former most appropriate for use when analyzing macroeconomic relationships of Uganda.

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 Gross Domestic Product (GDP) for Sub-Saharan African (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

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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).

There are various statistical approaches to calculating GDP but the most common methods are the income, expenditure and output or value added approaches. Even when theoretical foundations are in place (Scott, 2005), using these different approaches with different data sources raises the likelihood that GDP estimates can considerably vary, revealing problems of measurement errors in economic statistics. In such circumstances, one will have different estimates of the level, change and growth of GDP for the same country over the same period.

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[2].

This paper uses the available Ugandan time series data for GDP and GDP in Purchasing Power Parity (PPP) from WDI, Uganda Bureau of Statistics (UBOS)

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[2] See Jerven (2010: 287) for a general discussion with reference to Kenya, Tanzania, Botswana and Zambia.

and PWT6.3[3] 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. The choice of these data sources, as summarized in Table 1, reflects data availability. The paper 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. While the paper is inspired by a similar comparison in Jerven (2010) where the author focuses 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, Kasekende and Atingi-Ego (2008), on Uganda's growth appears to use data from alternative sources, unlike here they are not explicit about any differences.

The rest of the paper is structured as follows. Section 2 explores GDP construction, especially the role of exchange rates, while issues relating to real GDP, real GDP per capita, GDP PPP per capita and the analysis of growth rates, including a brief discussion on the particular period when series diverge is discussed in Section 3. The time series characterization of Uganda's real GDP is presented in Section 4 while Section 5 draws the conclusions.

2 GDP Construction and Exchange Rates

2.1 Introduction

The primary sources for GDP are WDI and UBOS (as given in UNSTAT[4] and reported in year 2009) although time coverage differs, 1960-2008 (WDI) and 1970-2008 (UBOS)[5]. 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 (also reported in year 2009) are in constant 2000 USD while UBOS estimates are in constant 1990 prices. Appendix **A** presents the sector disaggregation of GDP and shows that both sources

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[3] 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.

[4] www.unstat.org/

[5] 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.

derive aggregate GDP using the expenditure method. Here we focus on how the choice of exchange rate affects the derived series in USD.

2.2 Current Price dollar value GDP

Based on current price GDP series in LCU series given in *Appendix* **A**, we assess the 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).

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:

$$\text{RER} \quad = \frac{P_N}{P_T} = \frac{P_N}{eP_T^w} \tag{1}$$

Where $e = LCU : USD$, 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):

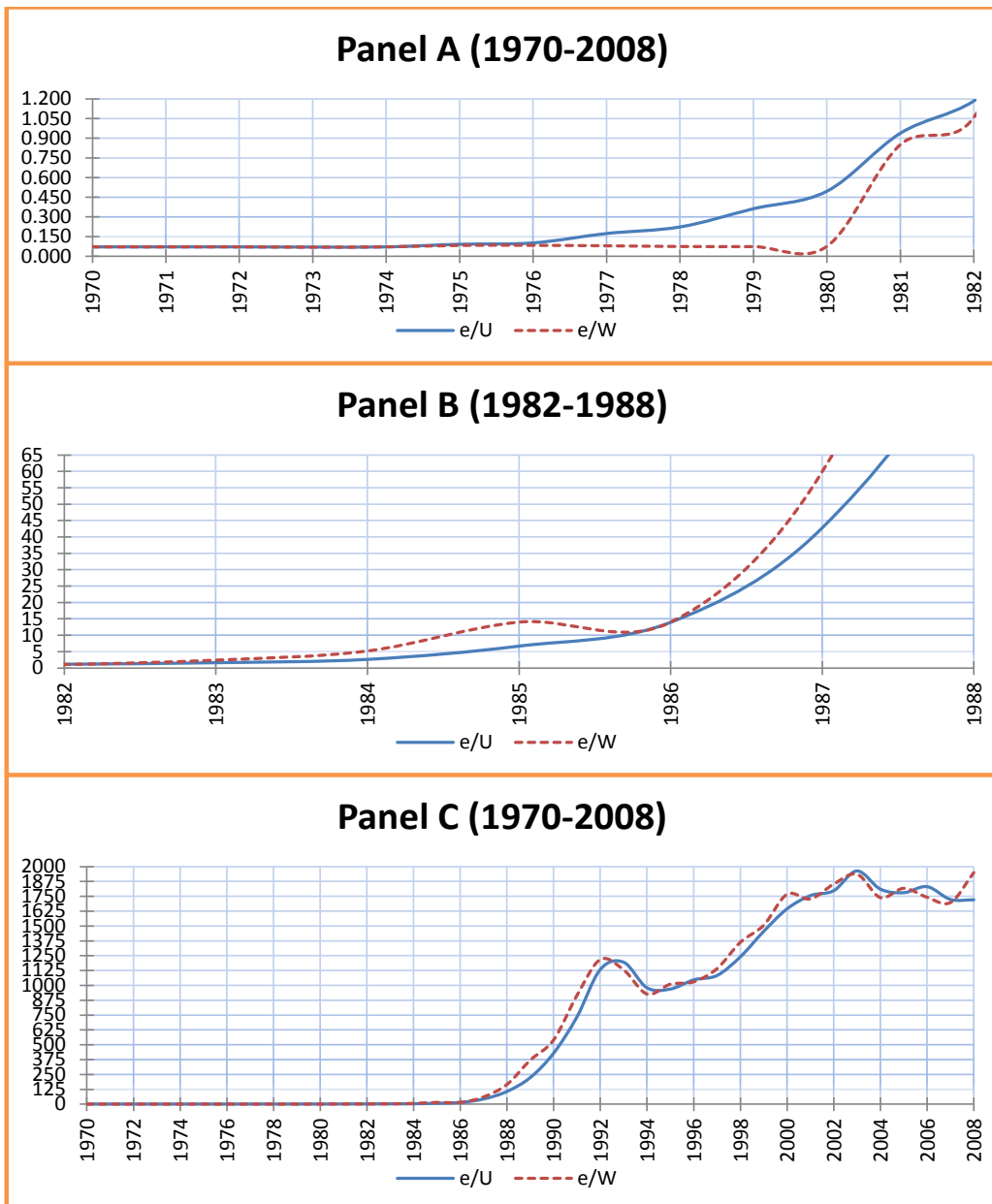$$RER \; = \; e\left(P^f\!\!\Big/P^d\right) \tag{2}$$

From (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). As e adjusts to maintain the RER when relative prices change, we use end of year nominal exchange rate index in the conversion. The index data is obtained from the World Bank and OECD National Accounts data files (2009) for WDI and National Accounts Estimates of main Aggregates for UBOS, and are provided in Figure 1as panels A (when there was an official and overvalued exchange rate, B (a transition to a market exchange rate) and C (entire sample period).

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, causing significant variation from that of WDI. A flexible exchange rate regime with a two-window system was introduced in August 1982[6]. 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 (see *panel* B).

The nearly unified exchange rate in 1986 is a result of domestic monetary authority's intervention. It corresponds to a series of exchange rate events, including reductions of the exchange rate misalignment[7] effective 1986, legalization of foreign exchange market and adoption of a fully-fledged flexible exchange rate regime in 1992 (Kasekende and Atingi – Ego 1995).

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

[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).

Panel A (1970-2008)

Panel B (1982-1988)

Panel C (1970-2008)

Notes: On the vertical axis is Official exchange rate (LCU per US$, end of Period), *e* is nominal exchange rate. herein and elsewhere, U and W respectively are UBOS and WDI representations.
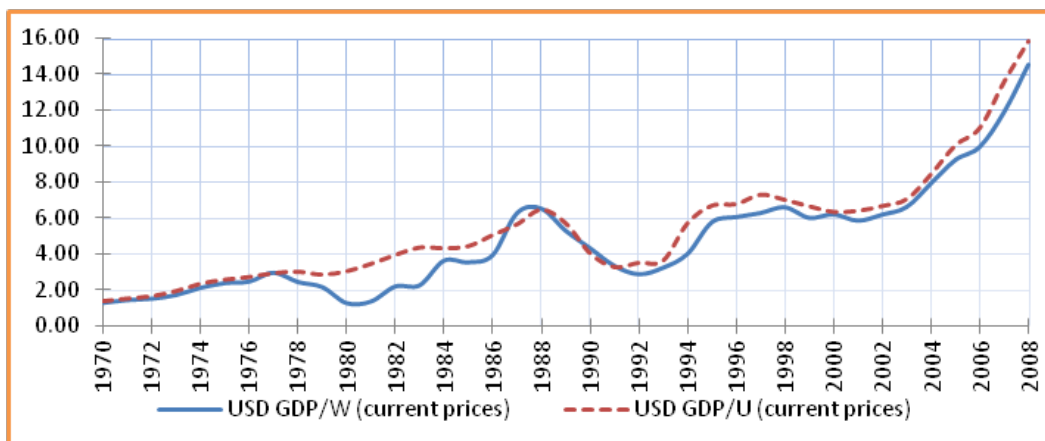
Figure 1: Nominal exchange rate (LCU per USD) index

Although in general the two series exhibit similar trend-like behaviour (see *panel* C), they are inconsistent even if none is consistently biased upwards. UBOS series appears relatively over valued due to Bank of Uganda's intervention (Mugume,

2008), 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. 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. The differences in the nominal exchange rate affects dollar value GDP estimates.

Using the aggregate UGX GDP series in Appendix Figures 1 and 2, and the respective source end of year nominal exchange rate in Figure 1, a series of GDP measured in billions of current price USD is recovered as in (3) and plotted in Figure 2.

$$\text{Current price USD GDP} = \frac{\text{current price GDP (UGX)}}{\text{nominal exchange rate}} \qquad (3)$$

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

Figure 2: USD GDP (current price U.S dollars), 1970-2008

The figure raises a number of striking features. 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 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.
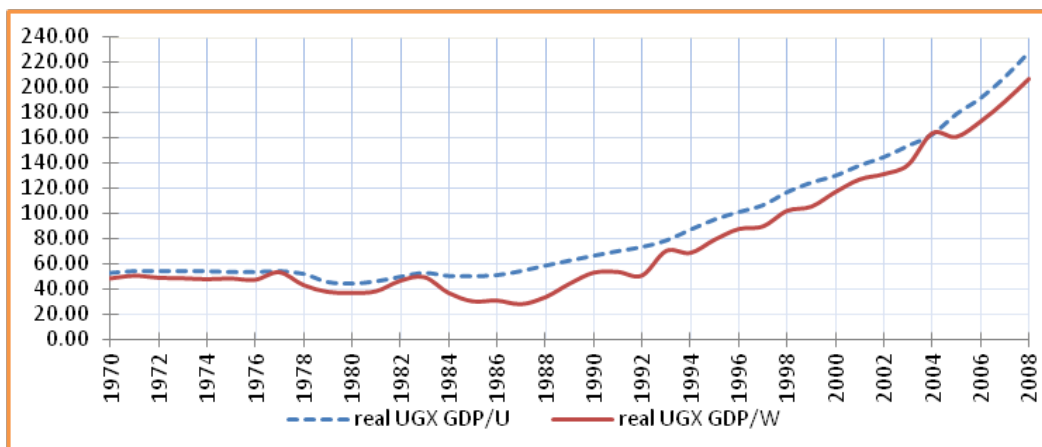
The discrepancy during the period 1977-1986 corresponds to economic shocks. The economy suffered deep economic crisis as a result of political turmoil, social disorder and pervasive state intervention (Shaw et *al.*, 2007) and external large petroleum price rises (Jerven, 2010; Niringiye, 2009). The 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.

3 Real UGX GDP and Real GDP per capita

3.1 Real UGX GDP

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, i.e. it attributes y-o-y 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 real UGX GDP series for the alternative sources. This is recovered from the nominal UGX GDP given in Appendix Figures 1 and 2 using the UGX implicit price GDP deflator in 2005 constant prices. This recovery employs the relationship in (4), and the resulting real UGX GDP series is provided in Figure 3.
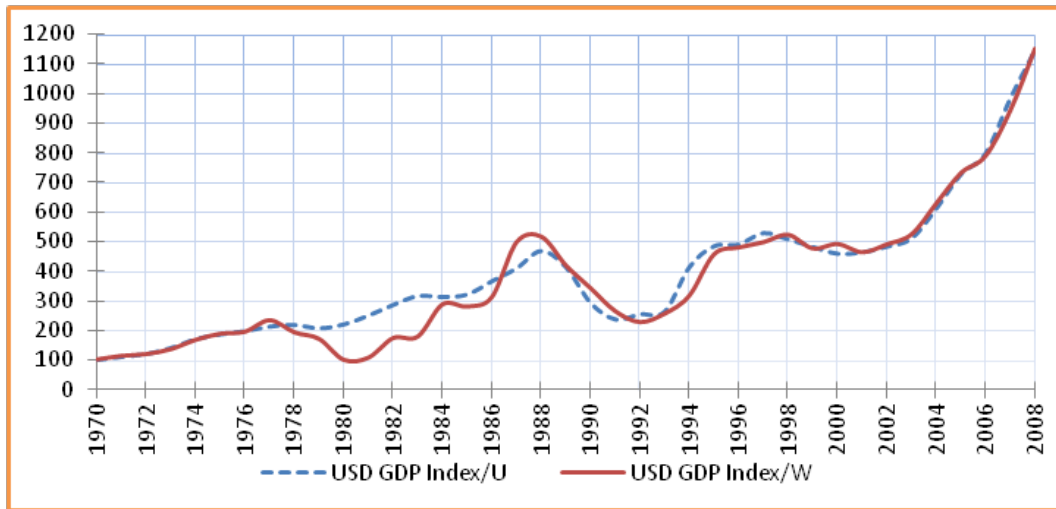
Notes: On the vertical axis is real UGX GDP in billions of constant 2005 prices

Figure 3: Real UGX GDP (2005=100), 1970-2008

$$\text{Real UGX GDP} (2005 = 100) = \frac{\text{Nominal UGX GDP}}{\text{UGX implicit price GDP deflator}} \quad (4)$$
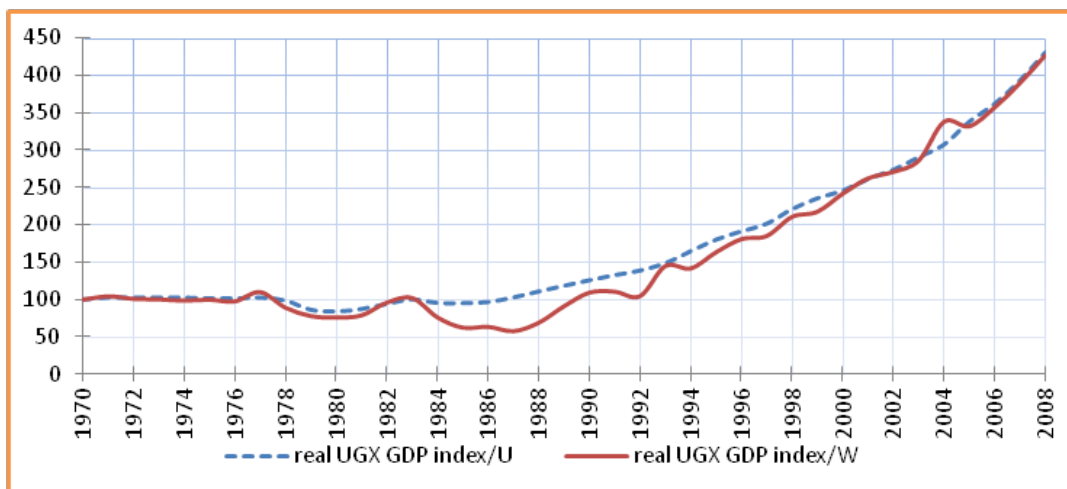$$(2005 = 100)$$

These are similar but inconsistent. Real UGX GDP/U is consistently higher than real UGX GDP/W and only converges 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 is due to differences in the regularity of 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 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 are available with UBOS except for one point, 2004 when multiple time series versions were linked by ratio splicing (as in WDI). Thus, 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. A similar argument may hold for the convergence observed in 1977 and 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 alternative series, each of these is 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. While one may argue that this is similar to the comparison of growth rates, it

Notes: On the vertical axis is USD GDP (in current price) indices

Figure 4: USD GDP index (1970=100)

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

Figure 5: Real UGX GDP index (1970=100)

is better because it shows when levels converge and diverge. The resulting USD GDP and real UGX GDP indices are shown in Figures 4 and 5 respectively.
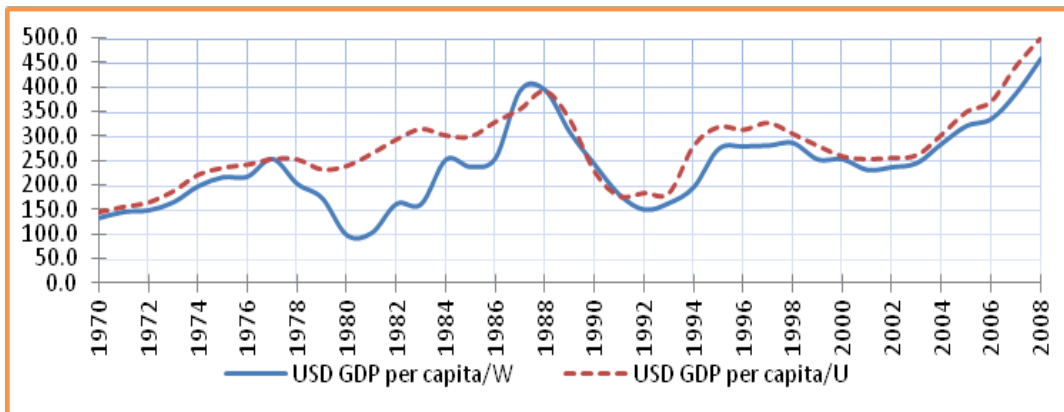
From Figure 4, we observe many points at which the series converge, occurring especially during the early to mid-1970s and from about 2002 onwards. The levels however also diverge, with a big disparity occurring over the period 1978-1984. Both indices show variability and the plots do not point to any 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. In Figure 5, the indices show that 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.

3.2 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 2, real UGX GDP in Figure 3 and the data on population, real GDP per capita is recovered from (5). The resulting USD GDP per capita series is plotted and compared in Figure 6 while the real UGX GDP per capita series is given in Figure 7.
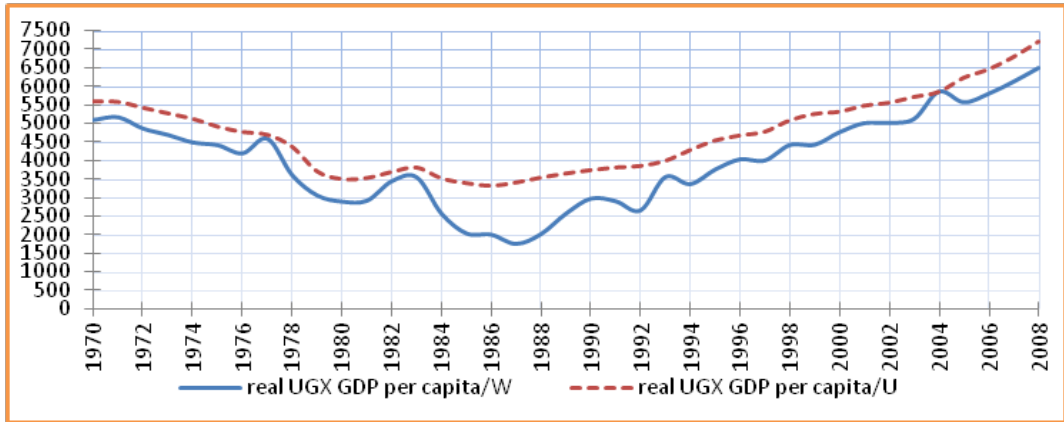
$$\text{Real GDP per capita} \ = \frac{\text{Real GDP}}{\text{Population}} \tag{5}$$

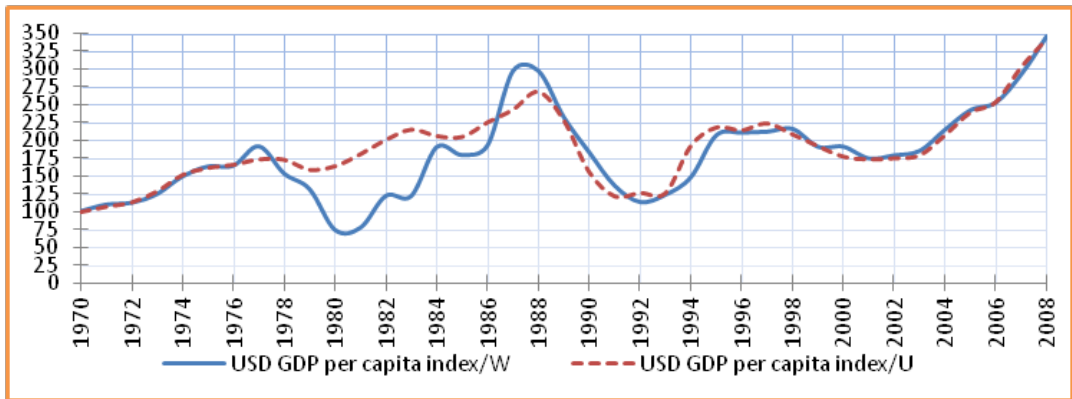Notes: On the vertical axis is USD GDP per capita (in current prices)

Figure 6: USD GDP per capita (current prices)

As with Figures 6 and 2 in levels, Figures 7 and 3 are comparatively similar, but differ in scale (due to the population factor). This suggests that aggregate and per capita measures yield growth rate estimates that may differ depending on the rate of population growth. As before, to reveal when levels converge and diverge, per capita series are converted into indices. These are given in Figures 8 and 9 for USD GDP per capita and real UGX GDP per capita respectively.
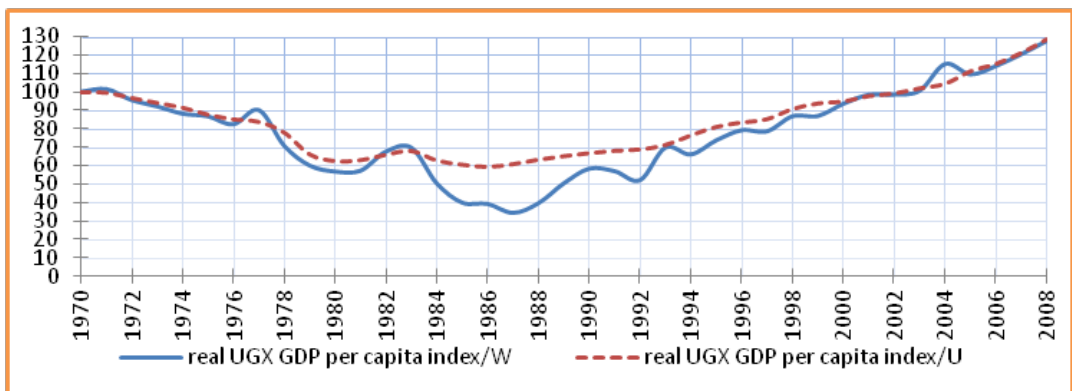
Notes: On the vertical axis is real UGX GDP per capita

Figure 7: Real UGX GDP per capita (2005=100)

Notes: On the vertical axis is USD GDP per capita (in current price) indices

Figure 8: USD GDP per capita index (1970=100)

Notes: On the vertical axis are real UGX GDP per capita indices

Figure 9: Real UGX GDP per capita index (1970=100)

Figures 8 and 4 [USD GDP per capita and USD GDP indices respectively], and Figures 9 and 5 [respectively real UGX GDP per capita and real UGX GDP indices] are similar in levels, but differ in scales for the same reasons as above.

It emerges from this analysis that while real UGX GDP or USD GDP may have been used to gauge Uganda's growth performance, 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, although the two source USD GDP measures are similar, they show 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. From now on, we focus on a more stable real UGX GDP series (aggregate or per capita). As we show in the section below, y-o-y percentage growth rates, including percentage and absolute average growth rate discrepancies is derived to investigate if differences in underlying UBOS and WDI series yield significant discrepancies in the growth estimates.
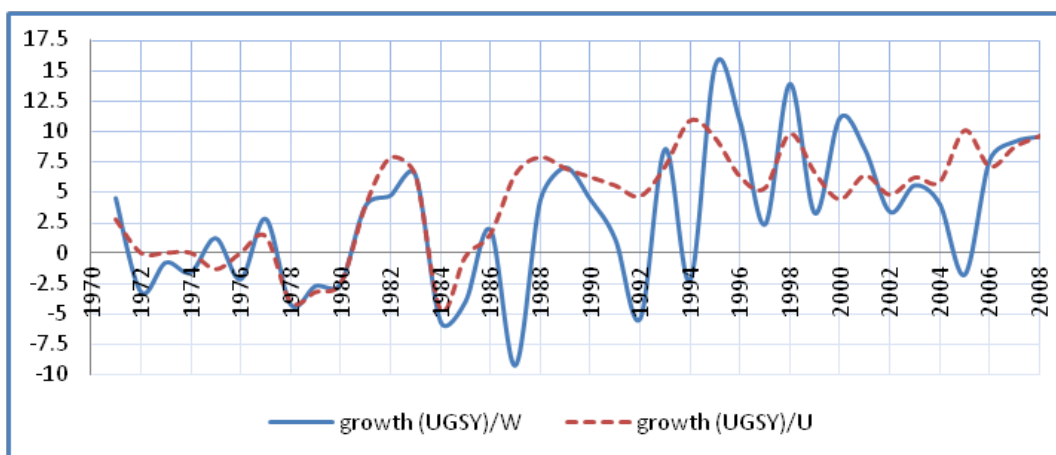
3.3 Analysis of annual GDP growth rates

This section derives y-o-y 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 analyzing 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 y-o-y percentage change in real GDP growth rate of a series of T annual observations, say $Y_1, Y_2, ..., Y_T$ is derived as

$$g = \left(\frac{Y_t - Y_{t-1}}{Y_{t-1}} \right) * 100 \tag{6}$$

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 computed year on year real UGX GDP growth rate using real UGX GDP data as in Figure 3, noting that real UGX GDP per capita data in Figure 7 could as well be used. The resulting economy-wide growth rates shown in Figure 10 are used to derive percentage growth rate discrepancies, i.e. the difference between WDI and UBOS estimated percentage growth rates in each period as is presented in Figure 11. In addition, we also compute and report the absolute average percentage discrepancy, which 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.
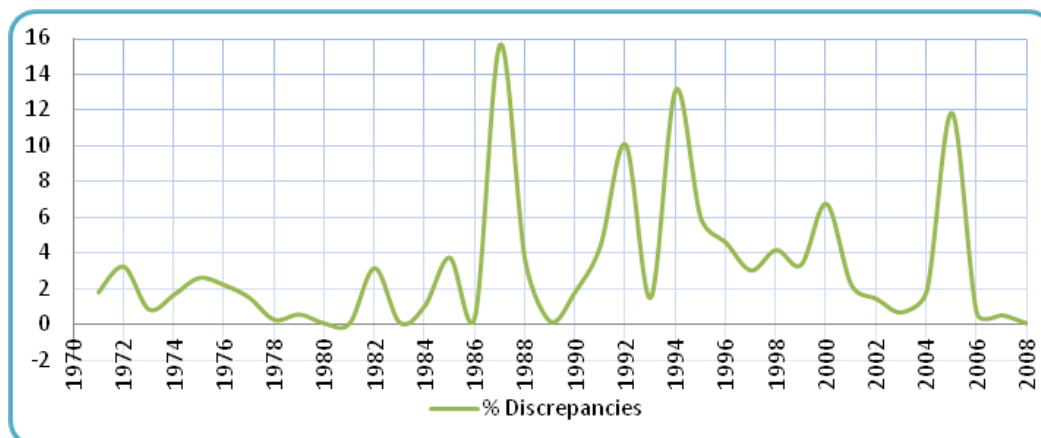

Notes: On the vertical axis are real UGS GDP percentage growth rates

Figure 10: Real UGX GDP percentage growth rate

The y-o-y 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 1.5 percentage points per year (i.e. the average absolute percentage discrepancy).

While this per year average absolute percentage discrepancy may matter, 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.

Notes: On the vertical axis are real UGX GDP percentage growth rate discrepancies
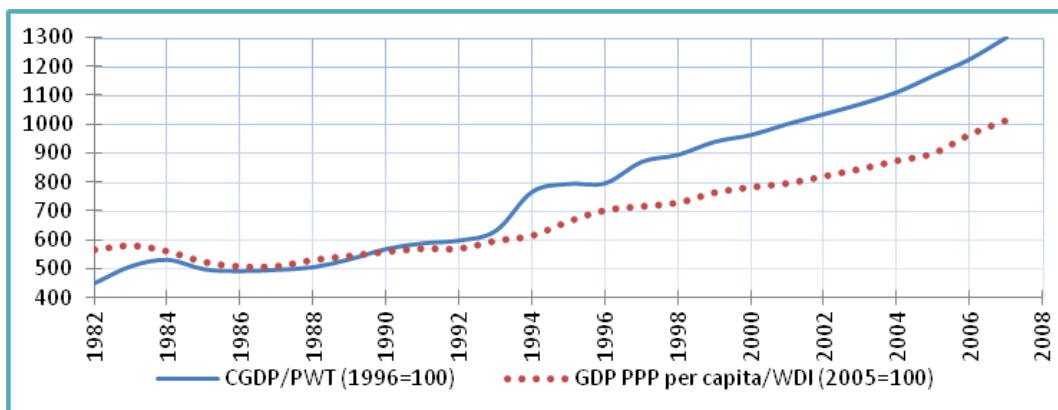
Figure 11: Real UGX GDP percentage growth rate discrepancies

3.4 Real GDP PPP per capita

We also explored Uganda's real GDP PPP per capita using two measures, PWT6.3 and WDI in constant international dollars for the period 1982-2008 (as this is the period over which the series is available in alternative sources). UBOS neither constructs GDP PPP nor GDP PPP per capita. As in PWT6.1, PWT6.3 series is in 1996 constant prices while that of WDI is in 2005 constant prices. The data are shown in Figure 12.

As can be noted, the series are not only inconsistent, but may also not be directly comparable given that they are based on different base years. In particular, the inconsistence is due to variations in the PPP compilation methods with the underlying source. Prior to 2000, WDI used the PWT (Summers and Heston, 1991) as the main source of PPP. This has however been updated 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). On the other hand, the PWT6.3 does not include the ICP round for 2005 data but would be incorporated in PWT7.0 version, which, at the time of compilation, was in preparation (Deaton and Heston, 2009). 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).

Johnson *et al.* (2009) illustrate the degree of measurement error intrinsic to the PWT methodology, the pending adjustment notwithstanding. They 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).

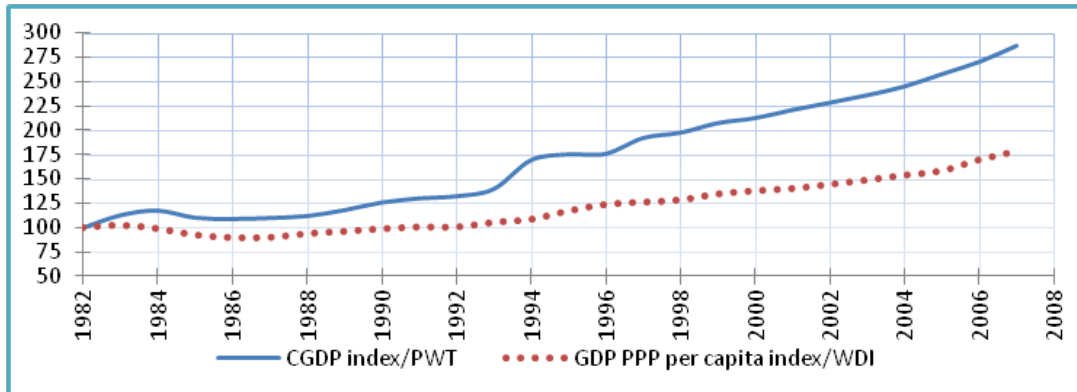Notes: On the vertical axis is GDP PPP per capita (in USD)

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.

Figure 12: Real GDP PPP per capita (1982-2008)

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) and as such produce GDP PPP per capita series that are
consistent with those of WDI.

As with GDP, these series are converted into indices by setting the index for
the first year of each (i.e. 1982) to 100. Against this base, we computed the
evolution, which then reveals when levels converge and diverge. The resulting
indices are given in Figure 13. The indices in the figure are different and do not
converge. This is rather 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, we would recommend WDI GDP PPP series for cross country studies

where one requires internationally comparable measures. However, as what we address herein is a country specific question, the discussions of the PPP measure are not pursued beyond this point.

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

Figure 13: Real GDP PPP per capita index (1982=100)

4 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 statistically characterize the data. 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).

As a precursor to cointegration analysis, it is customary to begin with the graphical expositions of the level and first difference of the series to reveal important data features. The level data, given in Figure 3, reveals the two series follow the same pattern, i.e. are not stationary as they are not mean-reverting. However, in first differences, they seem to be mean-reverting. Hence, both series seem to be I(1). More formally, the series are tested for the order of integration or non-stationarity using the Augmented Dickey Fuller (ADF) unit root test (Dickey and Fuller, 1979). Mindful of the fact that critical values of the t-statistic do depend on whether an intercept and/or time trend 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 for n=50 usable observations is used. The statistic critical values are

obtained from Table A in Enders (2010: 488). Results of unit root test are provided in Table 2, and as expected, indicate that both series are I(1) in levels.

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. The existence of long-run equilibrium relation is evaluated using the Johansen (1988) *trace statistic* test for cointegration. As the variables in levels appear to be trending and we are not sure whether these linear trends will cancel out in the cointegrating relation, we include an unrestricted constant and a restricted deterministic trend. 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). The choice of the lag- length was determined as the minimum number of lags that meets the crucial assumption of time independence of the residuals, based on a Lagrange Multiplier (LM) test. We began with *k=3* lags. Although Schwarz and Hannan-Quinn information criteria favor different lags i.e. *k=1* for the former and *k=2* for the latter, with *k=1*, the LM test could not reject the null hypothesis of no serial correlation in the residuals. Thus, the underlying model uses one lag. Results for the *Trace-* test for cointegration, including small sample Bartlett correction (see Johansen, 2002) are given in Table 3.

Table 2: The Augmented Dickey-Fuller (ADF) Unit root test

Variable	ADF test in Level			ADF test in First difference	
	$H_0 : \gamma = 0$	Lag-length	inference	$H_0 : \gamma = 0$	Inference
GDP/U	-1.558 (-3.50)	2	I(1)	-4.429 (-3.50)	I(0)
GDP/W	-1.321 (-3.50)	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.

Based on the results, presence of one equilibrium (stationary) relation between real UGX GDP/U and real UGX GDP/W is clearly suggested. 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. Thus, either series can be considered to represent trends in the size of the macroeconomy, but in a slightly different way.

Table 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 Gamma (Γ) distribution (Doornix, 1998).
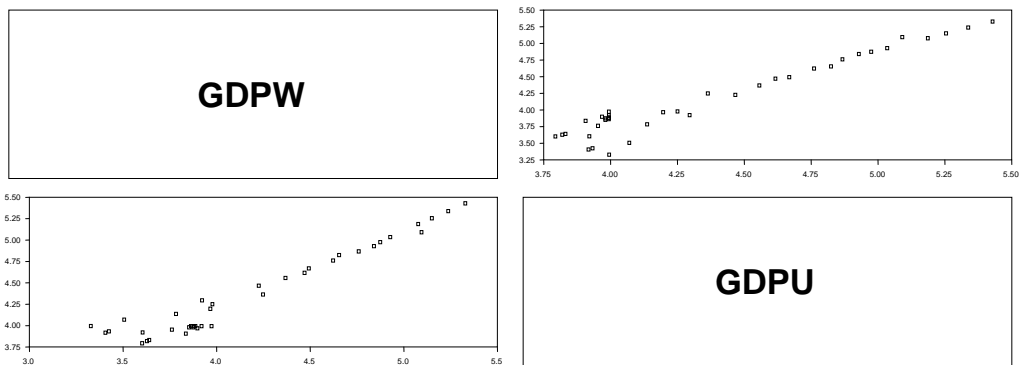

Figure 14: Cross plots of GDP measures

Even more, Figure 14 shows cross plots of the two GDP measures as given in Figure 3. 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 4. 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 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 3, cross plots in Figure 14 and correlation/covariance results in Table 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 modeling macroeconomic relationships of Uganda without losing generality on inference. 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 the underlying source from which macroeconomic data is sought by the international agencies, including WDI and is consistent with the remarks in Deaton and Heston (2009: 43-44) cited in Jerven (2010: 278) that ''*… it must always be remembered that the international accounts are no better than the national accounts ...*''.

5 Conclusion

This paper has 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 y-o-y growth rate estimates have a 1.5 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) would be the most appropriate for use when analyzing macroeconomic relationships of Uganda. However, as the smoothing may be artificial (i.e. introduced by statisticians), one may want to use the WDI series, at least if interested in performance during the period 1984-1992 when the two diverge, especially as assessment of the short-run effects of reforms during 1985-95 is likely to be sensitive to the start and end years, and the series chosen in the analysis.

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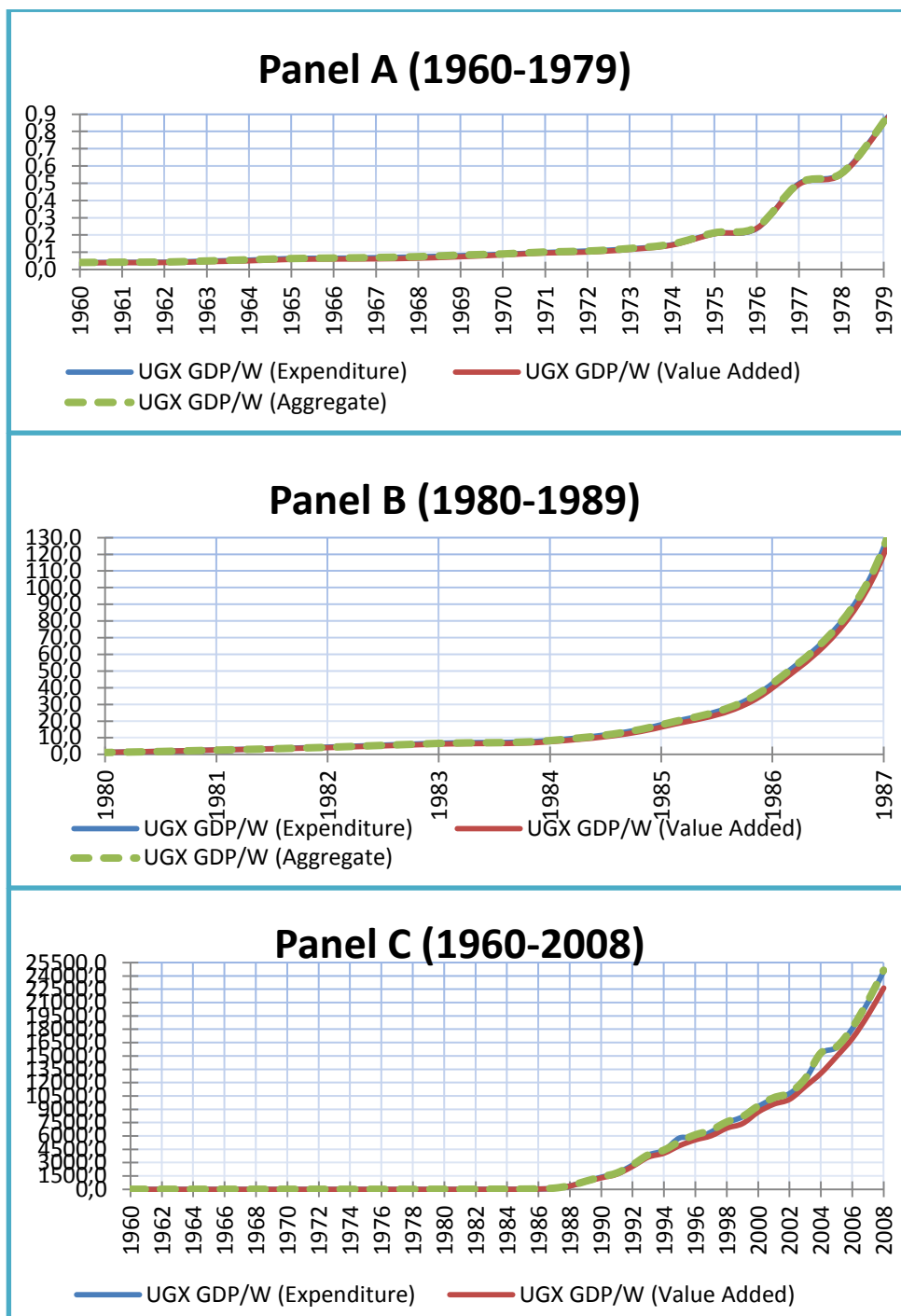
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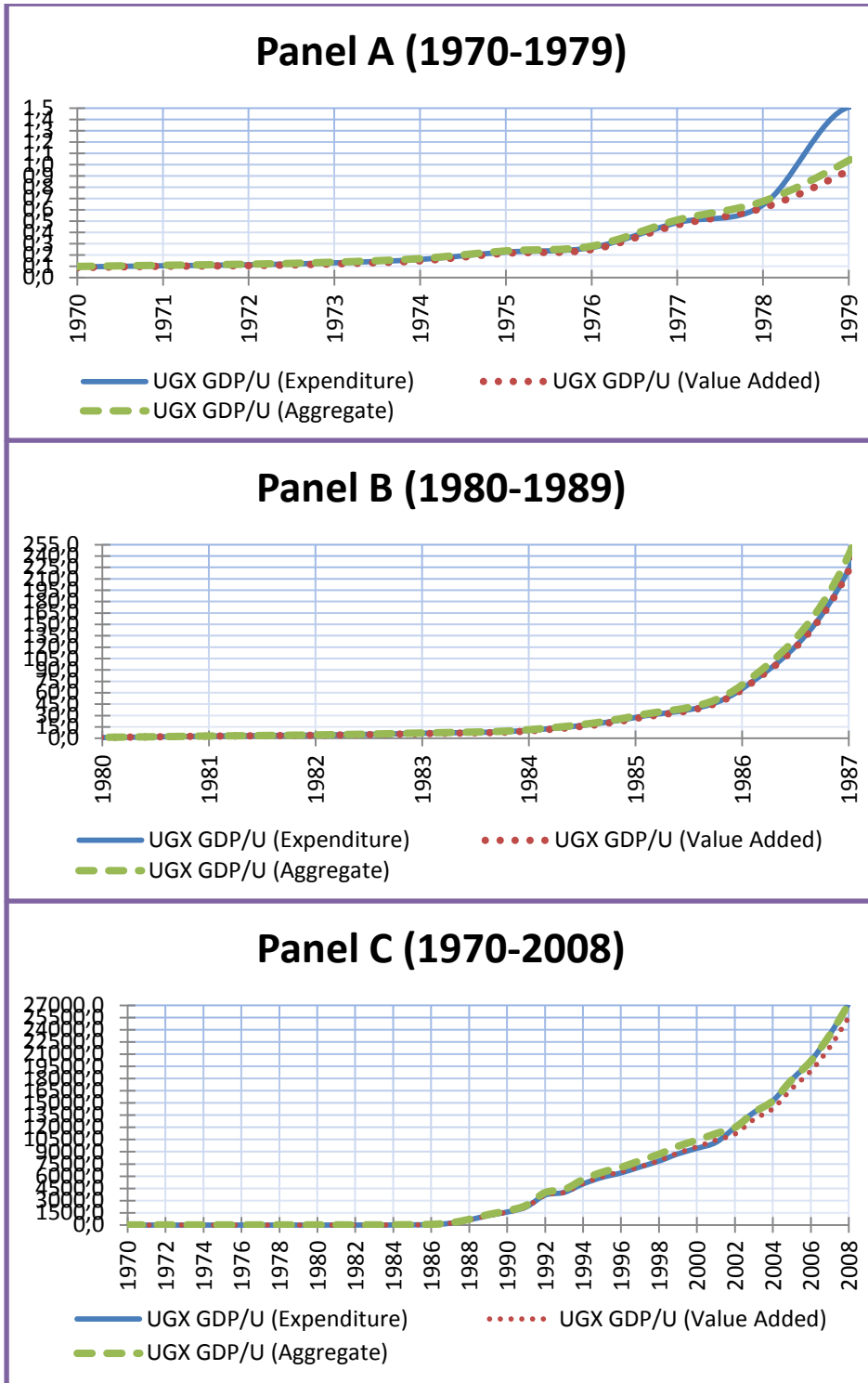Table 1: Uganda's GDP Data Description and Data Sources as used in this paper

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	In current Local and USD prices	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.
			Aggregate	In constant Local and USD prices (1990=100)	
GDP deflator			UGX 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
			USD GDP deflator (1990=100)		
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	In current Local and USD prices	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.
			Aggregate	In constant USD prices (2000=100)	
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)		Quantity of local currency (UGX) to 1 USD
GDP, PPP per capita		1982-2008	GDP, PPP per capita	In current UDD prices	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.
			GDP, PPP per capita	In constant USD prices (2005=100).	
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.

Appendix 1

Panel A (1960-1979)

Panel B (1980-1989)

Panel C (1960-2008)

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

Appendix Figure 1: Aggregate and reconstructed GDP from sector expenditure and value added disaggregated data: WDI

Panel A (1970-1979)

UGX GDP/U (Expenditure)   UGX GDP/U (Value Added)
UGX GDP/U (Aggregate)

Panel B (1980-1989)

UGX GDP/U (Expenditure)   UGX GDP/U (Value Added)
UGX GDP/U (Aggregate)

Panel C (1970-2008)

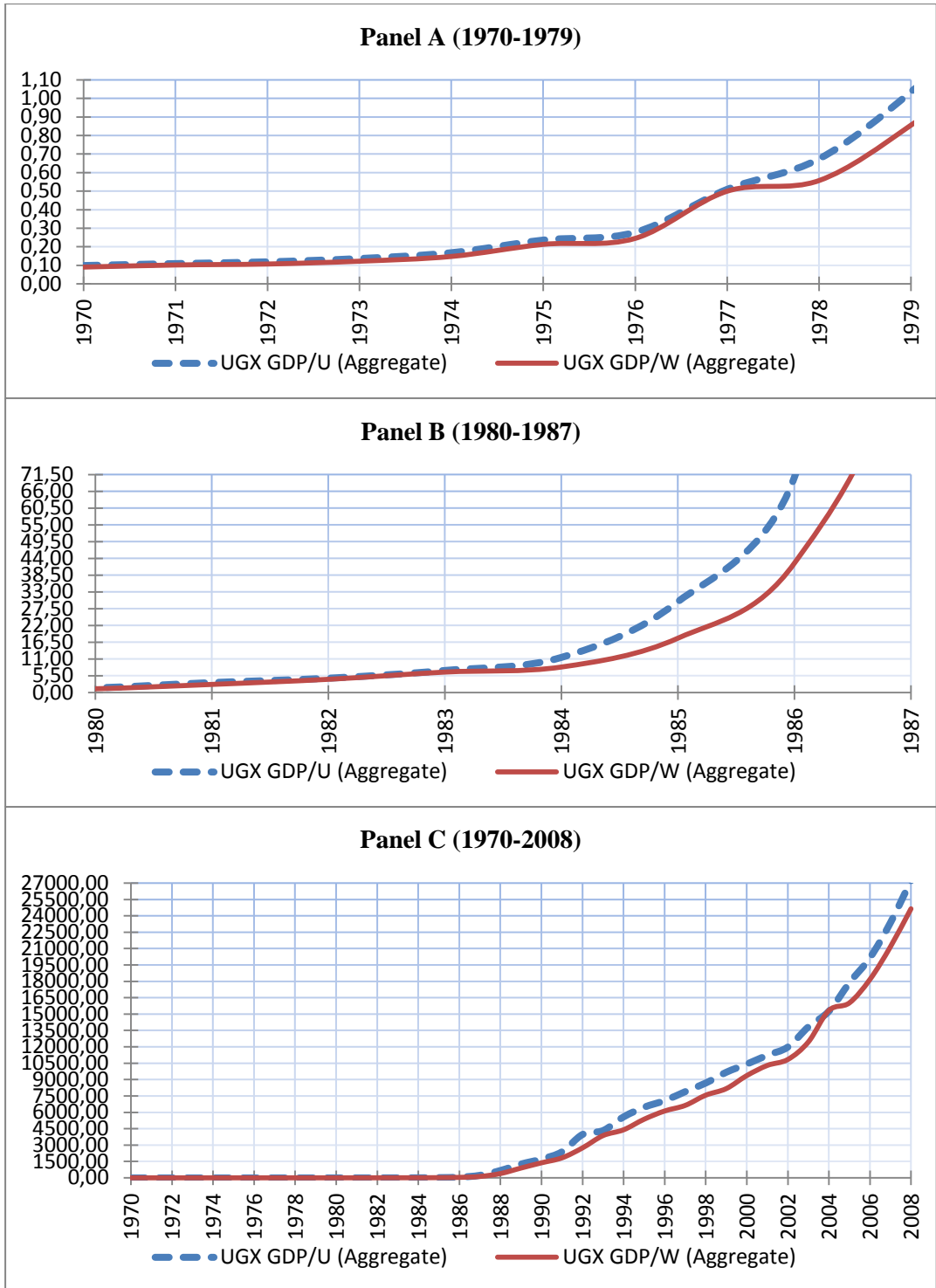UGX GDP/U (Expenditure)   UGX GDP/U (Value Added)
UGX GDP/U (Aggregate)

Notes: On the vertical axis is GDP in billions of current UGX
Appendix Figure 2: Aggregate and reconstructed GDP from sector expenditure
and value added disaggregated data: UBOS

Panel A (1970-1979)

Panel B (1980-1987)

Panel C (1970-2008)

Notes: On the vertical axis is GDP in billions of current UGX
Appendix Figure 3: Aggregate UGX GDP (current prices) comparison: WDI and
UBOS

Although sector value added and expenditure approaches in Appendix Tables 1 and 2 yield similar estimates of level GDP, these are not identical. 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.

Appendix Figure 3 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.

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.