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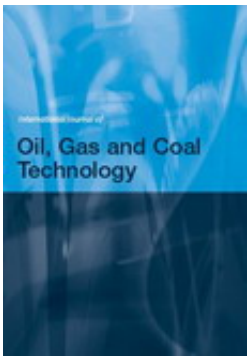

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Evaluating the effect of petroleum price volatility on government revenue in Ghana

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Abstract: The Ghanaian economy is highly exposed to petroleum price fluctuations (volatility) since petroleum revenues is a major contributor to total government revenue. The resulting volatility in government revenue also has a bullwhip effect on other sectors such as the private sector, making planning difficult and complex. This study examines the effect of petroleum price volatility (PPV) on government revenue and economic growth using quarterly time series data for the period 2010 to 2020. The study adopts the autoregressive distributed lag (ARDL) for estimating the models. Three regressions are estimated to address the set objectives of the study. A pairwise correlation matrix was adopted to determine the relationship between the variables. The findings indicate petroleum price volatility has a negative effect on government revenue both in the short run and the long run. Furthermore, the findings also demonstrate petroleum revenue makes a significant positive contribution to the growth of Ghanaian economy. [Received: January 5, 2022; Accepted: June 18, 2022]

Keywords: price volatility; autoregressive distributed lags; ARDL; petroleum revenue; cointegration; Ghana.

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1 Introduction

1.1 Background

With petroleum revenue being a significant contributor to total government revenue, the Ghanaian economy has a high-risk exposure as a result of its sensitivity to petroleum price volatility (PPV). These fluctuations in petroleum prices may have a significant effect on government policies as well as government expenditure. As a result, governments make adjustments to expenditure, factoring in variables such as petroleum revenue, all of which have social, economic and political implications.

Government revenue volatility may have a significant negative effect on other sectors. A government with a goal of providing sustainable infrastructural and social services over an extended period of time will have difficulty determining the optimal expenditure needed to achieve its goal without being certain of permanent and temporal aspects of the volatile changes in government revenue. Furthermore, government revenue volatility also makes long-term planning a complex process undermining the credibility of governments within the context of their ability to accurately forecast and manage its revenue. Due to uncertainty in extractive industries, future revenues are uncertain, and as such makes it difficult for governments to plan, exposing them to the risk of over-spending on inadequately planned projects during seasons of economic boom and harsh spending cuts during economic recessions.

Government revenue volatility is a hurdle for the private sector in its prediction of government tax and spending policies, which may have a detrimental effect on private sector investment decisions, consequently leading to slower economic growth (Barnett and Ossowski, 2002; Afonso and Furceri, 2008; Sturm et al., 2009).

Another notable effect of volatility of government revenue within many jurisdictions lies in its tendency to induce volatile movements in government expenditure. Governments have the tendency to conform to the theory of consumption smoothing such

that when revenue expands during a boom, there is a reflective increase in government expenditure. Conversely, when there is a reduction in government revenue there is also a reflective effect in government expenditure, although expenditure cuts are more controlled and not as spontaneous as the increases. As a result, volatility in government revenue can force governments to adopt a halt-go procyclical fiscal policy (Sturm et al., 2009). However, Seegert (2016) argues that tax revenue volatility has its impact on the welfare of states, causing them to spend revenue as received as opposed to adopting the theory of consumption smoothing over the business cycle, thereby causing an immediate impact on public good provisions during periods of unexpected budget shortfalls.

These procyclical policies enhance the impact of significant increases in government revenues during periods of revenue booms can also result in governments spending on services and investment in projects that have a lower rate of return. Ultimately, the spontaneous expansion of programs and capital expenditure during periods of revenue booms can significantly in capability of governments to provide more services and also to monitor spending, this often leads to wastage, subpar efficiency, and a relatively unproductive use of government resources (Barnett and Ossowski, 2002).

As a result, it is politically easier to increase government expenditure than to significantly reduce spending, there is a greater tendency to increase expenditure in response to revenue increases than to sporadically restrict expenditure. Volatility of government revenue can therefore result in an increase in government size and the adoption of an unsustainable fiscal policy which will inadvertently require an even greater expenditure cut.

1.2 Research aims and objectives

The aim of this study was to investigate the direct effects of oil price fluctuations on government of Ghana's revenue. This case study will provide a quantitative research on the impact of oil price volatility on revenue generated from hydrocarbon exploration and production in Ghana. The aim of the study will be achieved by the following objectives:

1 to examine the effect of PPV on government of Ghana's revenue

2 to analyse the contribution of petroleum revenue to the growth of the Ghanaian economy

3 to examine the effect of PPV on GDP.

2 Theoretical and conceptual review

According to Gujarati and Porter (2009), volatility is the period in which price behaviour of a commodity is characterised by significant swings for an extended period and immediately followed by an extended period of time with relatively no price movements. Hamilton (1983) stated that supply or demand changes in the international oil markets are the primary cause of oil price fluctuation. These changes may have been as a result of geopolitical disturbance, the increased popularity of shale oil, the global shift to green energy and global pandemics such as COVID-19.

The control variables to be adopted in this study include GDP, inflation, institutional quality foreign direct investment, exchange rate and gross capital formation. These

indicators allow us to assess economic activity on both the national scale and global scale.

Bondzie et al. (2014) argue that projected increases in oil revenue comes at a time of high inflation because during periods of increased government expenditure, there is a noted increase in prices of goods and services.

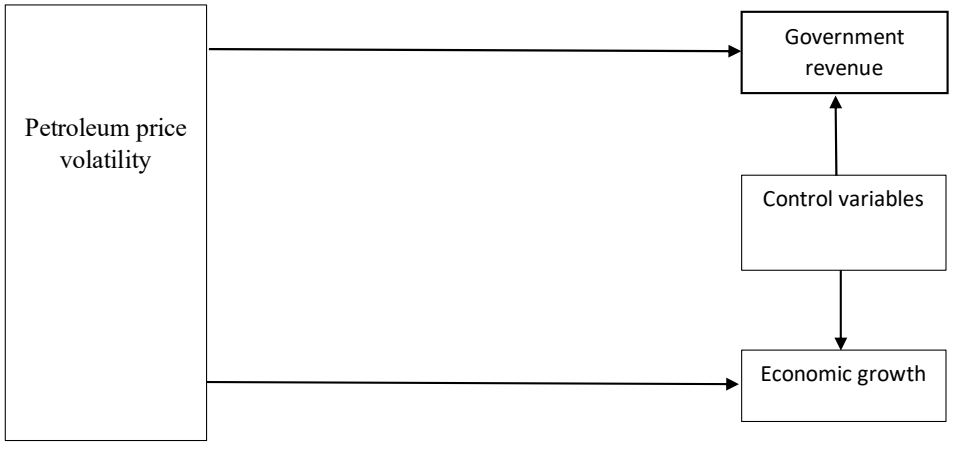
Mohammed Suliman and Abid (2020) identified a profound relationship between real exchange rate and oil prices such that increases in Saudi exchange rate generate an increase in crude oil demand which causes a surge in prices. Similarly, Nouira et al. (2018) found that increase in prices in Tunisia and Saudi Arabia are accompanied by changes in exchange rate, with significant evidence of volatility spillovers from oil markets to exchange rate markets in the MENA region.

Yu et al. (2022) found that there is a significant relationship between GDP and oil price during the period of global financial prices, with a shock in oil prices having a resultant effect on economic activities in both long run and short run.

Alavirad (2003) asserts that a budget deficit has a resultant effect of increasing money supply and ultimately inflation in Iran.

Ogbuabor and Orji (2020) found that institutional quality had a negative impact on economic growth in Nigeria, albeit insignificant.

Figure 1 Conceptual framework



Source: Authors

This conceptual framework has been developed to guide this research, evaluating the impact of crude oil price volatility on government revenue in Ghana. Studies from previous authors have established an existing relationship between the independent variable (PPV), the control variables and the dependent variables (government revenue and economic growth), this study draws on these relationships in evaluating the impact of price volatility on government revenue in Ghana.

The conceptual framework shown in Figure 1 illustrates the relationship between PPV (main independent variable), petroleum revenue (dependent variable), economic growth (dependent variable) and control variables.

2.1 Review of empirical studies

Kamasa et al. (2020) integrated an autoregressive distributed lag (ARDL) with an annual time series data between 1983 and 2017 in order to assess the impact of oil price volatility on the economy of Ghana. The results indicated oil price volatility has a significant negative impact on the economy of Ghana in both the long and short run. The dependent variables however, indicated a positive effect of trade openness and gross fixed capital formation on the economy. Furthermore, the authors observed a negative effect of interest rate on the economy in both short run and long run, however, foreign direct investment was found to have a positive impact on the Ghanaian economy. Kamasa et al. (2020) concluded that crude oil price volatility has an impact on economic well-being of the nation although insignificant. The authors further recommended the formulation of policies to be made with the aim of improving the economic welfare of Ghana and with enough consideration to crude oil price volatility. Due to Ghana being a net importer of crude oil derived products, the authors recommend adopting hedging as a risk management strategy as well as a more favourable energy portfolio with an aim of increasing the ratio of renewable sources of energy to mitigate the price exposure.

Ebrahim et al. (2014) analysed the macroeconomic implications of oil price volatility on a global scale, with the aim of mitigating the economic risks associated with oil price volatility through policy trade-offs. The authors identified the main drivers of volatility as; insufficient oil market data, speculation in crude oil futures markets and supply and demand behaviours specific to the oil and gas industry. The authors postulated that short-term change in demand and supply has a significant and disproportionate change in oil price. Furthermore, Ebrahim et al. (2014) attributed long-term growth in volatility to the decrease in price elasticity on the supply and demand over the last 40 years. This decrease in elasticity has its significant root causes embedded in the poor production rates in conventional reserves as well as the low rate of new discoveries.

The authors propose a policy framework that factors in a supply-side preventative policy that ensures stability of supply such as the IEA collective action framework to emphasise the need to maintain strategic reserves. Furthermore, Ebrahim et al. (2014) also assert that focusing only on supply risk mitigation policies in supply can only minimise oil price volatility. In order to achieve macroeconomic independence from oil price volatility there is a need for a demand-side policy which focuses on strategies to reduce total dependence on oil through methods such as facilitating a diversified energy portfolio.

Tazhibayeva et al. (2008) assessed the impact of oil price volatility on non-oil economic cycles in producing countries. The authors studied the relationship between fiscal policies and economic cycles to determine if public spending is positively correlated oil revenue. The authors adopted panel VARs configured for the variables; crude oil price, fiscal regimes and output to estimate impulse responses to crude oil price volatility. Their findings indicated that in countries with a robust and dominant oil and gas sector, oil prices do not have a direct and independent effect on non-oil output in the absence of a fiscal response to crude oil price volatility.

A cointegration analysis by Sackey et al. (2012) found a positive short and long run relationships among foreign direct investments, government revenues and GDP for Ghana.

The study of Farhani (2013) implemented the simple linear regression model (SLRM), dynamic regression model (DRM) and VAR model was used to assess the

effect of oil price fluctuation on the GDP of the USA. The analysis indicated non-significant coefficient or a poor compensation in the direct relationship, as well as a diminishing effect in the direct relationship, based on the above-mentioned model. As a result, the study's findings were strengthened by first using a breakpoint detection test and subsequently applying the vector error correction model (VECM) by adding another variable that has a major relationship with the USA's economic growth as well as oil price. As a result, the study concluded that the effect of PPV on economic growth is determined by a thorough understanding of the subject and the selection of the appropriate model. As a result of these factors, the outcomes of research papers can vary, however, they still merit further in-depth investigation in future study.

3 Methodology

3.1 Research design

This research will employ an event study design in order to investigate the impact of PPV on government revenue. This study will attempt to investigate the impact of crude oil price fluctuation on the financial performance (measured by petroleum revenue) of the oil and gas industry in Ghana using secondary data for the analysis.

3.2 Sample and scope

This study is a quarterly time series study, and which covers a ten-year period, from 2010 through 2020. This period also coincides with the period of Ghana's petroleum production. Although this study is specific to Ghana, this study can be reproduced in different countries and regions to assess the impact of crude oil price volatility on their government revenue.

3.3 Description of data and data sources

The main variables for the study are government revenue for Ghana, global petroleum prices, economic growth (real GDP per capita), and government petroleum revenues. The study covers a period of ten years (2010 to 2020) coinciding with the discovery and commercial extraction of crude oil in Ghana. A quarterly on the study variables as well as control variables are obtained and used for the analyses. Data on government revenue as well as government petroleum revenue is obtained from the various reports and websites of the Ministry of Finance of Ghana and the Bank of Ghana. Petroleum prices (dollars per barrel) are obtained from the US Energy Information Administration (EIA). Data on control variables including GDP, inflation, institutional quality, foreign direct investment, exchange rate, and gross capital formation for Ghana and obtained from the World Development Indicators (WDI) of the World Bank.

Table 1 present the summary statistics of the study variables. The average price for petroleum products over the study period is US $65.70 with a standard deviation of US $29.37. The maximum value is US $134.79, and the minimum is US $19.17. The average growth rate in government revenue over the study period is 9.15 with a standard deviation of 1.34. The highest growth rate in government revenue over the study period

was 11.09 and the lowest was 6.59. The descriptive statistics for the rest of the variables are presented in Table 1.

Table 1 Descriptive analysis of data

Variable	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. dev.*	*Observation*
FDI	5.31	5.85	10.01	0.89	2.68	44
GCF	22.77	23.91	31.38	12.21	5.78	44
In GOVREV	9.15	9.28	11.09	6.59	1.34	44
InGDP	8.56	7.03	29.62	–10.5	6.91	44
INF	14.96	13.22	41.95	7.6	6.72	44
INSQ	–0.14	–0.14	0.05	–0.4	0.11	44
PETPRICES	65.7	61.63	134.79	19.17	29.37	44
PETREV	1.88	1.3	5.31	0.28	1.58	44
PPV	34.29	19.72	436.17	8.79	47.95	44
EXR	87.99	92.36	113.33	54.47	15.17	44

Source: Authors' computation

3.3.1 Graphical presentation among variables

3.3.1.1 Effect of PPV on government revenue

Figure 2 shows the trend in petroleum prices and government revenues over 2001 through 2020, however, the focus of the study is from 2010 to 2020. It can be seen that petroleum prices are highly volatile while government revenues have grown steadily over the study period. The growth trajectory has increased significantly since the beginning of production from the petroleum reserves of Ghana. However, due to the relatively lower effect of petroleum prices on the government revenue through the period under review. This may be an effect of a robust and well diversified portfolio, with the multiple sources of revenue.

3.3.1.2 Effect of petroleum revenue on economic growth

Figure 3 shows a graphical presentation of the trend in government petroleum revenues and economic growth over the study period. It can be seen that both petroleum revenues and economic have not been stable over the study period. The is a spotted trend between petroleum revenue and economic growth such that a rise in petroleum revenue results in a rise in economic growth, conversely a fall in petroleum revenue has its negative effect on economic growth within the ten-year period under review, i.e., 2010 through 2020, thereby marking a positive correlation between petroleum revenue and economic growth.

3.3.1.3 Effect of PPV on economic growth

Figure 4 presents the graphs showing the trend in petroleum prices and economic growth over the study period. Both petroleum prices and economic growth has been volatile over the study period.

Figure 2 Graphs showing petroleum prices and government revenue trends (see online version for colours)

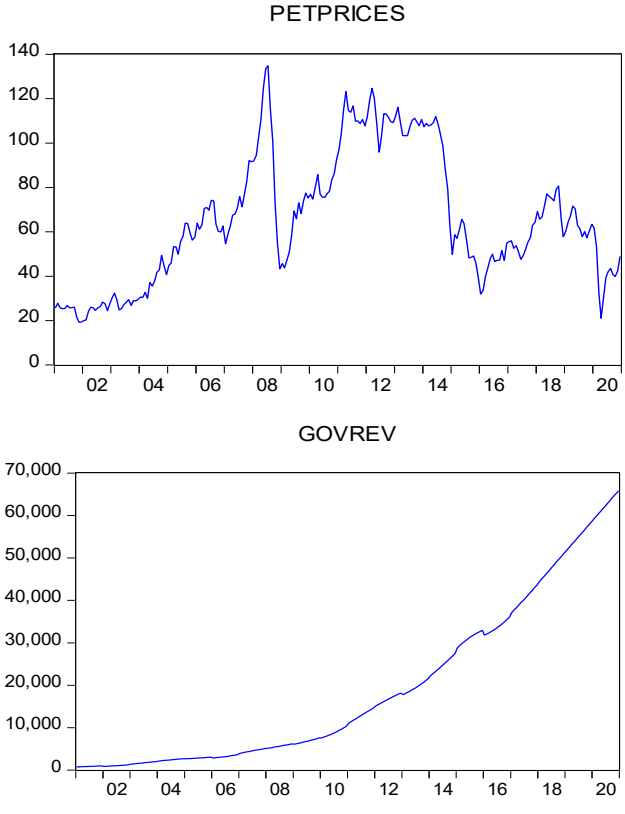


Figure 3 Graph showing petroleum revenue and economic growth trends (see online version for colours)

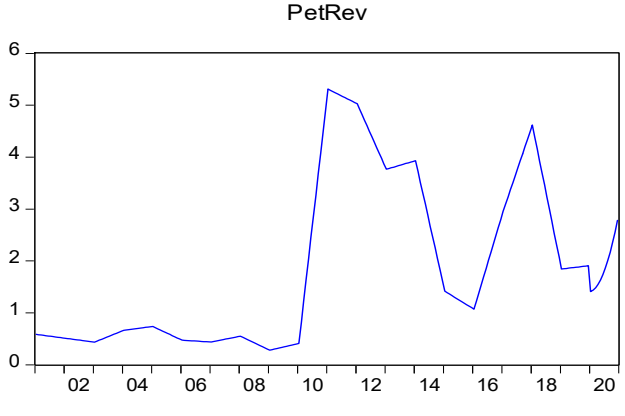


Figure 3 Graph showing petroleum revenue and economic growth trends (continued) (see online version for colours)

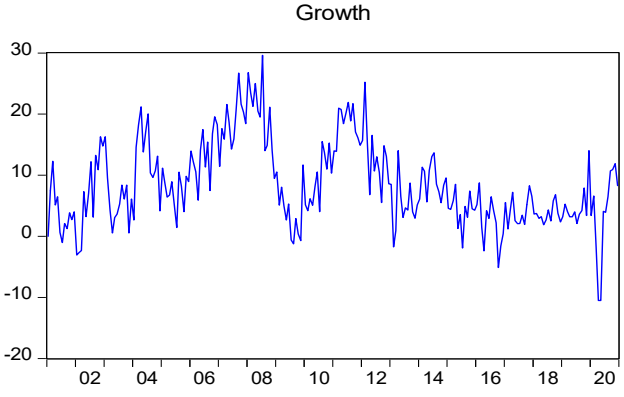


Figure 4 Graph showing petroleum prices and economic growth (see online version for colours)

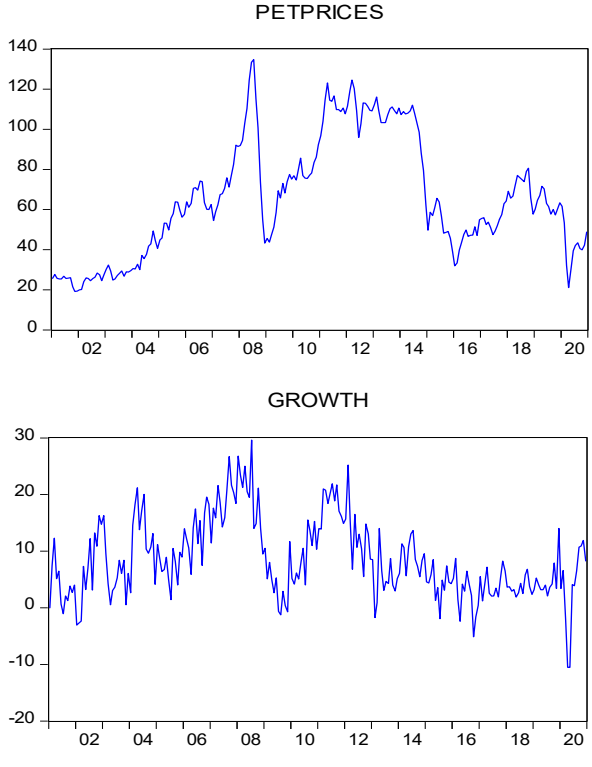


Table 2 Augmented Dickey fuller test for unit roots

At level										
		EXR	*FDI*	*GCF*	*GOVREV*	*GROWTH*	*INF*	*INSQ*	*PETPRICES*	*PETREV*
With constant	t-statistic	–0.5632	–1.7532	2.1804	3.8510	–3.3824	–2.3737	–1.8696	–2.5241	–2.7455
	Prob.	0.8748	*0.4032*	*0.2141*	*1.0000*	*0.0125*	*0.1504*	*0.3463*	*0.1110*	*0.0680*
	n0	n0	n0	n0	n0	n0	n0	n0	n0	*
With constant and trend	t-statistic	–2.6120	–1.8709	–2.3212	2.1418	–4.4101	–2.6105	–1.8420	–2.4453	–3.5179
	Prob.	*0.2754*	*0.6664*	*0.4204*	*1.0000*	*0.0025*	*0.2761*	*0.6810*	*0.3553*	*0.0397*
		n0	n0	n0	n0	***	n0	n0	n0	**
Without constant and trend	t-statistic	–0.7666	–0.0420	–0.1398	3.3749	–1.9723	–1.5419	–1.2080	–0.8557	–1.3849
	Prob.	*0.3833*	*0.6678*	*0.6345*	*0.9998*	*0.0467*	*0.1155*	*0.2078*	*0.3444*	*0.1542*
First difference										
		d(EXR)	*d(FDI)*	*d(GCF)*	*d(GOVREV)*	*d(GROWTH)*	*d(INF)*	*d(INSQ)*	*d(PETPRICES)*	*d(PETREV)*
With constant	t-statistic	–14.2043	–4.4603	–3.9433	–1.2644	–15.7465	–7.3448	–5.5414	–9.8161	–4.0734
	Prob.	*0.0000*	*0.0003*	*0.0021*	*0.6463*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0013*
		***	***	***	n0	***	***	***	***	***
With constant and trend	t-statistic	–14.2493	–4.4625	–3.8938	–4.8860	–15.7125	–7.3200	–5.5232	–9.8211	–4.0566
	Prob.	*0.0000*	*0.0021*	*0.0137*	*0.0004*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0083*
		***	***	**	***	***	***	***	***	***
Without constant and trend	t-statistic	–14.2052	–4.3892	–3.9606	–0.0601	–15.7812	–7.3108	–5.5561	–9.8348	–4.0591
	Prob.	*0.0000*	*0.0000*	*0.0001*	*0.6617*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0001*
		***	***	***	n0	***	***	***	***	***

3.4 Data analysis

PPV was obtained by the ARDL cointegration that test for both short-run and the long run relationship between Government petroleum revenue as the dependent variable.

Our empirical model for estimating the impact of monetary policies in stimulating economic growth shall be of the form:

$$GR_t = \beta_0 + \beta_1 PR_t + \beta_2 PPV_t + \beta_3 GDP_t + \beta_4 INS_t + \beta_5 EXR_t + \beta_6 FDI_t + \beta_7 INF_t + \beta_8 GCF_t + \varepsilon_t \quad (1)$$

where

GR	government revenue
PR	petroleum revenue
PPV	petroleum price volatility
GDP	gross domestic expenditure
EXR	exchange rate
FDI	foreign direct investment
INSQ	institutional quality
INF	inflation
GCF	gross capital formation
β_0	intercept of relationship in the model/constant
$\beta_1 - \beta_5$	coefficients of each independent or explanatory variable
t	time periods
ε	stochastic error term.

The log of both sides of equation (1) is taken in order to represent the function in elasticity form and scale down the size of the coefficients. Thus, we obtain the following:

$$\log GR_t = \beta_0 + \beta_1 \log(PR)_t + \beta_2 \log(PPV_t) + \beta_3 \log(GDP)_t + \beta_4 \log(INS)_t \beta_5 \log(EXR)_t + \beta_6 \log(FDI)_t + \beta_7 \log(INF)_t + \beta_8 \log(GCF)_t + \varepsilon_t \quad (2)$$

3.4.1 Models used for the first step

Let the variables for the test be Y_t, the ADF unit root test are based on the following three regression forms:

1 Without constant and trend:

$$Y_t \Delta = \varnothing Y_{t-1} + \varepsilon_t =$$

2 With constant:

$$Y_t \Delta = \alpha + \varnothing Y_{t-1} + \varepsilon_t =$$

3 With constant and trend:

$$Y_t\Delta = \alpha + \beta_t + \varnothing Y_{t-1} + \varepsilon_t =$$

Testing hypothesis for unit root:

- H0 = 0 (the series have a unit root) non-stationary.
- H1 = 1 (the series have a no unit root) stationary.

The decision rule:

a If t statistics of the ADF value is > 1%, 5% and 10% critical values = we fail to accept the null hypothesis, i.e., unit root does not exist (meaning it is stationary).

b If t statistics of the ADF value is < 1%, 5% and 10% critical values = we fail to reject null hypothesis, i.e., unit root exist (meaning it is non-stationary).

In order for any time series estimation to yield accurate and consistent results, it is imperative for the variables to be stationary. Non-stationary series will render the estimated coefficients inherently invalid and as such unreliable resulting in misleading conclusions and recommendations. There are a number of approaches that can be adopted as a formal test of stationarity such as the augmented Dickey-Fuller (1979, hereafter referred to as ADF), the Phillips and Perron (1988, hereafter referred to as PP), the Kwiatkowski et al. (1992, KPSS), and the Elliot et al. (1996, DF-GLS) unit-root tests. In the present study, the augmented Dickey-Fuller unit root test is performed in order to determine the stationarity of the variable used in the estimation of the regression models in this study. The results of the ADF unit root test following the all-unit root technique program developed by Dr. Imadeddin Al-Mosabbeh is presented in Table 2.

The ADF unit root test in Table 2 shows that only lnGDP and lnPETREV show signs of stationarity at levels. All the other variables are non-stationary at levels. Variables that have unit root are non-stationary. The null hypothesis of unit root is rejected for only lnGDP and lnPETREV but not for all other variables. This shows that only those two variables are stationary at levels.

After first differencing, all the variables are stationary. The bottom part of the table shows unit root test results for the variables after first differencing. The results show that the null hypothesis of unit root is rejected for all variables after the first differencing and hence all the variables are stationary at first differencing.

All the model estimations in this study are done with first differences of the variables in order to avoid the possibility of spurious regressions. The remaining sections present the results of the estimations.

4 Econometric analysis and discussion of results

4.1 Short-run relationships

First, we determine if our variables are correlated since the problem of multicollinearity with affect the estimation and the parameters (coefficients).

Table 3 Pairwise correlation matrix

	FDI	*GCF*	*GOVREV*	*GDP*	*INF*	*INSQ*	*PPV*	*EXR*	*PETREV*
FDI	1.00								
GCF	–0.45	1.00							
GOVREV	0.31	0.38	1.00						
GDP	0.20	0.46	0.38	1.00					
INF	–0.40	0.27	–0.42	–0.25	1.00				
INSQ	0.61	–0.53	–0.03	0.29	–0.18	1.00			
PPV	0.61	–0.39	–0.02	–0.43	–0.52	0.44	1.00		
EXR	–0,24	–0.54	–0.84	0.44	0.12	0.21	–0.02	1.00	
PETREV	0.40	–0.18	0.40	0.04	–.50	0.15	0.61	–0.40	1.00

Table 4 Evaluating the effect of PPV on government revenue in Ghana: short-run relationships

Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob.**
LOG(GOVREV(–1))	1.208767	0.064334	18.78888	0.0000
LOG(GOVREV(–2))	–0.216569	0.064057	–3.380851	0.0009
EXR	–.000657	0.000146	–4.497030	0.0000
FDI	0.014553	0.004972	2.927051	0.0038
FDI(–1)	–0.015869	0.004813	–3.297225	0.0011
GCF	–.000761	0.000334	–2.281168	0.0235
GROWTH	0.000132	0.000161	0.819169	0.4136
INF	–0.000194	0.000571	–0.339838	0.7343
INF(–1)	0.001256	0.000826	1.521720	0.1295
INF(–2)	–0.001067	0.000545	–1.958928	0.0514
INSQ	–0.054245	0.049684	–1.091815	0.2761
INSQ(–1)	0.173352	0.079168	2.189689	0.0296
INSQ(–2)	–.097027	0.048065	–2.018666	0.0447
PETPRICES	–0.000255	0.000140	–1.915433	0.0708
PETPRICES(–1)	0.000295	0.000141	2.090916	0.0377
PETREV	0.021979	0.006999	3.140459	0.0019
PETREV(–1)	–0.020781	0.007267	–2.859540	0.0047
C	0.164994	0.032286	5.110405	0.0000
R-square	0.999928	Mean dependent var		9.175401
Adjusted R-square	0.999922	SD dependent var		1.321988
SE of regression	0.011643	Akaike info criterion		–5.995526
Sum square resid	0.029825	Schwarz criterion		–5.732917
Log likelihood	731.4676	Hannan-Quinn criter		–5.889690
F-statistics	179,704.2	Durbin-Watson stat		2.101280
Prob (F-statistics)	0.000000			

Table 3 shows the correlation matrix showing the pairwise correlations between the study variables. From the table, it is observed that PPV correlates negatively with GOVREV and GDP. This is consistent with the regression outcomes in Tables 4 and 6. PETREV is

also found to correlate positively with GDP. This finding is also consistent with the regression outcome presented in Tables 4 and 6 as it indicates the non-existent of the problem of multicollinearity per the values.

We now determine the short run relationships between our dependent variable and the independent variables by estimating the ARDL. In Table 3, our results show that previous year's government petroleum revenues have positive impact on current years. Regarding our explanatory we observe that foreign direct investments have positive impact on government revenues lending support to the findings of Sackey et al. (2012). Al-Sasi et al. (2017), Mohammed Suliman and Abid (2020), and Oriakhi and Iyoha (2013) found a positive relationship between petroleum prices as well as petroleum revenues on government revenues. Our results are not different form their findings as we observed a positive relationship among these variables. However, these turn to affect government revenue negatively after a subsequent year period. Rahman and Serletis (2010) and Jiménez-Rodríguez and Sánchez (2009) in advanced countries; and Trung and Vinh (2011), Bouzid (2012), and Rafiq et al. (2009) in developing countries find similar results in their studies of the effect of oil price volatility and changes on economic growth. Farhani (2013) finds mixed results in their study and concluded that the effect of petroleum price changes on GDP depends on the measures used as well as the models used in the estimation process. All these results are consistent with our findings. We also found inflation, exchange rates and gross capital formation to have negative relationships with government revenues while institutional quality tends to have a positive relationship with government revenues.

4.2 ARDL cointegration

First, we determine if long-run relationships exist among variables by conducting our cointegration test. Our overall test results as presented in Table 5 show that our variables are cointegrated and hence a prove that long-run relationships exist among variables.

Table 5 ARDL cointegration results

Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob.*
DLOG(GOVREV(–1))	0.216569	0.064057	3.380851	0.0009
D(EXR)	–0.000657	0.000146	–4.497030	0.0000
D(FDI)	0.014553	0.004972	2.927051	0.0038
D(GCF)	–0.000761	0.000334	–2.281168	0.0235
D(GROWTH)	0.000132	0.000161	0.819169	0.4136
D(INF)	–0.000194	0.000571	–0.339838	0.7343
D(INF)	0.001067	0.000545	1.958928	0.0514
D(INSQ)	–0.054245	0.049684	–1.091815	0.2761
D(INSQ(–1))	0.097027	0.048065	0.018666	0.0447
D(PETPRICES)	–0.000255	0.000140	–1.815433	0.0708
D(PETREV)	0.021979	0.006999	3.140459	0.0019
CointEq(–1)	–0.007802	0.002506	–3.112921	0.0021

4.3 Long run relationships

Our results in Table 6 show that long run positive relationships exist between government revenue and foreign direct investment, GDP, institutional quality and petroleum revenues while we observed a negative long-run relationships between government revenues and exchange rates, gross capital formation, inflation and petroleum prices. These findings are not different from what we observed for the short-run periods.

Table 6 Evaluating the effect of PPV on government revenue: long-run relationships

Variable	*Coefficient*	*Std. error*	*t-statistic*	*Probab.*
EXR	–0.084260	0.022923	–3.675727	0.0003
FDI	–0.168729	0.148796	–1.133962	0.2580
GCF	–0.097589	0.065564	–1.488459	0.1381
GROWTH	0.016859	0.022693	0.742895	0.4583
INF	–0.000609	0.030155	–0.020200	0.9839
INSQ	2.829994	1.385253	2.042944	0.0423
PETPRICES	–0.019993	0.007278	–2.747230	0.0065
PETREV	0.153639	0.118186	1.299971	0.1950
C	21.147081	4.100789	5.156833	0.0000

The overall results are consistent with theory and empirical studies. Our test tests of diagnostics show there are no problems regarding heteroskedasticity and variable omissions and multicollinearity (see Appendices).

5 Summary, conclusions and recommendations

The first research question for the study was what is the effect of PPV on government of Ghana's revenue? The conclusion, based on results and discussions is that PPV positively and significantly affect government of Ghana revenues.

The second research question for the study was what is the contribution of petroleum revenue to the growth of the Ghanaian economy? The conclusion, based on result and discussion in chapter four, is that petroleum revenues positively and significant contribute to the economic growth of Ghana.

The third research question for the study was what is the effect of PPV on the growth of the Ghanaian economy? The conclusion, based on result and discussion in chapter four, is that PPV negatively affects the economic growth of Ghana.

Volatility in government revenue may have serious implications. A government that wants to offer long-term infrastructure and social care will have trouble determining the required amount of funding as it is difficult to ascertain the portions of volatile revenue changes that are permanent and the portions that are temporary. This uncertainty in revenue will also render it more challenging for a country to implement long-term policies as it damages the government's reputation in terms of the capacity to predict and handle revenues accurately. Revenue fluctuations also complicates potential government tax and expenditure policy forecasting for the private sector, this may have significant implications for private sector decisions on investment, resulting in causing a reduction in

economic growth (Barnett and Ossowski, 2002; Afonso and Furceri, 2008; Sturm et al., 2009).

Another significant effect of revenue fluctuations is that it causes volatile movements in government budgets in many jurisdictions. As revenues rise during a boom, expenses begin to rise as well, but as revenues decline, expenditures are reduced, although more slowly than they originally increased. In other words, revenue fluctuations will lead to policymakers pursuing stop-go procyclical fiscal policies (Sturm et al., 2009). These procyclical policies amplify the consequences of economic cycles, such that the government, rather than intervening to mitigate uncertainty, becomes a guiding force amplifying output variability. When people choose less uncertain wages and spending, the volatility of economic growth and the volatility of government benefits reduces individual welfare. Furthermore, given the actual costs of shifting capital between evolving and shrinking sectors, it is critical for government policy to contribute to economic stability rather than exacerbate economic instability.

Rises in government spending through revenue booms conflict with increases in private sector spending, which will lift incomes and other production costs, increasing both public and private sector costs. There is some evidence that growth in government revenues are linked to price increases.

Drastic increases in government income in periods of high oil revenue can also lead to governments spending on services and investment projects with low returns. Ultimately, spontaneous expansion of programs and capital expenditure during periods of higher revenues can strain governments' capability to provide services as well as track spending, resulting in wastage, inefficiency, and inefficient utilisation of state resources (Barnett and Ossowski, 2002). Furthermore, during a revenue collapse, it is impossible to slash expenses quickly – to prioritise cutting the projects and facilities that have the least value to taxpayers. Large spending cuts caused by a drop in revenues can also harm the morale and capacity of the public sector, resulting in more inefficient delivery of public services.

Due to it being easier to increase government expenditure as opposed to reducing it, there may be a higher likelihood to widen spending during increases in revenue than to shrink expenditure during revenue busts. As a result, revenue volatility can lead to an increase in the size of government and, potentially, the implementation of an unsustainable fiscal plan that justifies even more severe expenditure reductions in the long run.

Given the dire consequences of petroleum price and revenue volatility and the findings of this study, the study recommends that the Government of Ghana should put prudent revenue management in place in order to reverse the negative effects of petroleum prices. To mitigate the effects of PPV, the study recommends the following measures:

First is diversification of the tax base. Another approach to reducing fluctuations in revenue is to decrease the dependence of income on the unstable energy-related tax bases through diversification of tax base, as a result it is recommended that Government of Ghana implements policies aimed at diversifying its economy, increasing the contribution of other sectors such as agriculture and industrialisation.

Due to Ghana being a net importer of petroleum, the second approach in addressing the effect of PPV on the Ghanaian economy is to make use of the futures market much more often. The effect of the volatility can be mitigated by adopting the use of financial instruments specifically designed for such purposes. For example, it is possible to sell

commodities at a known price in futures markets or to buy 'put options' – contracts that give the buyer the option, but not the obligation, to sell a commodity at a stated price for a fixed period.

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Appendix

Table A1 Heteroskedasticity test: Breusch-Pagan-Godfrey

F-statistic	1.294247	Prob. F(17,220)	0.1976
		Prob. chi-2	
Obs*R-squared	21.63833	Square (17)	0.1990
scaled explained		Prob. chi-2	
SS	433.1103	Square (17)	0.0000

Table A2 Breusch-Godfrey serial correlation LM test

F-statistic	1.891585	Prob. F(2,218)	0.1533
Obs*R-squared	4.059797	Prob. chi-square(2)	0.1313

Figure A1 Cointegration graph (see online version for colours)

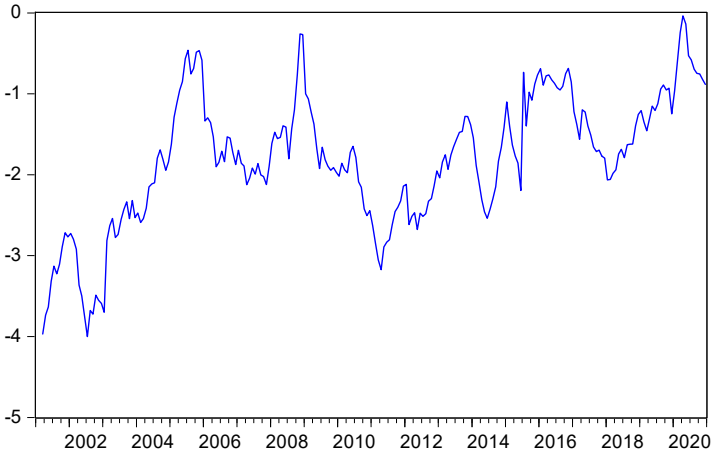

Table A3 Ramsey RESET test

	Value	*Df*	*Probability*
t-statistic	2.637313	219	0.0090
F-test summary			
	Sum of sq.	df	Mean squares
Test SSR	0.000918	1	0.000918
Restricted SSR	0.029825	220	0.000136
Unrestricted SSR	0.028907	219	0.000132

Figure A2 The CUSSUM graphs (see online version for colours)

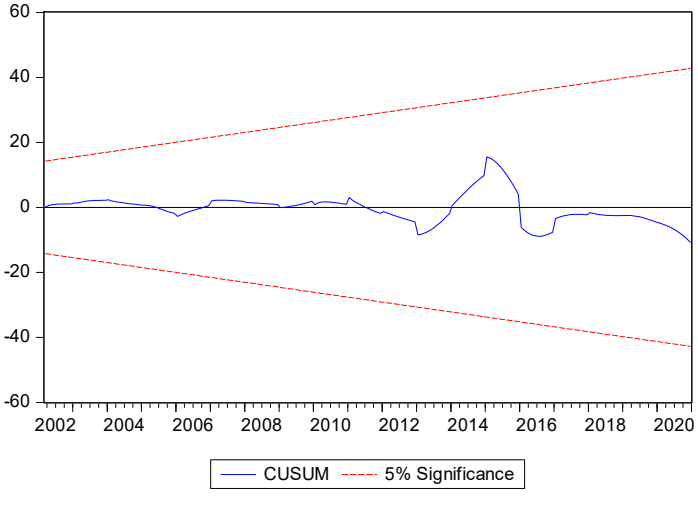

Figure A2 The CUSSUM graphs (continued) (see online version for colours)