Are output fluctuations transitory or permanent in Ghana?

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Abstract

The paper examines the stationarity properties of output for Ghana during the period 1970-2011. Using the Augmented Dickey-Fuller (ADF) test and the Kwiatkwski, Phillips, Schmidt and shin (KPSS) test on a single time series, it is found that output series have unit root or are nonstationary in levels. The policy implication suggests that the effect of shock on output will be temporary and not have a long memory effect for output. Future studies should use other unit root model such as Phillips-Perron (PP) test and panel unit root test to test whether the findings will be collaborated.

Keyword: Unit root, economic growth, Augmented Dickey-Fuller (ADF)
Jel Classification: F43, C22

1. Introduction

The issue of unit root has attracted the attention of researchers such as econometricians; macroeconomist; development economist and financial economist after the work of Nelson and Plosser (1992) who reported that output series variables are not stationary as proposed by traditional business cycle hypothesis (Polat et al., 2013; Furuoka, 2011; Smyth & Inder, 2004; Rapach, 2002; Hendry & Juselius, 2000; Cheung & Chinn, 1996). According to traditional business theory output series variables are not unit root and as such the effect of shocks on output series variables will be transitory and have short memory (Campbell & Mankiw, 1987). For output series variables to be used in forecasting their stationarity properties must be investigated. Various methods and data have been used to investigate the unit root properties in the literature with inconsistent results.

The use of panel data that is expected to resolve the inconsistencies have also provided missed findings (Furuoka, 2011; Rapach, 2002; Cheung & Chinn, 1996). According to researchers (Ozturk & Kalyoncu, 2007) the inconsistent findings result from the low power of some of the models use in testing for the unit root such as the ADF test. The ADF test is criticised to have lower power as compared to the Panel unit root test which is believed to have higher power (Banerjee et al., 2005).

The findings on the unit root properties of output are found in the works of various researchers (Phiri, 2014; Akinwale et al., 2013; Mehrara & Musai, 2013; Furuoka, 2011; Chang et al., 2008; Chen, 2008; Ozturk & Kalyoncu, 2007; Cushman, 2006; Hurlin, 2004; De Haan & Zelhorst, 1993; Campbell & Mankiw, 1987; Perron & Philips, 1987). For example, Phiri (2014) used ADF and PP unit root test models to investigate the unit root properties of real per capita GDP series for South Africa for the period of 1992-2013. The ADF test result with constant (t= -1.67; p= -11.22***) and with trend (t= -3.07; p=11.79***) and the PP test result with constant (t=

-2.63; p= -11.36***) and with trend (t= -2.71; p= -12.21***) could not reject the null hypothesis of unit root in levels at 1% significant level.

Akinwale et al. (2013) reported of non stationary GDP series at levels (t=-2.173; p=0.2192) and stationary at first difference (t= -5.4511; p=0.0001) for Nigeria for the period 1970-2005. The authors concluded that output fluctuations in Nigeria are permanent and not transitory. The findings of Akinwale et al. (2013) are consistent with that of Nnaji et al. (2013) who reported of unit root in real GDP series in Nigeria for the period 1971-2009 using ADF and Philips-Perron (PP) tests. The series achieved stationarity after first difference (ADF=-3.742; ADF-critical=-2.628 at 1%: PP= -5.069; PP-critical= -2.626).

Mehrara and Musai (2013) accepted the null assumption of unit-root when the real GDP values were in levels. The series achieved stationarity after first differenced, indicating the series are integrated of order 1. The unit root test is based on panel unit root. Omisakin et al. (2012) used ADF and PP test in models with constant and trend term for the period 1977-2008 and established unit root in real GDP series (ADF= -0.232; p=0.925: PP= -0.412; p=0.896) for Nigeria. The series became stationary after first differenced (t= -4.795; p=0.000).

Furuoka (2011) investigated the stationarity properties of ASEAN country GDP and reported that, the ADF and PP unit root test could reject the null hypothesis of a unit root at levels for only Indonesia and Singapore. The ADF or the PP test could reject the null hypothesis for Brunei, Laos and the Philippines. The PP and the ADF could not reject the null hypothesis in the case of Cambodia, Malaysia, Thailand and Vietnam, indicating that the real GDP for these countries are unit root. Furuoka (2011) used the first generation of panel unit root tests in the analysis and reported that the null hypothesis of a unit root could be rejected at levels. Furuoka (2011) lastly used the second generation of panel unit root. The results accepted the null hypothesis of a unit root at levels. The researcher concluded that per capita GDP in the nine ASEAN countries are featured with unit root processes and that shocks to the GDP series will persist over time.

Kakar et al. (2011) established that the real GDP values for Pakistan for the period 1980-2009 were unit root in levels but achieved stationarity at first difference at 1% level of significance. The test was based on ADF. In a study by Ozturk & Kalyoncu (2007) all the univariate test could not reject the null assumption of a unit root at the model without trend. The null assumption of a non-stationary real GDP per capita is rejected for Austria, Finland, Germany, Portugal and turkey in a trend model. The test results from the use of IPS accepted the unit root assumption in a model with and without trend. This indicates that real GDP per capita series variables are nonstationary.

Rapach (2002) and Cheung and Chinn (1996) reported of unit root in real GDP for OECD economies using various panel cointegration models where as Flesissig and Strauss (1999) reported of stationary series variables of real GDP per capita for OECD economies in a different panel models which considered trend. Lucke (2002) established unit root properties for GDP series variables for Germany and indicated that unit rot model should be accepted for Germany in econometric estimation to avoid spurious results. Researchers such as Meier (2001) and Assenmacher (1998) consider the series variables of GDP (West Germany) as trend stationary. Other researchers such as Rudebusch (1993); DeJong et al. (1992); DeJong and Whiteman (1991) and Perron (1989) consider output series variables as not having unit root in GPD for Germany.

In summary, the review indicates that real output series variables in some studies are unit root whereas in some other series the unit root hypothesis is not supported depending on the data span and type and unit root model used. This calls for further studies to enrich the debate using current data set and various measure of output. This is the focus of the current research.

Governments in all economies put in place policies to ensure sustainable economic growth. If output series are unit root, shocks to the series will have permanent effect and policies on output will not be effective. The focus of the current is to investing the unit root properties of Output (Proxied by NGDPC; NGDPD; RGDPC; RGDPD) for the period 1970-2011 in Ghana. The empirical verification of the unit root properties of output have produced mixed results. In the knowledge of the researchers the current study is the only study that examines the unit root properties using different proxies of output in detail, especially in the case of the study area. The paper fills in the literature gap. The findings of the research contribute to the theories of unit root by providing answers to the research questions raised in the paper. The empirical results provide information to policy makers on the nature of unit root properties and its policy implications for government policies. Students doing research using output series variables will find the results useful as reference material.

The paper contributes to the body of knowledge that exists in literature in the area of stationarity of macroeconomic series variables by empirical investigating the nature of unit root properties of output. The paper specifically;

- Test whether output series variables are stationary in levels?

Answer is provided to this questions.

- Is output trend stationary?

The assumption behind the research is;

H1: The unit root hypothesis is valid for Ghana in the case of output series during the period under discussion.

Output data used are secondary data from World Bank data base. The series variables might suffer from missing values; errors in variables which might not be known by the researchers. The rest of the sections of the paper are research methodology, empirical results; conclusions and recommendations.

2. Research Methodology

2.1 Design

The research design is time series modelling, and quantitative, whereas the research format is descriptive. Quantitative design allows for the relationship among variables to be quantified and hypothesis tested. The study is based on annual output data for Ghana for the period 1970-2011.

2.2 Data

Output series data used are secondary data obtained from World Bank data base. Data is available for the period chosen. The sample size is 41. Articles reviewed were selected through purposely from internationally recognised Journals. The data used in the estimation are nominal GDP (Cedis); NGDP (dollars); real GDP (Cedis) and real GDP (dollars).

2.3 Conceptual Framework

The nature of fluctuations in output series variables are modelled for Ghana to determine whether fluctuations are permanent or temporary.

2.4 Econometric Model and Estimation Methods

The research is based on Augmented Dickey-Fuller (1981) (ADF) and Kwiatkowski et al. (1992, KPSS) estimation tests. The unit root test is conducted to determine whether the series in model are stationary. In the case where the output series variables are non-stationary, they series

are made stationary through differencing. A non-stationary series use in estimation produces unreliable results. For the purpose of the current study, the unit root test is performed using the Augmented Dickey-Fuller (1981) (ADF) and Kwiatkowski et al. (1992, KPSS). The unit root test provide information on the order of integration of the series (order zero; one or higher order of two).

These tests (ADF and KPSS) have their strengths and their weaknesses. The ADF test is considered to have low power of tests as compared to the KPSS test (Nanthakumar and Subramaniam, 2010) and might accept a false null hypothesis. The null assumption (H_o) is that there is a unit root in levels. The alternative hypothesis (H_1) is that the series are stationary in levels. Following Nanthakumar and Subramaniam (2010) and Hurng et al. (2007), the ADF test are specified as in equations (1) (Nanthakumar & Subramaniam, 2010), and (2), (3), (4), and (5) for Hurng et al. (2007).

$$\Delta G_t = \alpha_t + \beta_t \gamma_t + \rho G_{t-1} + \sum_{i=1}^{q} \partial \Delta G_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where γ = trend coefficient, G= time series variable in the model (Proxies of output), ε_t = error term or stochastic error term.

$$\Delta G_t = \sum_{i=1}^{p} \gamma_i \Delta G_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\Delta G_t = \mu + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta G_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\Delta G_t = \mu + \partial T + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta G_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where G_t = level of the series variable, μ= drift term, T = time trend, P = number of lags, Δ= shows the series are in their first difference. The ε_t is the error term/ white noise which have the features of normal distribution. It's expected mean value is zero and has constant variance. The errors are independent of each other. Equation (2) has no constant term and time trend while equation (3) has a constant term with equation (4) having constant term, and time trend. The KPSS test (Kwiatkowski & Schmidt, 1992) is as specified in equation (5), and (6).

$$g_t = \beta D_t + \mu_t + u_t$$

$$\mu_t = \mu_t - 1 + \varepsilon_t,\ \varepsilon_t \sim WN(0, \sigma^2_\varepsilon)$$

where D_t contains deterministic components (constant or constant plus time trend), u_t is I(0) and may be heteroskedastic. In the equations, μ_t is a pure random walk with innovation variance σ^2_ε. The null assumption that the variables (g_t) is I(0) is given as $H_0 : \sigma^2_\varepsilon = 0$, where μ_t is a constant in the equation.

3 Empirical Results

The empirical results on descriptive statistic; ADF test results and KPSS are presented and discussed in this section of the paper.

3.1 Descriptive Statistics

The results of the summary statistics of the variables are shown in Table 1. The minimum and maximum values measure the degree of variations in the variables under investigated. The mean measures the central tendency of the series variables and the values indicate a good fit. The volatility of the series variables are measured by the coefficient of variation. The most volatile series are nominal gross domestic product in dollars (2.18241) and nominal gross domestic product in Cedis (1.03522). The nature of the distribution of the series is measured using the coefficient of skewness. The range of the coefficient of skewness is between positive one (1) and negative one (-1). All the series variables are positively skewed. The nature of the peakness of the series variables were measured using the coefficient of kurtosis. The coefficient values of kurtosis of the series variables such as NGDPD ($: 5.91421); NGDPC (Cedis: 3.52014) are more than unity (1) which indicates less flat-topped distribution.

Table 1 Summary Statistics, using the observations 1970 - 2011

Variable	**Mean**	**Median**	**Minimum**	**Maximum**
Real gross domestic product (RGDPD) ($)	4.17×10^9	3.35×10^9	2.3×10^9	1.0×10^{10}
Real gross domestic product (RGDPC) (Cedis)	1.15×10^{10}	9.25×10^9	6.3×10^9	2.80×10^{10}
Nominal gross domestic product (NGDPD) ($)	6.16×10^9	2.15×10^8	22593	5.90×10^{10}
Nominal gross domestic product (NGDPC) (Cedis)	8.48×10^9	$5.35. \times 10^9$	2.10×10^9	3.90×10^{10}
Variable	**Std. Dev.**	**C.V**	**skewness**	**Ex. Kurtosis**
Real gross domestic product (RGDPD) ($)	2.00×10^9	0.481043	1.22812	0.612632
Real gross domestic product (RGDPC) (Cedis)	5.58×10^9	0.483503	1.22166	0.599099
Nominal gross domestic product (NGDPD) ($)	1.35×10^{10}	2.18241	2.57866	5.91421
Nominal gross domestic product (NGDPC) (Cedis)	8.78×10^9	1.03522	2.14873	3.52014

Source: Author's computation, 2013

3.2 Results of Unit Root Tests without Structural Breaks

The two main unit root tests used in the current study are the Augmented Dickey-Fuller test (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS).

3.2.1 The ADF Test

First, the Augmented Dickey-Fuller test was used to test for unit root without allowing for any structural breaks and a trend. The results of the ADF test for unit root in levels show that the series are non-stationary in intercept. Table 2 reports the results. The null hypothesis of unit root was accepted for all the series.

Table 2 ADF stationarity test results with a constant

Variables (Levels)	t-statistics	ADF P-Value	1% Critical Value	5% Critical Value	10% Critical Value	Results	Lag length
RGDP($)	8.783	1.0000	-3.641	-2.955	-2.611	Accept Ho (Unit root)	0
RGDP(CEDIS)	8.783	1.0000	-3.641	-2.955	-2.611	Accept Ho (Unit root)	0
NGDP($)	17.025	1.0000	-3.641	-2.955	-2.611	Accept Ho (Unit root)	0
NGDP(CEDIS)	3.905	1.0000	-3.641	-2.955	-2.611	Accept Ho (Unit root)	0

Source: Author's computation, 2013

Taking the logarithm of the first difference of the series and testing these with intercept and trend makes some series stationary. Nominal gross domestic product in Cedis became stationary. That is, the null hypothesis of unit root was rejected. The results are reported in Table 3. These results indicate that the series exhibit unit root processes.

Table 3 ADF stationarity test results with a constant and a time trend

Variables (First Difference)	t-statistics	ADF P-Value	1% Critical Value	5% Critical Value	10% Critical Value	Results	Lag length
ΔlnRGDPD	-2.983	0.1370	-4.270	-3.552	-3.211	Accept Ho (Unit root)	2
Δln RGDPC	-2.983	0.1370	-4.270	-3.552	-3.211	Accept Ho (Unit root)	2
ΔlnNGDPD	0.676	0.9970	-4.270	-3.552	-3.211	Accept Ho (Unit root)	2
Δln NGDPC	-3.410	0.0501	-4.270	-3.552	-3.211	Reject Ho (Stationary)	2

Source: Author's computation, 2013

4.2.2 The KPSS Test

The KPSS test is based on the null assumption (Ho) that the series variables under investigation are stationary (series are not unit root) against the alternative hypothesis (H1) that

the series are not stationary (series are unit root). The KPSS is a reversed test for unit root. It is used in the current study for confirmation of the stationarity properties of the series. The results are reported in Table 4 and Table 5. The series were examined in levels and in first difference as were as in their logarithm form. The results are mixed. Some series are unit root in levels but become stationary in first difference, indicating that they are integrated of order one, I (1). Series variables that are stationary at levels are integrated of other zero, I(0). The levels of significance are 1%; 5% and 10%. Some series are stationary at 10% but not at 1% and 5%.

Table 4 KPSS stationarity test results with a constant and a time trend

Variable	KPSS P-value	Results	Lag length
ΔlnRGDPD-1st difference	0.0558667	Reject Ho	3
ΔlnNGDPD-1st difference	0.111381	Accept Ho	3
NGDPD-level	0.22462	Accept Ho	3
RGDPC-level	0.281011	Accept Ho	3
NGDPC-level	0.198684	Accept Ho	3
ΔlnNGDPC-1st difference	0.112671	Accept Ho	3
ΔlnRGDPC-1st difference	0.0558667	Reject Ho	3

Source: Author's computation, 2013

4 Conclusions and Policy Implementations

The objective of the paper has been achieved. The test results from the ADF and the KPSS indicates that the series exhibit unit root processes and are integrated of order one, I(1). The findings on the unit root test are in support of the findings f previous researchers such as Phiri (2014); Akinwale et al. (2013); Mehrara and Musai (2013); Furuoka (2011); Ozturk and Kalyoncu (2007); Rapach (2002); Ceung and Chinn (1996), which support the view of unit root in output for various countires. The detection of unit roots in the series indicate that shocks to the series will have permanent effects and not transitory effects as proposed by business cycle theorists. Government policies to influence output will have limited effect. Policy makers should incorporate these findings in their policy programmes to ensure sustainable economic growth. The results also indicate that any regression analysis using the series without taking into account the stationarity properties of the series will be spurious. Future studies should examine why these series exhibit unit root and also use other unit root test such as the Phillips-Perron (PP) and panel unit root models to examine whether the current findings will be replicated.

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