Macroeconomic fluctuations in Botswana

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Abstract

This paper documents some empirical regularities in Botswana's macroeconomic variables. The facts we document include the volatility and persistence in and the co-movement among output and other major real and nominal variables. Output is more volatile in Botswana than in industrialised countries, but is consistent with evidence from emerging economies. Exports are the most volatile components of aggregate spending. Cross-correlations between non-mineral private output and a large group of macroeconomic variables (including money, Government spending, interest rate, inflation, consumption and exchange rates) are presented. The paper also analyses the effects of external conditions on Botswana's output fluctuations. The results suggest that the main sources of macroeconomic fluctuations are world oil prices, monetary aggregates, prices and nominal exchange rates. World oil prices and inflation are strongly counter-cyclical. This lends support to the view that supply-side determined business cycle models are more relevant for Botswana than the conventional demand-driven models.

Keywords: Macroeconomic fluctuations, external conditions, components of spending, monetary and financial variables.

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Introduction

Societies in general prefer a steady growth path for their national incomes, even if that growth rate is low, than one characterized by large swings. However, in reality growth patterns are far from smooth. It is for this reason that recent research in quantitative macroeconomic analysis has focused on understanding and distinguishing among the determinants of macroeconomic time series. Although several studies have examined macroeconomic fluctuations elsewhere, we are not aware of any study that used Botswana data. Yet, as a small open and developing economy, it is likely to experience more intense output fluctuations.

Documenting the stylized facts on macroeconomic fluctuations in Botswana could be useful for several reasons. First, they can be used for constructing analytical models of short-run fluctuations that incorporate features germane to Botswana. Second, as highlighted by Canova (1998), such insights may guide researchers in choosing indicators of economic activity. Finally, because of the high degree of openness, Botswana was among the worst hit by the just ended world economic recession that was triggered by the financial crisis, which originated in the United States. The country's GDP contracted by 14.8 percent at the height of the recession in the first quarter of 2009 compared to the same quarter in the previous year. This was the worst contraction in the country's history. With another world economic recession looming, an accurate assessment of the sources of macroeconomic fluctuations can provide useful information for the design and implementation of policy interventions to mitigate the effects of the recession if it occurs.

This paper builds on the existing literature by systematically documenting the regularities in macroeconomic fluctuations for Botswana. In particular, the paper seeks to measure the relative importance of domestic versus external shocks. The analysis is carried out by considering the three dimensions of macroeconomic fluctuations: standard deviations are used to measure volatility, cross-correlations measure the co-movements amongst the variables of interest, while autocorrelations are used to examine the persistence of business cycle fluctuations. Although unconditional correlations do not imply causality, the findings of this study are still useful in identifying the shocks that could be of relative importance to the Botswana economy.

The rest of the paper is organized as follows: the next section describes the data, along with a number of economic features of the Botswana economy over the past two decades and also presents the

summary statistics for the variables used in the empirical analysis. It is followed by the presentation of the characterization of the macroeconomic fluctuations in Botswana. The last section summarizes the main results of the study.

Data transformation and some key macroeconomic indicators

Key macroeconomic features of the Botswana economy

In this section we describe a number of important economic features of the Botswana economy that are relevant for the analysis in this paper. Table 1 below summarizes the composition of aggregate demand. It shows that although the share of Government spending has been declining over the years as reflected in the relatively lower mean for the 2002q1-2010q4 period, it is still significant. The other component of aggregate demand that is gaining in importance is household consumption. This suggests that changes in Government spending and household consumption could have serious implications for the country's economic activity. The average openness index also indicates that Botswana is an open economy and, as such, external shocks are likely to significantly influence its domestic economic activity.

Table 1: Composition of aggregate demand: 1993-2010

	Period		
Sector (as % of GDP)	**1993q3-2010q4**	**1993q3-2002q1**	**2002q2-2010q4**
Household consumption	33.9	32.1	35.7
Government consumption	24.4	26.5	22.3
Investment	25.7	26.0	25.4
Exports	43.2	48.0	38.5
Imports	-37.0	-38.9	-35.1
Openness index (exports + imports as a share of GDP)	80.3	86.9	73.6

Source: Author's calculations based on data obtained from various Bank of Botswana Annual Reports

The Government of Botswana has over the years put in place policy initiatives aimed at diversifying the economy away from overdependence on mineral production to other sectors. Specifically, the Government implemented several policies and programmes aimed at

diversifying production to manufacturing and services. Table 2 presents the structure of production in the economy. It is clear that the mining sector, with an average share of 38 percent contribution to the GDP, dominates Botswana's economic activity. However, the increased shares of financial services and commerce in the latter sub-period suggest that there have been some improvements in economic diversification.

Table 2: Contribution of the productive sectors to total GDP

	Period		
Sector (as % of GDP)	**1993q3-2010q4**	**1993q3-2002q1**	**2002q2-2010q4**
Mining	37.5	37.2	37.9
Trade, hotels and restaurants	9.9	9.6	10.1
Banks, insurance and business services	10.7	10.5	10.8
Transport and communications	3.6	3.6	3.6
Construction	5.3	5.8	4.9
Manufacturing	3.9	4.3	3.6

Source: Author's calculations based on data obtained from various Bank of Botswana Annual Reports

The Data

The study is based on quarterly data ranging from the third quarter of 1993 to the fourth quarter of 2010. The data cover a wide range of macroeconomic variables and include output, prices, inflation, Government expenditure, investment, consumption, exports, imports, money, private sector credit, interest rates, and exchange rates. Since Botswana is a small, open economy and it is likely to be affected by the external economic environment, we also examine the relationships between economic activity in Botswana and some key indicators that represent world economic activity and commodity prices.

Main features of macroeconomic fluctuations

Descriptive statistics: volatility and persistence

We gauged the volatility and persistence of business cycle fluctuations by examining summary statistics for the stationary component of real GDP (and its variants), components of aggregate demand and inflation. The second and third columns of Table 3 report the means and standard

deviations of output growth rates and standard deviations of the cyclical components of output derived using the HP with λ set at 1600 (the standard choice for quarterly data) and BP filters (with cycle periods set at 6-32). Output growth rates were measured as four-quarter differences of the log levels of the relevant variables.

Table 3: Summary statistics for output and inflation

Output measure and filter	Output					
			Autocorrelations			
	Mean (%)	Std. Dev.	lag 1	Lag 2	Lag 3	Lag 4
Agg. GDP						
Growth	5.2	6.6	0.20	0.12	0.00	-0.28
HP		4.1	0.08	0.01	-0.13	-0.16
BP		2.2	0.76	0.29	-0.16	-0.38
Non-mineral GDP						
Growth	5.7	3.5	0.39	-0.60	-0.16	-0.31
HP		2.3	0.38	-0.04	-0.08	-0.06
BP		1.9	0.84	0.45	0.09	-0.08
Non-mineral private GDP						
Growth	5.7	5.0	0.37	0.14	-0.02	-0.26
HP		3.1	0.37	0.11	-0.01	-0.11
BP		2.5	0.85	0.54	0.22	-0.00
Mineral GDP						
Growth	4.2	18.2	0.18	0.12	0.07	-0.28
HP		11.1	0.05	0.02	-0.05	-0.15
BP		5.2	0.75	0.33	-0.08	-0.31

Source: Author's calculations based on data obtained from various Bank of Botswana Annual Reports

The results reported in Table 3 show that the mean annual growth rates during the sample period are 5.2 for aggregate output, 4.2 for mineral output and 5.7 for non-mineral output and non-mineral non-Government output, indicating the growing importance of non-mineral output in Botswana's economic activity. The volatility of growth rates as measured by standard deviations indicates that mineral GDP is the most unstable, followed by aggregate GDP, with non-mineral GDP being the least volatile. The same pattern, although of lower magnitude, emerges

from the standard deviations of the filtered cyclical components of output.

The persistence of the business cycle fluctuations is determined by examining the first four autocorrelations of the filtered series and the results are presented in columns 4-7 below. In the case of aggregate GDP and mining GDP the autocorrelations from growth rates and HP-filtered series are weakly positive, but statistically insignificant. Autocorrelations for non-mineral GDP and non-mineral private GDP are relatively stronger and statistically significant indicating some persistence in the cyclical components. The autocorrelations from the BP-filtered series are the most strongly positive and statistically significant. One can therefore view Botswana's non-mineral output as having short-term fluctuations that could be reasonably characterized as business cycles. These business cycles are characterized by low magnitude and low intensity compared to those of developing countries reported in Agenor et al. (2000) and Central and Eastern European countries (CEE) and EU countries reported in Benczur and Ratfai (2010). The large gyrations in mineral GDP and aggregate GDP suggest that it will be difficult to discern any type of cycle or economic regularity on those aggregates. Moreover, the autocorrelations of their growth rates and HP-filtered series are statistically insignificant. The study therefore concentrates on non-mineral real GDP and non-mineral private GDP as a measure of economic output.

Table 4 reports measures of persistence and volatility in components of aggregate spending and inflation. Volatility is measured by the standard deviation as in Table 3 above, while the first order autocorrelation coefficient measures the persistence of a series. Inflation is measured as four-quarter differences of the log levels of the consumer price index. Consistent with evidence from both industrial, transition and emerging economies reported above, consumption is the least volatile of all the components of aggregate spending. However, it is more volatile than aggregate output, which is contrary to the Permanent Income and Life Cycle theories of consumption smoothing behaviour. Exports are more volatile than those reported in most of the available studies. These could reflect the dominance of diamonds in the country's exports data. Persistence patterns are similar to those reported in the literature.

Table 4: Characteristics components of aggregate spending and inflation

	g	c	I	ex	im	xm	Inf.
Absolute volatility	5.0	2.7	5.2	11.9	7.4	6.0	1.69
Relative volatility	2.27	1.23	2.36	5.41	3.36	2.73	0.77
Persistence	0.88	0.89	0.85	0.83	0.78	0.85	0.82

Notes: All data are at the quarterly frequency, de-seasonalized by the band-pass filter. 'Absolute volatility' is the standard deviation of the variable. 'Relative volatility is measured as the ratio of standard deviation of the variable and that of real GDP'. 'Persistence is the AR (1) coefficient'. g – Government consumption, c – household final consumption, I – investment, ex – exports, im – imports, xm – net exports, inf. – inflation.

Methodology

We measure the degree of co-movement between two variables x and y with their unconditional cross-correlation function

$r\_xy\ (k) = corr(x\_t, y\_(t-k)\ ), k\ \epsilon\ \{0, \pm 1, \pm 2\ \ldots\}.$

These correlations are between the stationary components derived using the same filters. In the discussion that follows, y is an indicator and x is the cyclical component of real GDP (or its variant), y is considered to be procyclical, acyclical, or countercyclical, depending on whether the contemporaneous correlation coefficient r(0) is positive, zero or negative. Following Agenor et al (2000), we consider the indicator to be strongly contemporaneously correlated if $0.26 \leq |r(0)| < 1$, weakly contemporaneously correlated if $0 \leq |r(0)| < 0.13$, and contemporaneously correlated with the cycle if $0.13 \leq |r(0)| < 0.26$. In addition, we say that yt leads the cycle by k period(s) if |r(k)| is maximum for a negative k, is synchronous if |r(k)| is maximum for k=0, and lags the cycle if |r(k)| is maximum for a positive k.

Tables 5 through 7 summarize the results for the three major groups of variables: external conditions (world output, oil prices and world interest rates), components of aggregate demand (consumption, investment, government spending, real exports, real imports and net exports) and monetary and financial variables (private sector credit, CPI level, CPI inflation, nominal and real interest rates, nominal and real exchange rates). The highest degree of the co-movement of each variable, with real output, is reported in bold if the absolute correlation coefficient is at least >0.13.

Correlations with external conditions

We first analyse correlations between real output and a set of variables representing the external environment and the results are reported in Table 5. Real output is represented by real non-mineral private GDP, while the variables representing the external environment are US real GDP, world oil prices and the US real Treasury bill rate. The contemporaneous correlation function indicates a negative and weak association between US GDP and Botswana output. This weak and countercyclical relationship is unsurprising because Botswana has weak trade links with the US in non-mineral products. Agenor et al (2000) also found that Morocco, Nigeria and Turkey cycles are weakly and negatively related to the US cycle. Second, we note that the world business cycle conditions could also influence fluctuations in a developing country through changes in real interest rates. This is because these real interest rates reflect credit conditions in international capital markets and may also influence domestic interest rates. The Bank of Botswana monitors movements in the world, especially the US, and real interest rates, and adjusts domestic rates accordingly (BoB, 2010). However, the results show that contemporaneous correlation is weakly negative, suggesting that US real interest rates do not influence non-mineral private output in Botswana. A further channel through which world events could affect macroeconomic fluctuations is change in commodity prices. As expected, the results for world oil prices indicate a strong negative contemporaneous correlation. Moreover, the correlations peak at k=-2 suggesting that the negative effects of oil prices are transmitted within six months. Since oil is an important input in the production process, an increase in its price is expected to raise production costs and dampen economic activity.

Table 5: Cross-correlations: Non-mineral private output, external conditions (x_t, y_{t-k}) – BP

Variable/ lag	-8	-4	-2	-1	0	1	2	4	8
y^{*US}	0.15	-0.13	-0.12	-0.13	-0.15	-0.14	-0.10	-0.06	**-0.20**
o*	0.38	-0.26	**-0.62**	-0.61	-0.44	-0.26	-0.06	0.20	0.06
r*	0.32	0.37	0.20	0.09	-0.17	-0.40	**-0.56**	**-0.56**	-0.13

Notes: y^{*RSA} - South Africa real GDP, y^{*US} - US real GDP, o* - world oil price, r* - US real Treasury Bill rate

Components of aggregate demand

Correlation coefficients between real output and components of aggregate spending are reported in Table 6. Most of the results are consistent with evidence from other countries.

Government consumption: The Government plays a central role in Botswana as it is the main link between the export stable (diamonds) and the rest of the economy. The Government gets royalties and tax revenues from the diamond sector and channels the funds to other sectors through budgetary allocations. Cross correlations indicate weakly procyclical Government consumption. However, this does not necessarily imply the efficacy of the fiscal policy since Government consumption does not lead the cycle. Thus, there is no clear role for Government expenditures in non-mineral economic activity. This result is similar to those reported by Alpher (2003) using data for Mexico and Turkey. Benczur and Ratfai (2010) also found similar relationships for five (Croatia, Latvia, Lithuania, Poland and Slovakia) out of twelve CEE countries. Other studies that found no clear cyclical pattern include Fiorito and Kollintzas (1994) for G-7 countries. Fiorito and Kollintzas argue that the relationship between Government consumption and output depends on a variety of factors, such as military expenditures in the total budget, the existence of stabilization programmes and the evolution of institutions.

Household consumption*:* The contemporaneous correlation between consumption and GDP is positive, suggesting that private consumption in Botswana is procyclical. The magnitude of the correlation functions appear to be smaller than those found in industrial and CEE countries. The peak of the correlation function occurs at k=+4, with a correlation coefficient of 0.48, implying that household consumption lags GDP by about a year.

Investment*:* Investment is strongly procyclical and close to being synchronous. In fact, this is the component of aggregate spending most strongly associated with output and is consistent with evidence from other studies reported in the literature (see, e.g., Benczur and Ratfai, 2010).

Net exports: The contemporaneous correlation coefficient between net exports and GDP is negative, which is consistent with much of the empirical literature (see, e.g., Aguiar and Gopinath, 2007; Backus and Kehoe, 1992; Benczur and Ratfai, 2010; Raffo, 2008). Backus and

Kehoe contend that this counter cyclicality arises because countries borrow from international capital markets during high income periods.

Imports: As expected, and in line the experience of other countries, imports are strongly procyclical and approximately coincidental. The phase shifts show that imports lead output by one quarter. As an import-dependent economy, this could mean that imported inputs play an important role in Botswana's output fluctuations.

Exports: Exports are negatively correlated with GDP, suggesting that they are countercyclical. The result is counter-intuitive and stands in sharp contrast to much of the literature surveyed in this paper. However, Kydland and Zaragaza (1997) found similar results for Argentina and Mexico and suggested that they could be due to faulty reporting by exporters.

Table 6: Cross - correlations: Non-mineral private output, components of aggregate demand (x_t, y_{t-k}) - BP

Variable/ lag	-8	-4	-2	-1	0	1	2	4	8
g	0.05	-0.14	-0.08	-0.05	0.02	0.17	**0.30**	0.27	-0.24
c	-0.30	-0.24	-0.15	-0.06	0.24	0.38	0.47	**0.48**	0.00
I	-0.35	-0.01	0.42	0.57	0.62	**0.64**	0.59	0.29	-0.16
ex	**0.40**	-0.03	-0.36	-0.32	-0.21	-0.14	-0.11	-0.11	-0.18
im	-0.04	0.03	0.32	**0.40**	0.39	0.36	0.28	0.03	-0.14
xm	0.35	0.00	-0.36	**-0.38**	-0.32	-0.29	-0.26	-0.19	-0.14

Notes: g – Government consumption, c – household final consumption, I – investment, ex – exports, im – imports, xm – net exports

Correlations with monetary and financial variables

Correlation coefficients between real output and monetary and financial variables are reported in Table 7. Most of the results are consistent with evidence from other countries.

Money: The views on whether monetary aggregates influence output in industrial countries are varied. However, many agree that the monetary mechanism could still play an important stabilizing role in middle income countries. The correlations between real GDP and both definitions of money, M1 and M2, show that money is highly cyclical and rather leading or synchronous. In fact, M1 is synchronous while M2 leads the cycle by two quarters, which suggests that the transmission of monetary

shocks to real activity is very rapid. These results are consistent with those reported in Backus and Kehoe (1992) using data for industrial countries and suggest that monetary policy could play an important role in short-term output fluctuations. However, this relationship may simply be reflective of the endogenous response of money to output fluctuations that are driven by non-monetary shocks as suggested by King and Plosser (1994). To test this we ran bivariate Granger-causality tests on these two variables. The Granger-causality tests indicate bi-directional causality with M2 and output, but no evidence that M1 Granger-causes output. Rather there is evidence that output Granger-causes M1.

Private sector credit: In countries with underdeveloped equity markets, such as Botswana, private sector credit could have an important influence on economic activity. That is, private sector credit could be the main source of finance for investment and working capital needs. The contemporaneous correlation between output and credit is weakly positive, suggesting that credit is procyclical. However, the phase shifts do not show any clear and interpretable pattern between the two variables. The bank of Botswana has also found the relationship between these variables to be weak and as a result abandoned the use of credit as an intermediate target in its monetary policy setting (BoB, 2010).

Consumer price index and inflation: Next we turn to the correlations between prices and output. A substantial body of literature documents countercyclical behaviour of prices in industrialised countries, which provides support for supply-driven models of the business cycle (see, e.g., Alper 2003). However, Chadha and Prasad (1994) argue that the appropriate correlation to discriminate between demand-driven and supply-driven models of the business cycle is between inflation and cyclical output. We therefore examined the cyclical behaviour of both the price level and inflation rate. The contemporaneous correlation between output and consumer price level is negative, indicating countercyclical variation of the price level. Similarly, the inflation rate is countercyclical and synchronous, indicating that appropriate models for Botswana would be supply-driven as opposed to the more conventional demand-driven models. Similar findings are reported by Alper (2003) for Mexico and Turkey.

Nominal effective exchange rate: The contemporaneous correlation indicates that nominal exchange rate is strongly procyclical and almost synchronous. The phase shifts show that the correlation function peaks

at lag two and four, suggesting that nominal effective exchange rate leads the business cycle. This exchange rate behaviour could be explained by the high import-dependence of economic activity in Botswana. A currency appreciation lowers the prices of imported inputs which may in turn stimulate production, especially where most of the output is for domestic consumption.

Real effective exchange rate*:* The real effective exchange rate is weakly countercyclical with an absolute contemporaneous correlation coefficient of 0.08. The correlation function peaks at lag four, indicating that it takes about a year for a currency appreciation to fully dampen economic activity.

Nominal and real interest rates: Most theoretical models suggest that interest rates are not key determinants of business cycle fluctuations. At the empirical level, the link between interest rates and the business cycle is not clear. While most studies of developed countries indicate that interest rates are procyclical, those for emerging market economies show that they are countercyclical. However, Neumeyer and Perri (2005) developed a business cycle model in which interest rates are countercyclical. The model shows that because firms have to pay for factors of production before production takes place, working capital needs to make labour demand sensitive to interest rate fluctuations. When interest rates increase, working capital becomes more expensive and firms tend to reduce their demand for labour. Correlations reported in Table 7 indicate that both nominal and real interest rates are procyclical, with the latter being strongly so and coincidental. The positive and synchronous correlation between output and real interest rate can be explained by the dominance of non-mineral output by the financial services and the contribution of interest income to banks profits. That is, an increase in the interest rates increases the interest income of the financial sector, especially the commercial banks, because they hold Bank of Botswana Certificates. Since financial services account for a large proportion of non-mineral output, this shows up as an increase in economic activity.

Table 7: Cross-correlations: Non-mineral private output, monetary and financial variables

(x_t, y_{t-k}) - BP

Variable/ lag	-8	-4	-2	-1	0	1	2	4	8
m2	-0.04	0.55	**0.71**	0.61	0.42	0.19	-0.04	-0.45	-0.34
m1	-0.18	-0.04	0.38	0.56	**0.65**	0.63	0.47	-0.07	-0.27
cr	-0.28	**-0.42**	-0.06	0.10	0.20	0.27	0.31	0.27	0.03
inf	0.11	0.16	-0.20	-0.34	**-0.38**	-0.34	-0.23	0.10	0.17
cpi	0.16	0.19	0.05	-0.11	-0.20	**-0.24**	-0.19	0.06	0.13
r	-0.13	-0.15	0.28	0.43	**0.46**	0.38	0.22	-0.19	-0.23
i	-0.05	0.11	0.21	**0.19**	0.15	0.05	-0.06	-0.18	-0.18
rer	**-0.53**	-0.13	-0.11	-0.10	-0.08	-0.00	0.10	0.33	0.24
ner	-0.47	0.34	**0.62**	**0.62**	0.54	0.39	0.22	-0.13	-0.29

Notes: m2 – broad money; m1 – narrow money; cr – private sector credit, inf. - inflation, cpi – consumer price index, r – real 88day interest rate, i – nominal 88day interest rate, rer – real effective exchange rate, ner – nominal effective exchange rate

Summary and conclusions

This study attempted to uncover sources of macroeconomic fluctuations in small open economies by presenting evidence from Botswana for the period 1993-2010. Using real non-mineral private GDP as a measure of output, the main findings can be summarized as follows:

Volatilities of the cyclical component of real output in Botswana are much higher than in developed countries. Consumption expenditure is more volatile than real output, which is contrary to the Permanent Income and Life Cycle theories of consumption smoothing behaviour. This may be due to the age pattern of Botswana's population, which is relatively young. Exports are the most volatile component of national income, owing to the undiversified nature of Botswana's exports.

Both US real output and interest rates are negatively associated with Botswana's business cycle. However, these relationships are weak, suggesting that economic activity in the US should not be a major concern for non-mineral output fluctuations. In contrast, world oil prices are strongly countercyclical and lead the cycle by two quarters, suggesting that oil prices dampen economic activity as expected.

Government consumption is weakly procyclical but does not lead the cycle, indicating that unexpected shocks to fiscal policy cannot be

blamed for the sources of business cycles. This also suggests a limited role for fiscal policy in managing fluctuations in non-mineral private output.

Money supply is strongly procyclical and either leads the cycle or is synchronous at best. However, Granger causality tests indicate that the line of causation runs from economic activity to money supply. Private sector credit is weakly procyclical, but does not lead the cycle. These findings suggest that restrictive monetary policy is not likely to be costly in terms of output loss. As such the Bank of Botswana can continue to focus on inflation control without fear of dampening economic activity.

Nominal exchange rate is procyclical and leads the cycle suggesting that the exchange rate could be used to influence short-term macroeconomic dynamics. However, the real exchange rate does not show any clear pattern.

Price variables both in levels and in annual growth rates are countercyclical, giving support to the view that supply-side determined business cycle models are more relevant for Botswana than the conventional demand-driven models. Therefore appropriate models for the analysis of non-mineral output fluctuations should incorporate supply-side variables.

Acknowledgement

The author acknowledges valuable comments from an anonymous reviewer. All errors and omissions remain those of the author.

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