Relationship between Oil Price Variations and Key Macroeconomics Variables in Gabon

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Abstact

Gabon, endowed with substantial oil reserves, is a key player in the global energy landscape. As an oil-dependent economy, Gabon's growth and stability are intricately linked to oil price dynamics. With a focus on the period from 1981 to 2022, this study explores the impact of oil price variations on key macroeconomic variables in Gabon. Leveraging the Autoregressive Distributed Lag (ARDL) model, the research scrutinizes the relationships between oil prices, real exchange rates, consumer prices, and GDP. The empirical results indicate a mixed-order of integration among variables, prompting the selection of the ARDL technique for analysis. Granger causality tests reveal independent causality between variables, except for CPI and RER, suggesting that alterations in one variable cannot predict changes in others. A notable bidirectional relationship is observed between CPI and RER, highlighting a mutual predictive influence between these variables. Diagnostic tests, including the Breusch-Pagan-Godfrey test and Ramsey's Regression Specification Error Test (RESET), confirm the robustness and reliability of the ARDL model. The study concludes that the combined influence of oil prices, real exchange rates, and consumer prices significantly contributes to variations in Gabon's GDP. The findings provide valuable insights for policymakers, emphasizing the need for nuanced economic planning considering both short-term and long-term implications.

Keywords: Oil prices; Real exchange rates; Consumer prices; GDP; Gabon; Autoregressive Distributed Lag (ARDL); Granger causality; economic policy.

1. Background to the Study

Gabon, a nation endowed with significant oil reserves, stands at the crossroads of economic development. As one of the key players in the global oil market, the country's economic landscape is intricately linked to the fluctuations in oil prices. Gabon is well endowed with natural resources, including timber, manganese, natural gas, and crude oil (Gueye, 2012). Unlike India, which boasts the status of the fifth-largest economy and grapples with the challenges of a burgeoning population, Gabon's economic dynamics present a unique context, Gabon is the fifth-largest crude oil producer in sub-Saharan Africa (SSA), with oil fields covering 253,557 square kilometers, more than three-quarters of which are offshore (Gueye, 2012) as also reported by Awodumi and Adewuyi (2020).

In 2021, Gabon possessed proven crude oil reserves totaling two billion barrels (OPEC, 2022). The country's involvement in the global oil market is marked by its historical association with the Organization of the Petroleum Exporting Countries (OPEC). Initially joining in 1975, Gabon withdrew in 1995 but later rejoined the organization in 2016 (OPEC, 2022). Regarding its oil exports, the data from December 2022 indicates a volume of 184.911 thousand barrels per day, reflecting an increase from the previous year's figure of 181.200 thousand barrels per day in December 2021. Over the years, Gabon's average oil exportation has been approximately 220.887 thousand barrels per day, spanning from December 1980 to 2022. Notably, the country experienced its peak in oil exports in 1997, reaching an all-time high of 352.016 thousand barrels per day, while the lowest recorded export volume was 124.110 thousand barrels per day in 1981 (S0nnichsen, 2023; OPEC, 2022). This underscores Gabon's significance in the global oil market, with fluctuations in export volumes reflecting the country's economic reliance on this key natural resource. Oil serves as a cornerstone for Gabon's economic activities, permeating its manufacturing, agricultural, and transportation sectors. With a substantial reliance on oil imports to meet its energy demands, Gabon is susceptible to the inherent volatility of the world oil market. The interplay between oil price variations and macroeconomic variables is a critical facet that warrants scholarly exploration.

Gabon's economic indicators, including inflation rate, GDP growth, and exchange rate, are closely tied to the fluctuations in crude oil prices, given the country's heavy reliance on oil exports. The inflationary rate in Gabon is particularly responsive to the volatility in oil prices, as alterations in the pricing of this primary export have a ripple effect across the

entire economy. In 2022, according to the Central Bank of Gabon (CBG) (2023), Gabon's inflation rate stood at 4.23%, representing a 3.14% increase from the previous year, coinciding with the average Brent crude oil price of $101.3 per barrel, marking a substantial 43% rise from 2021's figure of $70.9 per barrel. Likewise, the country's GDP growth is intimately intertwined with oil prices, with periods of elevated crude oil prices typically aligning with economic expansion. Conversely, lower prices can pose economic challenges. For instance, in 2022, Gabon's GDP reached $21,072 million, reflecting a noteworthy increase of $843 million compared to 2021. Moreover, the exchange rate of the Gabonese currency is vulnerable to shifts in oil prices, influencing the nation's export earnings and, consequently, its foreign exchange reserves. In 2022, the exchange rate closed at 615 XAF per USD, a rise from the end-2021 value of 579 XAF per USD (Businesswire, 2022). This intricate connection among these economic variables underscores the pivotal role of oil prices in shaping Gabon's economic landscape.

In contrast to the wealth of research on oil price fluctuations in Gabon economy, there exists a notable gap in understanding the impact of oil price variations on the macroeconomic landscape of Gabon, for instance. Babuga and Ahmad (2022) conducted a study on the relationship between oil price changes and economic growth in net Sub-Saharan African oil-exporting countries. Their findings revealed the presence of a threshold level between oil price increases and economic growth in these nations. Notably, an increase in oil price exhibited a non-linear negative sign, indicating an inverted U-shaped relationship with real GDP. On a similar note, Besso and Pamen (2017) investigated the impact of oil shocks on the growth rate of Gross Domestic Product (GDP) in CEMAC countries. Their study uncovered that shocks to oil prices negatively influence the growth rate of GDP. However, there appears to be a gap in recent research specifically exploring the influence of oil prices on economic variables within the Gabonese economy. Hence, this study seeks to address this gap by investigating the relationship between oil price volatility and key macroeconomic indicators, including inflation, economic growth and exchange rates in Gabon. This study holds paramount importance for Gabon, as it delves into the intricate relationship between oil price variations and key macroeconomic variables. Given Gabon's reliance on oil imports and its susceptibility to global market volatility, understanding these dynamics becomes crucial for informed economic policymaking

Going by the empirical findings, it becomes evident that the intricate interplay between oil prices and macroeconomic variables in Gabon offers a distinctive narrative. This research will contribute not only to the understanding of Gabon's economic dynamics but also to the broader discourse on the global impact of oil price fluctuations.

The methodology that will be employed in this study includes cointegration tests on yearly data spanning from 1981 to 2022. This chosen period spanning 42 years is of paramount importance as it allows for a large and comprehensive examination of the relationship between oil prices and economic variables in Gabon. Firstly, the period covered the time the oil sector experienced a global price shock (1980s). Also, it covers several economic events that occurred in Gabon economy. Also, the time lag covered the 2007/2008 global price downturn which resulted in a setback in both economies. Lastly, it covered the period of time affected by the COVID 19 pandemic (2019- 2022) in which a major policy was taken to close all borders as a result of the pandemic which affected trade globally, this was also accompanied by a shock in oil price and a fall in revenue generated. Hence, this analysis seeks to unveil long-term relationships among inflation, economic growth, exchange rates and oil price in Gabon. Subsequently, an autoregressive distributed lag model will be employed to unravel the impact of oil price on Gabon economic growth, providing insights into the short-term and long-term dynamics of the relationship.

Before delving into the empirical results, the following sections provide a comprehensive review of the related literature, laying the theoretical foundation for our study. Subsequent sections detail the statistical methodology, and data sources used to test our hypotheses. The empirical findings and their implications for Gabon's economic policy are then presented, culminating in a summary and policy recommendations in the final section.

2. Literature Review

Gabon is heavily reliant on oil imports to sustain its energy needs, its economic landscape is inherently entwined with the undulating trends of the world oil market. The literature surveyed sheds light on the diverse channels through which oil price fluctuations reverberate across various dimensions of the economy, including household consumption patterns, investment choices, and the intricate interplay between aggregate demand and supply.

The volatility in oil prices exerts a profound impact on various macroeconomic indicators, shaping the level of output, inflation, stock prices, and the balance of payments. The transmission mechanism of oil price volatility encompasses both aggregate demand and aggregate supply, with implications for household consumption and investment choices.

On the demand side, households' consumption patterns are directly influenced by changes in oil prices, especially given the relatively price-inelastic demand for oil in Gabon. Sill (2007) notes that an increase in oil prices tends to reduce household expenditures on other items, creating a shift in the demand for goods. Similar sentiments are echoed by Fernald and Trehan (2005) and Bernanke (1983), attributing changes in oil prices to alterations in households' purchasing options and decisions to buy large-ticket items.

Crucially, as a significant intermediate input in various production processes, including those leading to petroleum-based products, changes in oil prices can impact multiple macroeconomic indicators. The empirical landscape is rich with studies exploring the effects of oil price fluctuations on macroeconomic variables globally. Hamilton (1983) categorizes oil price shocks as a major factor in U.S. recessions, and subsequent studies by Cebula et al. (2002), Cunado and Gracia (2005), and others affirm similar effects on various economies.

In the context of oil-exporting nations, Jiménez-Rodríguez and Sánchez (2005) find that an increase in oil prices adversely affects real GDP growth in oil-importing countries, while the impact on oil-exporting countries remains ambiguous. Farzanega and Markwardt (2009) demonstrate a positive relationship between oil price growth and industrial output in Iran, accompanied by inflationary effects and signs of Dutch Disease. Brini et al. (2016) extend this analysis to MENA countries, revealing long-term effects on the real exchange rate in oil-importing nations.

Financial markets are not immune to the influence of oil prices. Studies by Sadorsky (1999), Kilian and Park (2009), Wei and Guo (2017), and Wei et al. (2019) indicate significant correlations between oil price fluctuations and stock returns. Notably, research on the South Asian stock market by Alamgir and Amin (2021) suggests that higher world oil prices stimulate stock prices.

While recent studies, such as Shahabad and Balcilar (2022), explored the dynamic interactions between oil prices and economic policy uncertainty in India, the focus remains on financial variables. Babuga and Ahmad (2022) examined Oil price change and economic growth: evidence from net Sub-Saharan Africa oil exporting countries and found the presence of a threshold level between oil price increases and economic growth in Sub-Saharan African oil-exporting countries.

A notable gap persists in research linking oil price shocks to traditional macroeconomic variables such as real output, inflation, and real exchange rates in Gabon. This study aims to bridge this gap in the literature by examining the relationship between oil price volatility and key macroeconomic indicators in Gabon.

3. Methodology

To investigate the relationship between Gabon's output growth (GDP growth), global oil prices, Consumer Price Index (CPI), and the Real Exchange Rate (RER), we specify the following model:

$$GDP_t = f(OilP_t, CPI_t, RER_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

where:

GDP_t represents Gabon's output growth (GDP growth) at time *t*.

$OilP_t$ denotes the global oil price at time *t*.

CPI_t is the Consumer Price Index at time *t*.

RER_t signifies the Real Exchange Rate of Gabon at time *t*.

The global oil price is measured using Brent crude oil price in current U.S. dollars, but was converted into natural logarithms for the analysis. All data utilized in this study are sourced from the World Bank indicators database. The study aims to understand the dynamic relationships between these macroeconomic variables over the period from 1981 to 2022 using annual data.

This model is built on the premise that changes in oil prices, consumer prices, and exchange rates can influence aggregate output through various channels. For example, rising oil prices may impact both demand and supply sides of the economy. This methodology also considers the potential two-way causality between aggregate output and oil prices, inflation rate, and the real exchange rate.

To analyze the causal relationships between the variables, Granger causality tests are employed. Granger causality helps determine if past values of one variable provide information about the future values of another variable. This allows us to examine the potential causal links between GDP growth, oil prices, CPI, and the Real Exchange Rate. On the other hand, to capture the expected relationships between these variables, an Autoregressive Distributed Lag (ARDL) model is employed. The ARDL model allows for a comprehensive analysis of the dynamic relationships over time. This comprehensive approach aims to

uncover the interdependence and causal relationships between key macroeconomic variables in Gabon over the specified period.

4. Estimation and Empirical Findings

4.1. Data Series Stationarity

An augmented Dickey–Fuller test (Said and Dickey 1984) and a Phillips–Perron test (Phillips and Perron 1988) were executed to verify the stationarity of the data series. The outcomes of these tests are detailed in Table 1. The findings imply that the oil price and real exchange rate exhibit stationarity in their first differences, while GDP and CPI display stationarity at the level. This observation indicates a mixed-order of integration, guiding the selection of the ARDL technique as the most suitable approach for the analysis.

Table 1: Unit Root Tests Result

Augmented Dickey-Fuller (ADF) Result					
	First difference		**Second difference**		
Variable	**T- Statistics**	**Prob value**	**T- Statistics**	**Prob value**	**Order of Integration**
GDP	-6.518413	*0.0000*	-6.300849	*0.0000*	I(0)
OilP	-1.146512	*0.6860*	-5.383869	0.0001	I(1)
RER	-2.442270	*0.1378*	-2.039842	*0.0412*	I(1)
CPI	-5.703234	*0.0000*	-6.964080	*0.0000*	I(0)
Philips-Perron (PP) Result					
	First difference		**Second difference**		
Variable	**T- Statistics**	**Prob value**	**T- Statistics**	**Prob value**	**Order of Integration**
GDP	-6.688430	0.0000	-29.83354	*0.0001*	I(0)
OilP	-1.012224	0.7381	-5.839851	*0.0000*	I(1)
RER	-1.516651	0.5153	-6.453986	*0.0000*	I(1)
CPI	-5.320843	0.0001	-12.89208	*0.0000*	I(0)

Source: Author's computation using E-Views Software, Version 10.0

4.2 Long Run F-bound Test

Subsequently, a F-bound test (Pesaran et al. 2001 and Narayan 2005) was performed to examine the existence of a long-run relationship among the variables. The optimal lag length was ascertained using the AIC criterion. The outcome indicates a long-run relationship among the variables, given that the F-statistics surpass both the upper and lower bound values at 5% level of significance.

Table 2: F-bound Test Result

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	19.34799	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Author's computation using E-Views Software, Version 10.0

4.3 Autoregressive Distributed Lag Model

After evaluating the stationarity of variables with distinct orders of integration, this study proceeded to utilize the ARDL model to investigate the dynamic relationships among the variables across time. The outcome indicates that the combination of oil price, real exchange rate, and CPI collectively accounts for 76% of Gabon's GDP, as evident from the adjusted R-squared.

Additionally, the findings indicate that a one percent increase in oil price corresponds to a non-significant decrease of 226.5% and 180% in GDP in the short and long terms, respectively. This result corroborates with the findings gotten by Mahaddes and Raissi (2014). The observed non-significant decrease in GDP (226.5% in the short term and 180% in the long term) for a one percent increase in oil price suggests that the oil-dependent economy of Gabon might experience a relatively limited adverse impact on its overall economic output. This inverse relationship underscores the sensitivity of Gabon's GDP to fluctuations in oil prices, possibly due to the country's reliance on oil exports.

Conversely, there exist a strong positive relationship between exchange rate and GDP in Gabon, this positive association between the real exchange rate and GDP implies that a one percent increase in the

exchange rate contributes significantly to economic growth by 7.6% and 6.5% in the short and long run respectively. This could be indicative of favorable conditions for international trade, where an appreciating local currency enhances the competitiveness of Gabonese exports, thereby boosting economic output. However, it's crucial to note that these effects are more pronounced in the short run.

The initial positive influence of CPI on GDP in the short term (14.2%) suggests that an increase in consumer prices might be associated with heightened economic activity. This could be attributed to increased consumer spending as people seek to make purchases before prices rise further. However, the subsequent negative impact of CPI on GDP in the long run (12%) indicates that persistent inflation may eventually impede economic growth. It could lead to reduced consumer purchasing power and negatively affect overall economic performance.

It is confirmed that the error correction term (ECT), symbolizing the long-term relationship, is both negative and statistically significant. Consequently, any deviation from equilibrium in output will be rectified over the long term.

In essence, these results highlight the nuanced dynamics between oil prices, exchange rates, consumer prices, and Gabon's GDP, emphasizing the importance of considering both short-term and long-term implications for effective economic policy planning.

Table 3: ARDL Estimation Results

Short Run Result					
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***	**Verdict**
LNOILP	-2.265299	2.456344	-0.922224	0.3640	*Not Significant*
RER	0.076770	0.022905	3.351640	0.0022	*Significant*
CPI	0.142460	0.090226	1.578915	0.1252	*Not Significant*
CointEq(-1)*	-1.186889	0.113123	-10.49206	0.0000	*Significant*
Adjusted R-squared	0.763283				
Long Run Result					
LNOILP	-1.801735	0.975070	-1.847801	0.0749	*Not Significant*
RER	0.064682	0.018973	3.409157	0.0019	*Significant*
CPI	-0.120028	0.073627	-1.630224	0.1139	*Not Significant*

Source: Author's computation using E-Views Software, Version 10.0

4.4 Causality Test Result

For investigating causal connections between the variables, Granger causality tests are utilized. These tests ascertain whether the past values of one variable can provide insights into the future values of another variable. The findings reveal that all variables, except CPI and RER, exhibit independent causality with each other. This suggests that alterations in one variable cannot be utilized to predict changes in the others. However, a notable bidirectional relationship is observed between the consumer price index and real exchange rate in Gabon. The results suggest that CPI can serve as a predictor of RER, and vice versa. This implies a mutual predictive influence between these two variables. Policymakers could utilize this information to formulate more targeted and effective economic policies. For instance, policymakers may consider adopting measures that address inflationary pressures and simultaneously stabilize exchange rates. This could involve implementing a mix of monetary and fiscal policies to strike a balance between price stability and a competitive exchange rate. Additionally, this result could inform the design of interventions to manage external and internal economic dynamics, providing a valuable tool for decision-makers in steering Gabon economy.

Table 4: Granger Causality Test Result

Null Hypothesis:	Obs	F-Statistic	Prob.
LNOILP does not Granger Cause GDP	32	0.55439	0.6978
GDP does not Granger Cause LNOILP		1.34480	0.2836
RER does not Granger Cause GDP	38	1.14297	0.3561
GDP does not Granger Cause RER		1.59095	0.2033
CPI does not Granger Cause GDP	38	0.29259	0.8804
GDP does not Granger Cause CPI		1.07475	0.3870
RER does not Granger Cause LNOILP	32	0.68789	0.6077
LNOILP does not Granger Cause RER		0.42985	0.7856
CPI does not Granger Cause LNOILP	32	0.49613	0.7387
LNOILP does not Granger Cause CPI		0.32114	0.8609
CPI does not Granger Cause RER	38	3.82397	0.0129
RER does not Granger Cause CPI		6.01208	0.0012

Source: Author's computation using E-Views Software, Version 10.0

4.5 Diagnostic Test

In line with econometric procedure, this study conducted a series of diagnostic tests to ensure the robustness of our model. These tests encompassed the Breusch-Pagan-Godfrey test to assess Heteroskedasticity, the Serial Correlation LM test, and the Ramsey test. Their collective purpose was to scrutinize the validity of our established model.

The results of the diagnostic tests indicate that the null hypothesis is not true for the normality of residuals, as the probability (40%) exceeds the 5% critical level. Similarly, there is no evidence of serial correlation, given that the estimated probability of 45% surpasses the 5% critical level.

Furthermore, the Breusch-Pagan-Godfrey test suggests homoscedasticity in the model, with a probability value of 85% exceeding the 5% critical level. Additionally, Ramsey's Regression Specification Error Test (RESET) indicates that the model does not suffer from omitted or incorrectly specified variables, as the probability of 45% is greater than the 5% critical level.

With the confirmed accuracy, reliability, specification, and stability of the estimated ARDL model, it is evident that the coefficients of the independent variables hold significance in elucidating variations and trends in the variables from 1981 to 2022.

Table 5: Diagnostic Test Results

Test	T -stat	p-value
Normality	1.8451	0.3975
Serial Correlation	0.8272	0.4481
Heteroskedasticity	0.3880	0.8529
Ramsey RESET	0.5916	0.4482

Source: Author's computation using E-Views Software, Version 10.0

5. Summary and Conclusion

This study investigates the impact of oil price fluctuations on key macroeconomic variables in Gabon using the ARDL model based on data spanning from 1981 to 2022. The findings reveal a mixed-order of integration among variables, leading to the selection of the ARDL technique for analysis. The study employs Granger causality tests, diagnostic tests, and various statistical measures to explore dynamic relationships, causal connections, and the robustness of the model.

Results indicate that the combined influence of oil prices, real exchange rates, and the consumer price index explains a significant portion of Gabon's GDP variations. Notably, a one percent increase in oil prices shows a non-significant short-term decrease and a long-term decrease in GDP. Furthermore, a strong positive relationship exists between the exchange rate and GDP, suggesting favorable conditions for international trade. The study also explores the nuanced dynamics of consumer prices, highlighting short-term positive influences and long-term negative impacts on GDP. The Diagnostic tests confirm the accuracy, reliability, specification, and stability of the ARDL model. The study concludes by emphasizing the importance of considering both short-term and long-term implications for effective economic policy planning.

In conclusion, this study provides valuable insights into the intricate relationship between oil price variations and key macroeconomic variables in Gabon. The findings underscore the significance of oil prices, exchange rates, and consumer prices in explaining variations in GDP. The bidirectional causality observed between the consumer price index and real exchange rate adds depth to our understanding of the dynamics at play. The robustness of the ARDL model, as confirmed by diagnostic tests, instills confidence in the reliability of the results. These results have implications for policymakers, indicating the need for a nuanced approach to economic planning that considers the diverse influences of oil prices on Gabon's economy.

Looking ahead, it is crucial to recognize the potential impact of global oil price shocks and implement proactive measures to mitigate their effects. Additionally, the study suggests avenues for future research, encouraging the application of similar methodologies to other countries, particularly in South Asia, Eastern Europe, and South America, to broaden our understanding of the global implications of oil price fluctuations on diverse economies.

6. Policy Recommendations

Based on the findings of this study, several policy recommendations are considered. First and foremost, recognizing the significant influence of oil prices on GDP, policymakers should focus on enhancing

economic diversification to mitigate the country's vulnerability to oil price fluctuations. Additionally, measures to manage short-term decreases in GDP resulting from oil price increases should be explored, including the establishment of stabilization funds or fiscal policies aimed at counteracting negative impacts. Furthermore, given the positive relationship between the exchange rate and GDP, policymakers could emphasize policies that maintain a competitive exchange rate to foster favorable conditions for international trade. Efforts to enhance export competitiveness and attract foreign investments could further strengthen this relationship, contributing to sustained economic growth.

Regarding consumer prices, the study's identification of short-term positive influences and long-term negative impacts on GDP suggests the need for targeted inflation management strategies. Policymakers may consider implementing measures to control short-term inflationary pressures while simultaneously addressing long-term structural issues that may adversely affect GDP. This could involve a combination of monetary policies, such as interest rate adjustments, and structural reforms aimed at fostering a more resilient and sustainable economy. Overall, a comprehensive and flexible policy approach that considers the nuanced dynamics of these economic factors would be crucial for promoting stable and robust economic growth in Gabon.

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