ECONOMIC SHOCKS AND GROWTH IN POST-INDEPENDENCE GHANA, 1957 TO 2017

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Abstract

The study analyses economic growth based on annual changes in real gross domestic product (GDP) in Ghana during the post-independence period from 1957 to 2017 using an econometric approach involving an autoregressive modelling scheme that incorporates several economic shocks as separate independent variables. The economic shocks included in the model are world cocoa price shock, world oil price shock, weather shock due to an El Nino weather phenomenon, and political instability shock for military coups or attempted military coups. The results of the analysis confirm the considerable impact of various economic shocks on economic growth. Using the standardised regression estimates, the most important variable affecting economic growth in Ghana over the 60-year period was political instability shock followed by world oil price shock, weather shock dealing with the El Nino weather phenomenon, and then world cocoa price shock. The results indicate the need for policy makers to pay more attention to economic shocks in the development of programmes to enhance sustainable and broad-based economic growth in Ghana. Several policy proposals are made in the paper including the establishment of enhanced and larger stabilisation funds for export commodities such as cocoa. It is recommended that policy makers see the Ghanaian economy as vulnerable to intermittent major economic shocks, including natural hazards, which require their close monitoring and the use of adaptive measures.

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1.0 Introduction

Ghana experienced its first military coup on 24th February, 1966, almost nine years after independence, partly due to a temporary balance of payments crisis in 1965 resulting from historically-low world market prices for its leading export, cocoa, for which it was the largest world producer, accounting for about 37.5% of world production (refer to Kotey ***et al.,*** 1974 for real world cocoa prices from 1920 to 1974), and international political pressures from 1963 to 1966 (Hersh, 1978). A 27-year period of political instability then followed after the first military coup in February 1966 until January 1993 when the Fourth Republican Constitutional System came into force (Anaman, 2006; Anaman, 2016).

Using a measure of 1,000 United States (US) dollars as the minimum threshold figure for middle income status, Ghana attained a middle-income status in 2009 based on per capita real GDP rising above 1,000 US dollars. The country was formally declared to be of such a status by the Government of Ghana based on the rebasing exercise conducted by the Ghana Statistical Service in November 2010 using the year 2006 as the base year (Ghana Statistical Service, 2010; Ghana Statistical Service, 2017). However, it is important to note that *given this definition of middle-income status,* Ghana achieved middle-income status once during the First Republican era (from 1960 to 1966). The country first achieved a middle-income status in 1961 with a per capita real GDP of 1,004.5 US dollars using the year 2006 as the base year (refer to Appendix 1). *Middle-income status, defined in this study as per capita GDP of at least 1,000 US dollars* (in 2006 constant value) was also achieved in Ghana in 1973 and 1974, and then from 2009 to 2017. period.

Using data compiled in Appendix 1, the variation in economic growth was analysed over three periods: (1) first post-independence period from 1957 to 1965, (2) the politically unstable period from 1966 to 1992, (3) over the 25-year period of political stability from 1993 to 2007 (Fourth Republican period). From 1957 to 1965, the average annual growth rate was 4.62% with a standard deviation of 6.00% and a coefficient of variation of 130%. From 1966 to 1992, the average annual growth rate was 1.74% with a standard deviation of 6.46 and a coefficient of variation of 372%. For the third period from 1993 to 2017, the average annual economic growth was 5.61% with a standard deviation of 2.41% and coefficient of variation of 43%. The considerable variation in annual economic growth rate would reflect political instability and possibly other economic shocks.

Economic shocks have been recurring in Ghana since political independence in 1957 and are of varied types. These include dramatic changes in weather and climate variability such as the El Nino weather phenomenon observed in 1962/63, 1977/78, 2006/2007 and 2014/2015. Other sources of economic shocks are related to international trade shocks and these include sudden dramatic increases in world oil prices and collapse of world cocoa prices such as the world price shocks from 1975 to 1980 partly resulting from the 1973 Arab-Israeli conflict, and the 1962-65 world cocoa price slump partly related to the oversupply of cocoa (Kotey et al., 1974).

International cocoa prices reached a record low of 211 US dollars per tonne in July 1965, and an all-time high of 4,361.58 US dollars per tonne in July 1977. World cocoa prices dropped from a

high of 3,300 dollars in October 2016 to about 1,900 dollars per tonne in July 2017 but recovered to 2,700 dollars in April 2018 (International Cocoa Organisation, 17 April 2018).

An important source of economic shock in Africa in the 1960s, 1970s and 1980s was political instability through failed and successful military coups. This phenomenon has largely waned over the last two decades. But this has been replaced in Ghana by an intense competition for political power through a two-party system that reinforces constant mobilisation of ethnic and regional differences (Anaman, 2016). Given the background information presented, the main objective of this paper is to ascertain the influence of economic shocks on economic growth in Ghana over the post-independence period from 1957 to 2017. The rest of this paper is organised as follows: the next section deals with the review of the literature with some emphasis on the appropriate definitions of economic shocks and empirical works in the area. This section is followed by a description of the methodology used for the study, the results, conclusions, appendices and cited references.

Figure 1: Illustration of Real per Capita GDP (in 2006 USD Constant Values) for Ghana from 1957 to 2017.

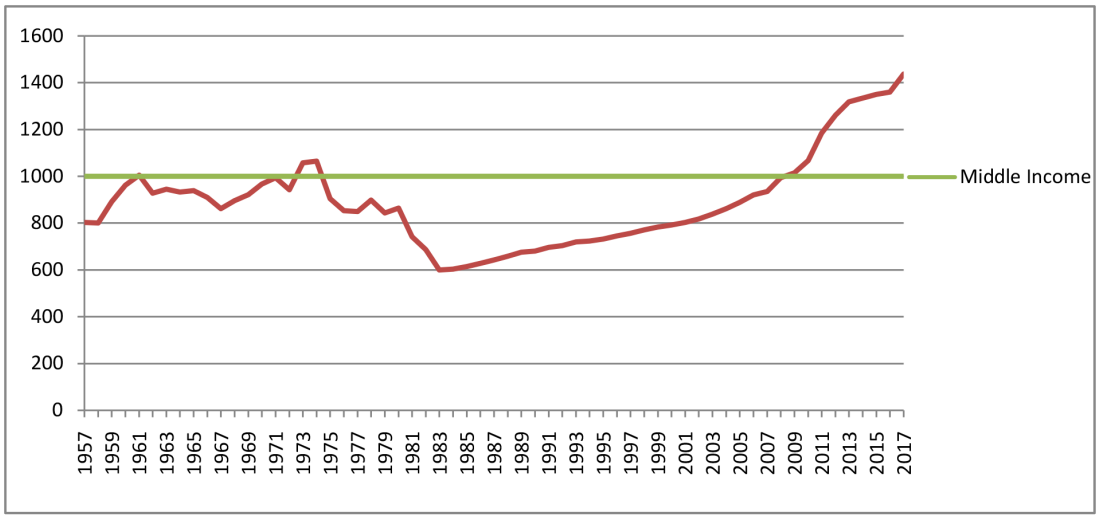
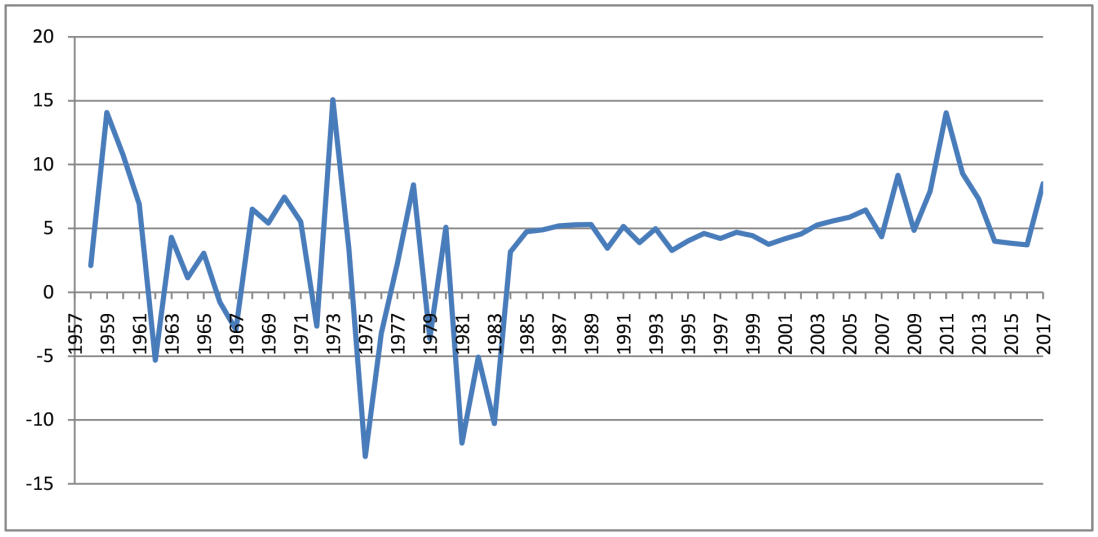


Figure 2: Illustration of Annual Economic Growth (Percent) in Ghana, 1957 to 2017.



2.0 Literature Review

2.1 Introduction and Theory of the Effect of Economic Shocks

An economic shock is an unexpected or an unpredictable event that causes drastic economic changes either positively or negatively often through changes in economic growth, employment and living standards. It is often exogenous or external to the economic system; however endogenous shocks also exist. Economic shocks can be domestic or externally induced. Economic shocks can quickly push millions of people into poverty and temporary hardships which then lead to political unrest. An economy with weak degree of diversification is more likely to suffer from major shocks compared to a more diversified economy.

It is well established in the literature that economic shocks affect the economy through changes in both the aggregate supply curve and aggregate demand curves through their disruptive and uncertain effects which in turn affect economic growth (Rogers, 2003). The aggregate supply curve of the economy is affected by economic shocks when the economy is unable to produce certain levels of outputs due to the disruptions in the supply of inputs such as labour, raw materials arising from a number of factors such as strikes and sharp increases in the costs of inputs. Other effects of economic shocks on aggregate supply curve include political instability such as military coups and natural disasters such as droughts, earthquakes and floods (Cavallo and Noy, 2010; Masih et al., 2014).

2.2 Brief Summary of Empirical Works Related to Shocks and Economic Growth

Empirical analysis of the impacts and effects of economic shocks on economic growth and aggregate economic activity is often reported in the literature in two groups: (1) shocks dealing with natural hazards and (2) shocks which are essentially derived from human activities including trading and speculative activities and decisions. In some cases, both types of shocks are combined for the analysis as was done by Kar and Bhattacharya (2011) who develop a macro-modelling framework to ascertain how external shocks (oil price hike, world trade shock and capital flow shock) and domestic shocks (rainfall shortfall and fiscal profligacy or excessive government spending) impact on economic growth through various channels in the Indian economy. Their results suggest that rainfall and fiscal profligacy shocks in both the short-run and long-run periods retard economic growth much more than the three external shocks of oil price hike, world trade shock and capital flow shock.

Miguel et al. (2004) analysed the impact of economic conditions on the likelihood of civil conflicts in 41 Sub-Saharan African countries using an econometric approach with exogenous rainfall variation being an instrumental variable for economic growth. They showed that negative economic growth shock of five percentage points was strongly related to the increased likelihood of civil conflicts. From their analysis, it could be inferred in largely rain-fed agricultural production systems, sharply reduced rainfall would lead to decreased agricultural production and increased likelihood of conflicts. However, this situation is not inevitable as the State can take preventive measures such as importing food in advance and distributing relief food and other items to reduce the suffering of the population.

While the previously-mentioned study was concerned about rainfall variation, Dell et al. (2012) analysed the effects of historical fluctuations in temperature within countries on aggregate economic outcomes. They showed that higher temperatures tended to reduce growth rates and not just the level of output. Further, higher temperatures had other effects such as reducing the outputs of the agricultural and industrial sectors and political stability. The variation in international commodity prices over the 1960 to 2014 period for a 138 country-study conducted by Fernandez et al. (2017) suggested that world economic shocks accounted for about 33% of the variation in the aggregate activity. This share doubled when only post-2000 data are used. The importance of this particular study is the amplification of the disturbing nature of international trade shocks on the aggregate activity of countries especially less developed ones.

Aisen and Viega (2013) employed a system-general method of moments modelling framework to empirically test the hypothesis that political unrest adversely affected economic growth using data for 169 countries and over the period, 1960 to 2004. They concluded that higher levels of political unrest were associated with reduced economic growth as expected. They showed that the harmful effects of political unrest were directly linked to the reduced growth of total factor productivity and to a lesser extent through discouraging physical and human capital accumulation. The impact of political unrest and political instability on economic growth has also been investigated by other authors. Alesina et al. (1996) found empirical evidence to show that political unrest lowered economic growth.

Alley et al. (2014) empirically queried the generally held belief in Nigeria that oil price disturbances had no impact on the Nigerian economy. The results of their study showed that increased oil prices positively affected aggregate economic output as measured by real GDP. However, oil price shocks in the form of dramatic drop in prices largely lowered economic growth. This lends support to the idea that the uncertainty the oil price shock introduces destabilises government fiscal operations which in turn distort economic plans and outcomes.

3.0 Methodology

The methodology used in this study is to specify an autoregressive model that incorporates various economic shocks in an economic growth model. The model used in this study is outlined in Equations 1 and 2 as follows for RGDP and PCRGDP respectively.

$$LRGDP_t = B_0 + B_1 LRGDP_{t-1} + B_2 LRGDP_{t-2} + \ldots\ldots\ldots\ldots\ldots + Bp\ LRGDP_{t-p} + C_1 WEATHERSHOCK_t + C_2 POLITICALINSTABILITY_t + C_3 OILPRICESHOCK_t + C_4 COCOAPRICESHOCK_t + U_t \quad \text{Equation 1}$$

where **$RGDP_t$** is the real gross domestic product in year "t";
$LRGDP_t$ is the natural logarithm of RGDP in year "t";
$PCRGDP_t$ is the per capita real gross domestic product in year "t";

WEATHERSHOCK$_t$ refers to the occurrence of severe El Nino weather phenomenon and/or droughts in year "t" with 1 denoting occurrence of the phenomenon and zero otherwise. Based on the available literature (Ofori-Sarpong and Annor, 2012; Masih et al., 2014; Economist Magazine, 2015), the years, 1962, 1977, 1983, 1990, 1992, 1998, 1999, 2003, 2007 and 2015 were considered relatively severe weather shock years with dummy value of 1. All other years were given a value of zero. This variable actually deals with both weather shock (affecting agriculture) and energy shock (from reduced hydro-power generation).

POLITICALINSTABILITY$_t$ refers to the occurrence of a military coup or attempted military coup in year "t" with 1 denoting occurrence of a coup or attempted coup and zero otherwise. A value of 1 was given for years of military coups or major attempted military coups. Thus, the years, 1966, 1967, 1972, 1978, 1979, 1981, 1982, 1983 were given a value of 1. All other years were given a value of zero.

COCOAPRICESHOCK$_t$ refers to a year when world cocoa dropped sharply compared to previous years with 1 denoting a year of sharp drop in world cocoa prices and zero otherwise. A value of 1 was given for years of very sharp drops in world cocoa prices or historically very low world cocoa prices based on the literature provided by Kotey et al. (1974) covering cocoa prices from 1920 to 1970, and the International Cocoa Organisation Quarterly Bulletin of Cocoa Statistics covering the period from 1960 to 2017. The years, 1962, 1963, 1964, 1965 and 1971 were given a value of 1. All other years were given a value of zero.

U_t is the equation error term initially assumed to be normally distributed with zero mean and constant variance.

$$LPCRGDP_t = B_0 + B_1\, LPCRGDP_{t-1} + B_2\, LPCRGDP_{t-2} + \ldots\ldots\ldots\ldots\ldots + B_p\, LPCRGDP_{t-p} + C_1\, WEATHERSHOCK_t + C_2\, POLITICALINSTABILITY_t + C_3\, OILPRICESHOCK_t + C_4\, COCOAPRICESHOCK_t + U_t \qquad \text{Equation 2}$$

LPCRGDP$_t$ is the natural logarithm of PCRGDP in year "t";
The first difference of a natural logged variable represents the growth rate of the level variable (refer to Gujarati, 2003, p. 176). Hence the first differences of LRGDP would measure the growth rate of RGDP or simply annual economic growth rate. The correct use of the autoregressive equations requires that the regression models be based on stationary variables. The test of stationarity was therefore conducted for the variables, RGDP, LRGDP, PCRGDP, LPCRGDP based on the analysis of unit roots.

The study used two well-known unit root tests known as Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979; Dickey and Fuller, 1981) and the Phillip Perron (PP) test (Phillips and Perron, 1988). The null hypothesis for both tests was that there was a unit root in the time series. The PP test of stationarity is generally preferred to the ADF test partly because the former test is more efficient in distinguishing between non-stationary and stationary time- series with high degree of autocorrelation (Culvell and Papell, 1997; Hall and Cummins, 2009).

The optimal lag length of the autoregressive analysis was determined to be one based on the use of Schwarz-Bayesian criterion and Akaike Information Criterion. As many as five lag lengths were analysed with lag length one being declared the optimal. The unit root test results are reported in Table 1 and they indicate that for both the ADF and PP tests, the two linear variables, RGDP and PCRGDP were non-stationary at their levels. Further, these results also show that the two logged variables, LRGDP and LPCRGDP were also non- stationary at their levels. However, the first differences of the two logged variables, DLRGDP and DLPCRGDP were both stationary (refer to Table 1).

Table 1: Unit Root Tests of the Variables at the Levels and First Differences

Variable	ADF Statistic	P Value	PP Statistic	P Value
RGDP	1.154	1.000	3.365	1.000
PCRGDP	-0.206	0.991	0.157	0.997
LRGDP	-0.345	0.988	-0.624	0.993
LPCRGDP	-0.344	0.988	-0.754	0.911
DLRGDP	-4.670	0.0008***	-43.003	0.0005***
DLPCRGDP	-5.123	0.0009***	-42.918	0.0005***

Notes

LRGDP and **LPCRGDP** are the natural logarithmic forms of the linear variables, **RGDP** and **PCRGDP** respectively.

DLRGDP and **DLPCRGDP** are the first differences of the variables, **LRGDP** and **LPCRGDP** respectively. The first difference of a natural logged variable represents the growth rate of the level variable (refer to Gujarati, 2003, p. 176). Hence **DLRGDP** and **DLPCRGDP** represent the growth rates of **RGDP** and **PCRGDP** respectively.

*** denotes 1 percent statistical significance
** denotes 5 percent statistical significance

With the formal establishment of stationarity for both **DLRGDP** and **DLPCRGDP** variables as indicated in Table 1, the ordinary least squares estimation method was employed to estimate Equations 3 and 4 shown below.

$$DLRGDP_t = B_0 + B_1 DLRGDP_{t-1} + B_2 DLRGDP_{t-2} + \ldots\ldots\ldots\ldots\ldots + B_p DLRGDP_{t-p} + C_t WEATHERSHOCK_t + C_2 POLITICALINSTABILITY_t + C_3 OILPRICESHOCK_t + C_4 COCOAPRICESHOCK_t + U_t \quad \text{Equation 3}$$

Where $\mathbf{DLRGDP_t}$ is the first difference of the natural logarithm of RGDP in year "t";

$$DLPCRGDP_t = B_0 + B_1\, DLPCRGDP_{t-1} + B_2\, DLPCRGDP_{t-2} + \ldots\ldots\ldots\ldots\ldots + B_p\, DLPCRGDP_{t-p} + C_1\, WEATHERSHOCK_t + C_2\, POLITICALINSTABILITY_t + C_3\, OILPRICESHOCK + C_4\, COCOAPRICESHOCK_t + U_t \quad \text{Equation 4}$$

Where **$DLPCRGDP_t$** is the per capita real gross domestic product in year "t";

4.0 Results

The results of the autoregressive model analysis for economic growth (DLRGDP) are reported in Table 2. As measured by the R2 and the adjusted R2, the power of the model was moderately strong. The model was correctly specified based on the Ramsey Reset Test. There was no significant heteroscedasticity problem with the model. The normality test confirmed that the error term was normally distributed at two levels of significance (1% and 5%) with the hypothesis of the normality of the error term not rejected at these two significance levels. This meant that even with the relatively small sample size of 60, the estimated sample coefficients could be generalised to the population parameters. The very low figures for the variance inflation factor (VIF) for all the independent variables, very close to the minimum possible level of 1.0 and far below the critical maximum level of 10.0 for the existence of the problem of multicollinearity (refer to Gujarati, 2003), suggested that there was no significant multicollinearity in the model or any close relationship among the independent variables.

As expected, all the five independent variables including the four economic shock variables were statistically significant in influencing the variation in economic growth. The lagged dependent variable used as the independent variable was statistically significant confirming the appropriateness of the use of an autoregressive modelling scheme. The most important independent variable, based on the absolute value of the standardised regression estimates, was **POLITICALINSTABILITY**, followed by **OILPRICESHOCK, WEATHERSHOCK,** the lagged dependent variable, **$DLRGDP_{t-1}$** and **COCOAPRICESHOCK.** The highly significant intercept term (with a value of 0.053) suggested an underlying annual growth of about 5.3% in the absence of any of the independent variables.

The results of the autoregressive model analysis for per capita economic growth (DLPCRGDP) are reported in Table 3. The statistical power of the model was moderately strong based on the R^2 and the adjusted R^2. The model was also correctly specified based on the Ramsey Reset Test. There was no significant heteroscedasticity problem with the model. The normality test confirmed that the error term was normally distributed at two levels of significance (1% and 5%). Similar to the results for economic growth reported in Table 2, all the five independent variables including the four economic shock variables were statistically significant in influencing the variation in economic growth with the relative importance of the independent variables also similar to those reported in Table 2. Hence, given the politically-stable period over the last 25 years during the Fourth Republican constitutional period, then attention for policy action and intermediation should be more focussed on **OILPRICESHOCK, WEATHERSHOCK** and **COCOAPRICESHOCK.**

Table 2: Results of autoregressive model analysis of annual economic growth with respect to various economic shocks in Ghana during the 60-year post- independence period from 1957 to 2017 and using the first lagged value of the dependent variable as an autoregressive independent variable.

Dependent Variable is $DLRGDP_t$ ($GROWTH_t$)

Explanatory Variable	Unstandardized Parameter Estimate	Standardised Parameter Estimate	T-statistic	P Value	VIF
INTERCEPT	0.053	0.000	7.452	0.000***	0.000
$DLRGDP_{t-1}$	0.221	0.220	2.321	0.024**	1.081
$WEATHERSHOCK_t$	-0.035	-0.244	-2.65	0.010***	1.020
$POLITICALINSTABILITY_t$	-0.068	-0.440	-4.525	0.000***	1.142
$OILPRICESHOCK_t$	-0.081	-0.425	-4.433	0.000***	1.109
$COCOAPRICESHOCK_t$	-0.036	-0.188	-2.042	0.046**	1.023

Notes

Sample size	60
R^2	0.561***
Adjusted R^2	0.520***
F value	13.573***
Probability level of significance of correct specification of the model using the Ramsey Reset test with null hypothesis of correct specification	0.280
Probability level of significance of normality of the error term using the Kolmogorov-Smirnov test	0.071
Probability level of significance of the LM test for heteroscedasticity	0.105

*** denotes 1 percent statistical significance
** denotes 5 percent statistical significance

Table 3: Results of autoregressive model analysis of annual per capita economic growth with respect to various economic shocks in Ghana during the 60-year post-independence period from 1957 to 2017 and using the first lagged value of the dependent variable as an autoregressive independent variable.

Dependent Variable is $DLPCRGD_t$

Explanatory Variable	Unstandardised Parameter Estimate	Standardised Parameter Estimate	T-statistic	P Value	VIF
INTERCEPT	0.033	0.000	5.261	0.000***	0.000
$DLPCRGDP_{t-1}$	0.221	0.220	2.321	0.024**	1.078
$WEATHERSHOCK_t$	-0.035	-0.247	-2.673	0.010***	1.020
$POLITICALINSTABILITY_t$	-0.068	-0.437	-4.477	0.000***	1.139
$OILPRICESHOCK_t$	-0.081	-0.426	-4.424	0.000***	1.109
$COCOAPRICESHOCK_t$	-0.035	-0.181	-1.962	0.055	1.022

Notes

Sample size	60
R^2	0.557***
Adjusted R^2	0.516***
F value	13.349***
Probability level of significance of correct specification of the model using the Ramsey Reset test with null hypothesis of correct specification	0.281
Probability level of significance of normality of the error term using the Kolmogorov-Smirnov test	0.068
Probability level of significance of the LM test for heteroscedasticity	0.401

*** denotes 1 percent statistical significance
** denotes 5 percent statistical significance

5.0 Conclusion and Policy Recommendations

The study analyses economic growth based on annual changes in real GDP in Ghana during the post-independence period from 1957 to 2017 using an econometric approach involving an autoregressive modelling scheme that incorporates several economic shocks as separate independent variables. The economic shocks included in the model are world cocoa price shock, world oil price shock, weather shock due to an El Nino weather phenomenon, and political instability shock for military coups or attempted military coups. The results of the analyses confirm the considerable impact of various economic shocks on economic growth. The most important variable affecting economic growth in Ghana over the 60-year period was political instability shock followed by world oil price shock, weather shock dealing with the El Nino weather phenomenon, and then world cocoa price shock.

With the intermittent major economic shocks throughout the post-independence period in Ghana, it is clear that the country is particularly vulnerable to economic shocks which when they are present render the economy weaker. Given the era of political stability over the last quarter of century, during the Fourth Republican era from 1993 to the present, it is important for policymakers to seriously address economic shocks dealing with natural hazards and international commodity prices.

In particular, policy makers must prepare the general population especially those living in Accra, the capital city, (which produces one-third of Ghana's GDP) of the real possibility of occurrence of major earthquakes and take measures to minimise the societal impacts of possible earthquakes. The Ghana Geological Survey in its interaction with the mass media in March 2018 indicated that a major earth quake was likely in Accra given the more recent activity of the fault lines (Ghana Web News, 29 March 2018). Earthquakes and earth tremors have occurred intermittently in Ghana especially within the Accra area, with major ones recorded in 1615, 1636, 1858, 1862, 1863, 1871, 1872, 1906, 1907, 1939, 1964, 1969 and 1997 (Ambraseys and Adams, 1986; Amponsah, 2004). In terms of societal costs and damages, the 1939 event was the worst (Amponsah, 2004).

Another major source of recurring natural hazard is drought often linked to the El Nino weather phenomenon since 1960. This hazard reduces the electricity generation capacity of hydro plants which had been the main sources of electricity energy supply in Ghana since 1966 (also refer to Appendix 2). Appendix 2 indicates the installed capacity, annual changes in installed capacity (%), and actual electricity generation in Ghana from 2000 to 2016 from both hydro-based dams and non-hydro sources. Appendix 2 shows that it was only in 2015 that non-hydro sources provided more energy generation than hydro-based dams.

It is clear that in general the production of installed electricity generation capacity as measured in megawatts (MW) has been limited and not at a fast pace as was done during the First Republic. During an El Nino year as occurred in 2003, 2007 and 2015, there was some modest increase in installed capacity. After the end of the El Nino event and with the resumption of full use of hydro plants (Akosombo and Kpong), politicians become complacent and do little about increasing the

level of installed capacity until another El Nino event comes and there is a rush to increase installed capacity involving non-hydro sources.

The biggest increase in electricity generation installed capacity over the period from 2000 to 2016 occurred in 2015 (which was a severe El Nino event year) with an increase of 29.1% (825 MW). This increase was undertaken following public pressure on the government to end the crippling energy shortages that occurred from mid-2014 and 2015 which affected industry and the welfare of ordinary citizens. It appears we are back to the normal game of complacency of the politicians with the end of the El Nino weather event. Little generation capacity was added in 2017 with the government claiming about 337 MW of electricity energy capacity which had been virtually installed in 2016 as work done in 2017 (refer to the Government of Ghana 2017 budget statement indicating 4,132 MW was the installed capacity in 2016 versus the revised Energy Commission figure of 3,795 MW). This could be the recurrence of the complacency disease of politicians who often ride on the back of investments that were undertaken during the crisis years.

Concerning commodity price risks, the need for the establishment of enhanced stabilisation funds for export commodities such as cocoa has been repeatedly made (see for example, Aidam and Anaman (2014)). The Ghana Cocobod started implementing bigger stabilisation funds in 2014 under Presidential directive. However, like the previous stabilisation funds, the levels were inadequate to cushion the large drop in cocoa prices that were experienced in 2016/2017 production year. It must be noted that the long-term solution to export commodity price shocks needs to involve broader diversification of the economy that includes the export of a wider range of goods and services beyond the traditional commodities of cocoa, gold and timber products and more recently crude oil.

6.0 Appendices

Appendix 1: Macroeconomic Data for Ghana from 1957 to 2017 Used for the Study.

year	real gdp2006	growth	exchange rate	population	pcrgdpghs 2006	pcrgdpusd 2006
1957	4599.91		0.000071	6246636	736.38	803.91
1958	4695.74	2.08	0.000071	6402761	733.39	800.65
1959	5356.18	14.06	0.000071	6562788	816.14	890.99
1960	5931.17	10.73	0.000071	6726815	881.72	962.58
1961	6340.64	6.90	0.000071	6890842	920.16	1004.54
1962	6003.61	-5.32	0.000071	7058868	850.51	928.50
1963	6261.54	4.30	0.000071	7230991	865.93	945.34
1964	6331.49	1.12	0.000071	7407312	854.76	933.15
1965	6524.88	3.05	0.000071	7587932	859.90	938.76
1966	6474.81	-0.77	0.000071	7772956	832.99	909.38
1967	6284.17	-2.94	0.000087	7962492	789.22	861.60
1968	6693.33	6.51	0.000102	8156649	820.60	895.85
1969	7056.37	5.42	0.000102	8355541	844.51	921.96
1970	7581.98	7.45	0.000102	8559313	885.82	967.05
1971	8000.74	5.52	0.000103	8783682	910.86	994.39
1972	7788.31	-2.66	0.000133	9013933	864.03	943.26
1973	8962.36	15.07	0.000117	9250219	968.88	1057.73
1974	9262.86	3.35	0.000115	9492699	975.79	1065.27
1975	8071.83	-12.86	0.000115	9741536	828.60	904.58
1976	7813.53	-3.20	0.000115	9996895	781.60	853.27
1977	7991.19	2.27	0.000115	10258948	778.95	850.38
1978	8662.52	8.40	0.000176	10527870	822.82	898.27
1979	8349.84	-3.61	0.000275	10803842	772.86	843.73
1980	8773.59	5.08	0.000275	11087048	791.34	863.91
1981	7737.76	-11.81	0.000275	11377678	680.08	742.45
1982	7344.28	-5.09	0.000275	11675926	629.01	686.69
1983	6588.46	-10.29	0.000883	11981992	549.86	600.29
1984	6797.15	3.17	0.003599	12296081	552.79	603.48
1985	7119.38	4.74	0.005437	12631429	563.62	615.31
1986	7466.74	4.88	0.008920	12975924	575.43	628.20
1987	7854.82	5.20	0.015373	13329813	589.27	643.30
1988	8269.28	5.28	0.020235	13693354	603.89	659.27
1989	8708.64	5.31	0.027000	14066810	619.09	675.86
1990	9008.60	3.44	0.032633	14450451	623.41	680.58

Appendix 1: Macroeconomic Data for Ghana from 1957 to 2017 Used for the Study.
(Continued from Previous Page)

year	real gdp2006	growth	exchange rate	population	pcrgdpghs 2006	pcrgdpusd 2006
1991	9471.73	5.14	0.036783	14844555	638.06	696.57
1992	9840.40	3.89	0.044000	15249407	645.30	704.47
1993	10329.60	4.97	0.065000	15665301	659.39	719.86
1994	10667.31	3.27	0.096000	16092537	662.87	723.66
1995	11096.50	4.02	0.120000	16531425	671.24	732.79
1996	11606.51	4.60	0.164000	16982283	683.45	746.12
1997	12093.78	4.20	0.205000	17445437	693.23	756.81
1998	12661.43	4.69	0.231000	17921223	706.50	771.29
1999	13222.14	4.43	0.267000	18409985	718.20	784.07
2000	13716.14	3.74	0.545000	18912079	725.26	791.77
2001	14289.78	4.18	0.716000	19420587	735.81	803.28
2002	14939.72	4.55	0.792000	19942768	749.13	817.83
2003	15723.75	5.25	0.867000	20478989	767.80	838.21
2004	16600.80	5.58	0.899000	21029628	789.40	861.79
2005	17574.96	5.87	0.906000	21595073	813.84	888.47
2006	18705.10	6.43	0.916000	22175721	843.49	920.85
2007	19518.00	4.35	0.935000	22771982	857.11	935.71
2008	21304.00	9.15	1.058000	23384275	911.04	994.58
2009	22336.00	4.84	1.409000	24013031	930.16	1015.46
2010	24101.00	7.90	1.431000	24658823	977.38	1067.01
2011	27486.00	14.05	1.512000	25321716	1085.47	1185.01
2012	30040.00	9.29	1.810000	26002567	1155.27	1261.21
2013	32237.00	7.31	1.920000	26701724	1207.30	1318.01
2014	33522.00	3.99	2.940000	27419680	1222.55	1334.66
2015	34808.10	3.84	3.780000	28156940	1236.22	1349.58
2016	36016.00	3.70	3.920000	28914024	1245.62	1359.85
2017	39077.36	8.50	4.300000	29691464	1316.11	1436.81

Notes

The source of the nominal GDP figures from 1957 to 2000 is from the International Financial Statistics Yearbook Annual Issues produced by the International Monetary Fund (IMF). The data from 2001 to 2017 are from the Ghana Statistical Service (2017).
All other data are sourced from the Ghana Statistical Service and are synchronised and compared to the data from IMF sources.

Exchange rate refers to the exchange rate measured as Ghana cedis per one US dollar. Pcrgdpghs2006 refers to the per capita GDP of Ghana measured in Ghana cedis using the year 2006 as the base year (100.00).

Pcrgdpusd2006 refers to the per capita GDP of Ghana measured in US dollars using the year 2006 as the base year (100.00).

Inter-censal population figures are estimated by the author based on figures provided by the Ghana Statistical Service for the census years of 1960, 1970, 1984, 2000 and 2010.

Appendix 2: Installed Capacity (MW), Annual Changes in Installed Capacity (%), and Actual Electricity Generation (GWh) in Ghana in 1966 and from 2000 to 2016.

Year	Population	Installed capacity (MW)	% Annual increase in installed capacity	Total generation of electricity (GWh)	% Annual increase in generation of electricity	Electricity generation from hydro plants (GWh)	Electricity generation from non-hydro plants (GWh)	Share of total from hydro dams
1966	7772956	1,020	-	-	-		0	100.0
2000	18912079	1,418	-	7,223	-	6,609	614	91.5
2001	19420587	1,551	9.4	7,859	8.8	6,609	1,250	84.1
2002	19942768	1,574	1.5	7,273	-7.5	5,036	2,237	69.2
2003	20478989	1,582	0.5	5,882	-19.1	3,886	1,996	66.1
2004	21029628	1,730	9.4	6,039	2.7	5,281	758	87.4
2005	21595073	1,730	0.0	6,788	12.4	5,629	1,159	82.9
2006	22175721	1,730	0.0	8,430	24.2	5,619	2,811	66.7
2007	22771982	1,935	11.8	6,978	-17.2	3,727	3,251	53.4
2008	23384275	1,981	2.4	8,324	19.3	6,195	2,129	74.4
2009	24013031	1,970	-0.6	8,958	7.6	6,877	2,081	76.8
2010	24658823	2,165	9.9	10,167	13.5	6,996	3,171	68.8
2011	25321716	2,170	0.2	11,200	10.2	7,561	3,639	67.5
2012	26002567	2,280	5.1	12,024	7.4	8,071	3,953	67.1
2013	26701724	2,831	24.2	12,870	7.0	8,233	4,637	64.0
2014	27419680	2,831	0.0	12,963	0.7	8,387	4,576	64.7
2015	28156940	3,656	29.1	11,492	-11.3	5,845	5,647	50.9
2016	28914024	3,795	3.8	13,022	13.3	5,561	7,461	43.0

Sources: Energy Commission of Ghana (2017); Energy Commission of Ghana (2015); Government of Ghana (2017). The installed capacity for 2016 is a subject of debate with the Ministry of Finance in its 2017 budget statement released in March 2017 indicating 4,132 MW for 2016 while Energy Commission gives a figure of 3,795 MW.

Notes

Electrical power is measured in megawatts (MW) or gigawatts (GW) indicating the amount of electricity a storage system can hold at any time. One GW is equivalent to

1,000 MW. Electrical energy, referring to energy supplied, is measured in megawatt- hours (MWh) or gigawatt-hours (GWh). One GWh is equivalent to 1,000 MWh. For 100% electrical power capacity, a power plant of 1 megawatt produces 8,760 MWh over the entire period of one year (made up of 24 hours multiplied by 365 days in the year)

(http://www.extremepower.com/about-energy-storage/mw-vs-mwh.php.)

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