# The moderating role of corruption in the oil price-economic growth relationship in an oil-dependent economy: Evidence from Bootstrap ARDL with a Fourier Function[*]

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**Abstract**

This study employs the recently proposed bootstrap autoregressive distributed lag (ARDL) model augmented with a Fourier function and the dynamic ARDL simulation procedures to examine whether the oil price-economic growth relationship is dependent on the level of corruption in an oil-dependent economy. Using Nigerian quarterly data during the 1996Q1-2021Q4 period, the results of the bounds-testing present evidence for cointegration between the variables. In addition, the results indicate that oil price and corruption are growth-enhancing, but the effect of oil price on growth is contingent on the level of corruption. Moreover, evidence suggests that the marginal effect of oil price on economic growth varies with the level of corruption; the lower the level of corruption, the higher the growth-enhancing effect of oil price on economic growth, and vice versa. The dynamic ARDL simulations plots demonstrate the significant increase (decrease) in predicted growth in the short-term due to a counterfactual rise in the price of oil price (corruption), which gradually deflates (increase) after the shock in the long-term. Therefore, policies geared toward diversifying the economy away from oil, reducing corruption in the oil and gas industry and the security sector, improving agricultural output, and reducing unemployment rate are recommended to enhance growth.

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[*] The R code used for the computational analysis and the data can be assessed via GitHub

**Keywords:** Economic growth, oil price, corruption, bootstrap ARDL, fractional flexible Fourier forms ARDL, dynamic ARDL simulation

**JEL Classification:** C15 , C22 , O4 , O43 , O13

# 1 Introduction

A large body of research indicates that changes in the price of oil have a significant effect on economic activity. More importantly, the impact of oil price changes differs for oil-exporting and oil-importing countries, with oil price increases considered good news in the former and bad news in oil-importing economies and vice versa (Moshiri, 2015). In oil-dependent economies, for instance, an increase in oil price is generally considered favourable because it brings in foreign exchange and investment opportunities beneficial to economic growth. In contrast, these countries consider negative oil price changes unfavourable. After all, they restrain public revenue and halt investment projects, leading to a deceleration in economic growth (Kriskkumar & Naseem, 2019; Moshiri, 2015).

However, evidence suggests that oil prices changes might cause a non-standard effect on growth, with positive oil price changes also encouraging growth-retarding economic conditions such as exchange rate appreciation, stagflation due to high inflation, rising unemployment, rent-seeking, and poor policy-making, amongst others (Moshiri, 2015; Moshiri & Banihashem, 2012). Interestingly, despite years of favourable oil prices, which brought in a vast financial resource that is critical for growth, most oil-dependent nations in the Middle East, Africa and Latin America have continued to record poor growth performance in comparison with the fast growth rates experienced in resource-poor East Asian countries (Moshiri, 2015; Moshiri & Banihashem, 2012; Sachs & Warner, 2001; Sala-i-Martin & Subramanian, 2003).

In the economics literature, the traditional approach used to explain the adverse effect of oil price changes on growth in oil-dependent economies is the Dutch disease theory (Corden & Neary, 1982). The view demonstrates the shift in human and financial resources from tradable sectors (specifically, manufacturing) following the discovery of natural resources (oil) to the non-tradable sector (oil sector). Thus, during the oil boom, an increase in oil prices and revenue lead to the appreciation of the local currency, a reduction in net-export and the shrinking of the non-resource tradable sector (manufacturing), and consequently the deceleration of economic growth (Kriskkumar & Naseem, 2019; Moshiri, 2015).

Recently, the quality of institutions (such as good governance, property rights, the rule of law, regulatory quality, et cetera) has been offered as an important explanation for the adverse effect of oil price changes on growth in oil-dependent economies (Moshiri, 2015). According to this approach, the dependence on natural resources, such as oil, themselves don't fully affect growth; instead, their interaction with poor institutional quality affects growth adversely (Boschini et al., 2007; Brunnschweiler, 2008; Mehlum et al., 2006). So, for oil-dependent countries with weak institutions, positive oil price changes might hamper growth but stimulate growth in countries with strong institutions. Perhaps, this is a plausible explanation why oil-rich Norway has done well while oil-endowed Nigeria has continued to record poor growth performance (Karabegović, 2009; Larsen, 2006; Olayungbo & Adediran, 2017).

Besides institutional quality explaining the effect of oil price changes on growth in oil-dependent economies, the level of corruption may also be fundamental in moderating the impact of oil price changes on growth in oil-dependent economies. It is well documented in the economic literature that corruption and a culture of rent-seeking are essential characteristics of oil-dependent economies (Sala-i-Martin & Subramanian, 2003; van der Ploeg & Arezki, 2008). Beyond this, empirical evidence suggests that oil price and corruption exhibit a strong direct association (Arezki & Brückner, 2009; Vogel, 2020).

Therefore, in an oil-dependent economy with a high level of corruption, positive oil price changes will lead to sluggish growth performance due in part to the interesting dynamic incentives that such windfalls generate for corrupt politicians to embezzle oil money, inflate the cost of social goods and services, and shift resource from growth-enhancing investments in favour of large capital-intensive projects, which may be non-productive but offer a vast opportunity for bribes and kickbacks (Dietz & Eric, 2005; Gupta et al., 2000; Mauro, 1998; Tanzi & Davoodi, 1997; Vogel, 2020). On the contrary, since such oil windfalls will be channelled to productive activities transparently in oil-dependent economies with a low level of corruption, the reverse is expected to play out (Moshiri, 2015).

Notwithstanding the coexistence of slow growth performance and widespread corruption in most oil-dependent economies amid unstable oil prices, researchers have done little to evaluate the role of corruption in moderating the effect of oil prices on economic growth. Therefore, the main objective of the present study is to examine whether the effect of oil prices on growth is contingent on the level of corruption. The research is relevant and contributes to the extant literature in several ways. First, the study is a pioneering effort to explore the role of corruption in the oil price-economic growth nexus in an oil-dependent economy using Nigeria's quarterly data from 1996Q1 to 2021Q4. The coexistence of consistent poor growth performance of the Nigerian economy amid a high level of corruption and unstable oil prices makes Nigeria a perfect case to study whether the impact of oil prices on growth is contingent on the level of corruption. Second, the study employs the recently developed bootstrap autoregressive distributed lag (ARDL) model with a Fourier function to draw a correct conclusion. As indicated by McNown et al. (2018), the bootstrap test is more robust compared to the traditional ARDL approach of Pesaran et al. (2001) due in part to its ability to address the issues of weak size and power properties and inconclusive inferences, which characterised the conventional approach (Abu et al., 2022; Goh et al., 2017; McNown et al., 2018). Since evidence suggests that structural breaks characterise most time series, failure to capture them in the analysis may lead to inaccurate conclusions (Adedoyin et al., 2020). Thus, the inclusion of a single fractional frequency flexible Fourier form in the bootstrap ARDL model ensures the incorporation of an unknown number of permanent gradual and sharp breaks in the presence of smooth transition autoregressive breaks (Gallant, 1981, Gallant & Souza, 1991; Solarin, 2019; Yilanci et al., 2020). The significant advantage of using Fourier terms, rather than dummy variables, to capture structural breaks is the elimination of the need for a researcher "to assume the exact frequency of breaks, the dates of the breaks and the exact form of the breaks" (Solarin, 2019). Also interesting is the fact that the Fourier approximation help eliminates the issue of over-parameterisation, leading to a test with more power and size properties (Enders & Lee 2012).

Third, the study also adopts the novel dynamic ARDL simulations procedure proposed by Jordan and Philips (2018) to simulate the response of economic growth to changes (shocks) in oil prices and the level of corruption over 50 years (2021-2070). The dynamic ARDL simulation procedure generally simulates the possible effect of a counterfactual shock in one explanatory variable on the dependent variables at a single point in time using stochastic simulation techniques while holding all other regressors constant (Abu et al., 2022; Jordan & Philips, 2018). Lastly, by examining the role of corruption in the relationship between oil price and economic growth using robust estimation techniques, findings from the present study are expected to rekindle the debate on the role of oil price and corruption on economic growth, and expand the frontiers of knowledge among policy makers, both in Nigeria and other oil-dependent economies.

The rest of this paper is structured as follows. Section two presents the review of the empirical literature. Section three contains a theoretical framework, model formulation and econometric techniques. The estimation results are presented in the fourth section, while section five is for discussion of the results. Finally, the conclusion and policy implications of the study are provided in section six.

## 2 Review of Empirical Literature

Much research has been conducted on the linkage between oil price and economic growth in developed and developing oil-dependent/oil-exporting economies. Generally, the empirical literature associated with the nexus presents mixed findings, with some studies demonstrating a positive and negative link while others established an insignificant relationship. Some existing studies focused on either a group of countries or regions. For example, using a sample of 10 oil-exporting Sub-Saharan African (SSA) countries during the 1986-2012 period, Akinlo and Apanisile (2015) established a positive relationship between oil prices and economic growth. Nusair (2016) also reported a similar outcome in the Gulf Cooperation Council (GCC) countries (including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, the UAE). In the same vein, Matallah and Matallah (2016) established a positive relationship between oil rent and economic growth in 11 Middle East and North African (MENA) oil-dependent countries (Algeria, Bahrain, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, the UAE, and Yemen) between 1996 and 2014.

Further, Mehrara (2008) indicated that oil price is growth-enhancing in 13 oil-exporting countries (Algeria, Colombia, Ecuador, Indonesia, Iran, Kuwait, Libya, Mexico, Nigeria, Qatar, Saudi Arabia, the UAE and Venezuela) during the period from 1965 to 2004. In contrast, Moshiri and Banijashem (2012) illustrate that oil price is not significant in influencing economic growth in six (6) Organisation of Petroleum

Exporting Countries (OPEC) member states (Algeria, Iran, Kuwait, Nigeria, Saudi Arabia, and Venezuela) in the 1970-2009 period.

Moreover, at the country-specific level, some studies have also assessed the impact of oil price on economic growth in oil-dependent/oil-exporting countries such as Algeria, Iran, Iraq, Kuwait, Libya, Nigeria, Norway, Oman, Qatar, Saudi Arabia, Syria, and the UAE (Abubakar & Akadiri, 2022; Aimer, 2016; Algahtani, 2016; Aliyu, 2009; Alley et al., 2014; Alkhathlan, 2013; Bala & Alhassan, 2018; Berument et al., 2010; Emami & Adibpour, 2012; Farzanegan and Markwardt, 2009; Jiménez-Rodríguez & Sánchez, 2004; Mahmood & Murshed, 2021; Okoro, 2014; Rotimi et al., 2022; Yusuf, 2015). These studies confirmed the presence of a significant positive relationship between oil prices and economic growth in the respective countries. In contrast, some authors reported a negative association in oil-exporting countries such as Nigeria and the UK (Jiménez-Rodríguez & Sánchez, 2004; Yakubu & Akanegbu, 2019), while others established a positive nexus in the short-term and an inverse relationship in the long-run (Olayungbo & Adediran, 2017). However, other studies demonstrate an insignificant relationship between oil price and growth in countries such as Bahrain, Brunei, Malaysia, Tunisia and Vietnam (Berument et al., 2010; Kriskkumar & Naseem, 2019; Matthew & Adegboye, 2014).

A survey of the literature suggests that, while studies on the oil price-economic growth relationship abound, researchers did not deem it essential to explore whether the effect of oil price on economic growth is contingent on the level of corruption. Most existing studies only focused on the direct impact of oil prices on economic growth while ignoring the potential role of corruption in the nexus. Perhaps, an exception is a study by Moshiri (2015), which examined the role of institutional quality (voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law, and control of corruption) in the relationship between oil price shocks and output growth in 11 major oil-exporting countries (Algeria, Iran, Kuwait, Nigeria, Saudi Arabia, Venezuela, Canada, Norway, and United Kingdom) during the 1970-2010 period. The empirical outcome demonstrates that the effect of oil price shocks on growth is moderated by institutional quality, with oil price shocks impeding growth in oil-exporting countries with low institutional quality. However, the present study extends the literature by explicitly investigating the role of corruption in the oil price-economic growth relationship in oil-dependent economies, with particular reference to Nigeria.

# 3 Theoretical Framework, Model, Estimation Technique and Data Issues

## 3.1 *Theoretical Framework and Model Specification*

This study relies on the Sachs-Warner's resource curse hypothesis (RCH) to forge a link between oil price, economic growth, and corruption. The RCH asserts that abundance and dependence on a natural resource (such as oil) hurts long-term economic growth (Sachs & Warner, 1995, 1997, 2001). Various explanations for why natural resources hurt long-term growth have been offered in the literature associated with the RCH. However, arguments relating to the Dutch disease syndrome, variations in natural resource price, and weak institutions (corruption) continue to dominate the literature (Boschini et al., 2007; Bravo-Ortega & de Gregorio, 2007; Brunnschweiler, 2008; Di John, 2011; Gylafson, 2001; Humphreys et al., 2007; Leite & Weidmann, 1999; Mehlum et al., 2006; Sachs & Warner, 1995, 1997, 2001; Sala-i-Martin & Subramanian, 2003). However, since the Dutch disease syndrome – the overvaluation of the exchange rate and thus de-industrialisation of the non-resource/tradeable sector – is triggered by the fluctuations in the price of natural resources and the earnings from its export (Kriskkumar & Naseem, 2019), it is argued that the Sachs-Warner's paradoxical finding can be attributed to changes in the price of natural resources (such as oil price) and weak institutions (corruption) (Devine, 2012; Olayungbo & Adediran, 2017). Therefore, this suggests that the effect of the abundance and/or dependence on oil on long-term growth can be assessed directly through the influence of oil prices and corruption on growth.

Moreover, evidence suggests that the direction and magnitude of the impact of oil prices on growth may be contingent on the level of corruption. This is premised on the argument that corruption, abysmal governance, and a rent-seeking culture being usual features of oil-dependent countries (Sala-i-Martin & Subramanian, 2003; van der Ploeg & Arezki, 2008), positive changes in oil prices, for instance, will generate interesting dynamic incentives for corrupt politicians to either inflate the cost of social goods and services, embezzle oil money, or divert resources away from growth-enhancing investments in favour of large non-productive capital-intensive projects which offers huge opportunity for bribes (Dietz & Eric, 2005; Gupta et al., 2000; Mauro, 1997, 1998; Tanzi & Davoodi, 1997; Vogel, 2020), leading to poor economic performance.

While the preceding discussion demonstrates the critical role of corruption in the oil price-economic growth relationship, modelling the moderating role on the relationship may be tricky. However, it is suggested in the literature that multiplicative interaction models can be utilised to determine the moderating effect of a variable on the relationship among two other variables (Brambor et al., 2006). Interestingly, many studies have adopted this approach to explore the role of corruption in the relationship between economic variables (Abu et al., 2022; d'Agostino et al., 2012; Drury et al., 2006; Freckleton et al., 2012; Fredriksson & Svensson, 2002; Morrissey & Udomkerdmongkol, 2012).

Therefore, an econometric model in which economic growth is dependent on oil price, corruption, and oil price-corruption interaction is specified as follows:

$$GDPG_t = \alpha_0 + \alpha_1 OILP_t + \alpha_2 CORR_t + \alpha_3 (OILP * CORR)_t + \phi' Z_t + \mu_t \qquad (1)$$

where $GDPG$ is the oil price, $CORR$ represents corruption, $OILP * CORR$ denotes oil price-corruption interaction term, $Z$ represents set of control variables (such as agricultural output, domestic security spending and unemployment rate), and $\mu_t$ is the stochastic error term with zero mean and constant variance. Through the oil price-corruption interaction term, we can determine whether corruption adversely or favourably moderates the effect of oil price on economic growth.

Therefore, we compute the marginal effect of oil price on economic growth through the partial derivative of Equation (1) as follows:

$$\frac{\partial GDPG_t}{\partial OILP_t} = \alpha_1 + \alpha_3 CORR_t \tag{2}$$

Emphasis is on the signs of the two coefficients ($\alpha_1$ and $\alpha_3$). If $\alpha_1 > 0$ and $\alpha_3 < 0$, it suggests that oil price improves economic growth, but the reduction in corruption diminishes the favourable effect. If $\alpha_1 < 0$ and $\alpha_3 > 0$, it connotes that oil price impairs growth, but low corruption levels mitigate the adverse effect. If $\alpha_1 < 0$ and $\alpha_3 < 0$, it signifies that oil prices slow economic growth and a reduction in corruption level aggravates that adverse impact. If $\alpha_1 > 0$ and $\alpha_3 > 0$, it denotes oil price is growth-enhancing, and a low level of corruption intensifies that positive effect. However, a positive marginal effect ($\alpha_1 + \alpha_3\ CORR_t$) demonstrates that a rise in oil prices and the level of corruption enhance economic growth, while a negative marginal effect connotes otherwise.

## 3.2 *Econometric Procedure*

The bootstrap ARDL bounds-testing approach of McNown et al. (2018) is adopted to investigate the cointegrating relationship between the variables. The choice of this approach is guided by its several advantages over the traditional ARDL bounds-testing approach of Pesaran et al. (2001). These include its ability to deal with the issues of weak size and power properties that characterise the traditional ARDL bounds-testing approach (Abu et al., 2022). Besides, the inclusion of an additional cointegration test on the lagged level(s) of the independent variable(s) in the bootstrap ARDL procedure to complement the existing F- and t-tests in the traditional ARDL bounds-testing framework further increase the power of the F-test, and by extension provides a better insight on the cointegration status of the system. More interestingly, this approach eliminates the issue of inconclusive inferences which may arise when using the traditional ARDL procedure (Goh et al., 2017; McNown et al., 2018).

Following Pesaran et al. (2001) and McNown et al. (2018), Equation (1) can be re-written as follows:

$$\begin{aligned}\Delta GDPG_t = \alpha_1 + \sum_{j=1}^{p} \delta_j \Delta GDPG_{t-j} + \sum_{i=1}^{q1} \beta_1 i \Delta lnOILP_{t-i} + \sum_{i=0}^{q_2} \beta_2 i \Delta CORR_{t-i} + \\ \sum_{i=0}^{q_3} \beta_3 i \Delta (OILP * CORR)_{t-i} + \sum_{i=0}^{q_4} \beta_4 i \Delta Z_{t-i} + \lambda_1 GDPG_{t-1} + \lambda_2 lnOILP_{t-1} \\ + \lambda_3 CORR_{t-1} + \lambda_4 (OILP * CORR)_{t-1} + \lambda_5 Z_{t-1} + \mathcal{E}_t\end{aligned} \tag{3}$$

where $\Delta$ represents the difference operator. The optimal lag length (p, q) is determined by the Akaike Information Criterion (AIC) of Akaike (1979). $\delta_1$ and $\beta_1 - \beta_4$ are the parameters of the lagged differenced regressors; $\lambda_1 - \lambda_5$ represents the coefficient of the lagged levels of the dependent and independent variables; $t = 1 \ldots T$ denotes time; $\mathcal{E}_t$ is the independent and identically distributed error term.

Following the bootstrap ARDL bounds testing procedure of McNown (2018), the presence or otherwise of a cointegrating relationship between series in Equation (3) is determined by testing the following three null hypotheses against their corresponding alternatives:

$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$, based on the overall F-test on all lagged level variables ($F_1$).
$H_0 : \lambda_1 = 0$, based on the t-test on the lagged level of the dependent variable ($t$).
$H_0 : \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$, based on the F-test on the lagged levels of the independent variable(s) ($F_2$).

The null hypothesis is rejected when the test statistics exceed the corresponding bootstrap-generated critical values at a specific significance level. As McNown et al. (2018) outlined, cointegration between series can only be established when all three hypotheses are rejected. Two degenerate cases, which express false cointegration, can be defined as follows: Degenerate case #1 (degenerate lagged dependent variable) occurs when the overall F-test and F-test on the explanatory variable(s) are significant but not for the t-test on lagged dependent variable. The degenerate case #2 (degenerate lagged independent variable) occurs when both the overall F-test and t-test on lagged dependent variable are significant but not the test on the lagged independent variable(s) (McNown et al., 2018; Sam et al., 2019). Since either of the case indicate the absence of cointegration between series, all three null hypotheses are expected to be rejected for a valid conclusion to be made on the cointegration between series.

Meanwhile, since evidence suggests that structural breaks are often present in most time series (Adedoyin et al., 2020), we need to make provision for such possibility in our cointegration test, so we don't end up with inaccurate conclusions. Interestingly, many empirical studies which employed the bootstrap ARDL approach consider structural breaks in the cointegration relationship by incorporating dummy variables in Equation (3) (Cai et al., 2018; Goh et al., 2017; Lin et al., 2018). Unfortunately, the use of dummy variable(s) to capture structural breaks is greatly limited because the break-dates have to be determined a priori. Another downside of using a dummy variable to capture structural break(s) is the issue of over-parameterisation, causing the test to have a weak size and power properties. To this end, studies have shown that a small number of low-frequency components of a Fourier approximation is capable of capturing unknown numbers of sharp gradual breaks in the presence of smooth transition autoregressive breaks as well as breakpoints that are sharp (Gallant, 1981, Gallant & Souza, 1991; Solarin, 2019; Yilanci et al., 2020). One of the main advantages of using the Fourier function to capture structural breaks is that it does not require a "researcher to assume the exact frequency of breaks, the dates of the breaks and the exact form of the breaks" (Solarin, 2019). Additionally, with Fourier approximation, the need to include many parameters in a model is eliminated, leading to a test with more power and size properties (Enders & Lee, 2012). Following the study by Solarin

(2019), to capture structural breaks, the Fourier function to be considered is given as:

$$d(t) = \sum_{k=1}^{n} \gamma_{1,k} \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \gamma_{1,k} \cos\left(\frac{2\pi kt}{T}\right) \tag{4}$$

where n is the number of Fourier terms, $pi = 3.1416$, k, t, and T denotes the frequency of the Fourier, trend and sample size, respectively, and $gamma_1$ and $gamma_2$ captures the amplitude and displacement of the frequency component, respectively.

Evidence suggests that if n is too large, it may lead to over-fitting problem (Kathuria & Kumar, 2022; Nazlioglu et al., 2016). Pata (2019) encouraged using a single frequency to overcome this problem. Moreover, since single frequency "allows for multiple smooth breaks and also serves as an appropriate approximation to breaks of an unknown form" (Enders & Lee, 2012), we follow Becker et al. (2006) and Ludlow and Enders (2000), and allow for a single-frequency Fourier function as follows:

$$d(t) = \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_1 \cos\left(\frac{2\pi kt}{T}\right) \tag{5}$$

Following Solarin (2019), we re-specify Equation (3) to incorporate the Fourier terms in Equation (5) as follows:

$$\begin{aligned}\Delta GDPG_t =& \alpha_1 + d(t) = \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_1 \cos\left(\frac{2\pi kt}{T}\right) \sum_{j=1}^{p} \delta_j \Delta GDPG_{t-j} + \\ & \sum_{i=1}^{q1} \beta_1 i \Delta lnOILP_{t-i} + \sum_{i=0}^{q_2} \beta_2 i \Delta CORR_{t-i} + \sum_{i=0}^{q_3} \beta_3 i \Delta (OILP * CORR)_{t-i} \\ & + \sum_{i=0}^{q_4} \beta_4 i \Delta Z_{t-i} + \lambda_1 GDPG_{t-1} + \lambda_2 lnOILP_{t-1} + \lambda_3 CORR_{t-1} + \\ & \lambda_4 (OILP * CORR)_{t-1} + \lambda_5 Z_{t-1} + \mathcal{E}_t\end{aligned} \tag{6}$$

Since fractional frequencies imply permanent breaks and integer frequencies indicate temporary breaks (Christopoulos & Leon-Ledesma, 2011; Omay, 2015), we follow the fractional frequency flexible Fourier form Bootstrap ARDL approach proposed by Yilanci et al. (2020). Thus, Equation(6) is estimated with all the values of $k$ in the interval $k = [0.1, \ldots, 5]$ with 0.1 increments, choosing the frequency, $k^*$, that minimises the AIC.

## 3.3 *Data Issues*

A major constraint to a study of this nature is getting substantial data for corruption. The notable corruption index of the World Bank is only available from 1996 to 2021, which falls short of the requirement for a time series analysis. Therefore, we transform the annual dataset covering the 1996-2021 period into quarterly data, spanning from

1996Q1 to 2021Q4, using the quadratic match average data interpolation technique suggested in the literature (Arain et al., 2019; Shahzad et al., 2017; Sharif et al., 2019). One of the significant advantages of the method lies in its ability to address end-to-end deviation during the conversion of low-frequency data into high-frequency data (Batool et al., 2019; Mishra et al., 2019; Shahbaz et al., 2018).

The variables are measured as follows. GDPG is measured as the percentage growth rate of real GDP. OILP is proxied by UK Brent crude oil's average per barrel spot price. CORR is measured by the World Bank's World Governance Indicator (WGI) control of corruption index. AGR is captured as the ratio of agricultural output to the GDP. INTS is the domestic security spending. UNEM is measured as the percentage unemployment rate. The data is collected from various notable sources. In particular, the data on real GDP growth rate and agricultural output is sourced from World Bank's World Development Indicators (WDI) database, while oil price (UK Brent) data is collected from the Organisation of Oil Exporting Countries (OPEC) annual statistical bulletin. In addition, the data on the control of corruption index is sourced from World Bank's WGI repository, while internal security expenditure data is collected from the Central Bank of Nigeria's (CBN) annual statistical bulletin, and unemployment rate data is sourced from Nigeria's National Bureau of Statistics repository.

# 4 Empirical Results

## 4.1 Summary of Descriptive Statistics and Correlations

The descriptive statistics of variables are computed, and the results are summarised in Table 1. The results demonstrate that the average real GDP growth rate, oil price (UK Brent), World Bank's control of corruption index, agricultural output (as a share of GDP), domestic security spending, and unemployment rate between 1996 and 2021 are 4.823 percent, US$56.733 (per barrel), -1.154, 24.644 percent, US$1.218 billion, and 19.924 percent, respectively. The corresponding standard deviation are 3.638, 30.895, 0.121, 3.999, 215.934 and 5.444, indicating that the data points are pretty spread out around the means. This is further confirmed by their skewness and kurtosis values which demonstrate that the data points are not normally distributed.

**Table 1**: Summary Staistics

| | Mean | Std. Dev. | Skewness | Kurtosis | Max. | Min. | Obs. |
|---|---|---|---|---|---|---|---|
| $GDPG$ | 4.823 | 3.638 | 0.466 | 4.005 | 15.962 | -2.179 | 104 |
| $OILP$ | 56.733 | 30.895 | 0.389 | 2.013 | 116.379 | 12.277 | 104 |
| $CORR$ | -1.154 | 0.121 | -0.337 | 3.019 | -0.879 | -1.438 | 104 |
| $AGR$ | 24.644 | 3.999 | 1.467 | 5.350 | 38.230 | 19.938 | 104 |
| $INTS$ | 1.218 | 0.668 | 0.011 | 1.519 | 2.333 | 0.234 | 104 |
| $UNEM$ | 19.924 | 5.444 | 2.353 | 8.500 | 39.944 | 13.107 | 104 |

Note: $GDPG$ = real GDP growth rate; $OILP$ = average spot price of UK Brent crude oil; $CORR$ = World Bank's WGI control of corruption index; $AGR$ = ratio of agricultural output to the GDP; $INTS$ = domestic security spending; $UNEM$ = unemployment rate.

Source: Authors' computation using R.

The results of the correlation analysis of the variables are presented in Table 2. The results reveal that control of corruption index, oil price-corruption interaction, log of public expenditure on internal security and unemployment negatively correlated with economic growth (real GDP growth rate). In contrast, agricultural output and economic growth have a moderate and significant positive correlation (0.56). In addition, the results indicate a positive, albeit weak and insignificant, correlation between the log of oil price and economic growth.

**Table 2**: Results of Correlation Analysis

| | $GDPG$ | $lnOILP$ | $CORR$ | $OILP \times CORR$ | $AGR$ | $lnINTS$ |
|---|---|---|---|---|---|---|
| $GDPG$ | 1.00 | | | | | |
| $OILP$ | 0.109 | 1.00 | | | | |
| | (1.113) | | | | | |
| $OILP \times CORR$ | -0.475$^{***}$ | 0.415$^{***}$ | 1.000 | | | |
| | (-5.453) | (4.602) | | | | |
| $CORR$ | -0.173$^{*}$ | -0.926$^{***}$ | -0.181$^{*}$ | 1.000 | | |
| | (-1.777) | (-24.753) | (-1.861) | | | |
| $AGR$ | 0.562$^{***}$ | -0.539$^{***}$ | -0.505$^{***}$ | 0.495$^{***}$ | 1.00 | |
| | (6.853) | (-6.479) | (-5.908) | (5.753) | | |
| $lnINTS$ | -0.205$^{**}$ | 0.782$^{***}$ | 0.436$^{***}$ | -0.619$^{***}$ | -0.494$^{***}$ | 1.00 |
| | (-2.114) | (12.679) | (4.893) | (-7.956) | (-5.735) | |
| $UNEM$ | -0.161$^{*}$ | -0.039 | -0.017 | 0.110 | 0.103 | 0.337$^{***}$ |
| | (-1.644) | (-0.400) | (-0.169) | (1.120) | (1.048) | (3.608) |

Note: Asterisks ($^{***}$), ($^{**}$), and ($^{*}$) denotes statistical significance at 1%, 5% and 10% levels, respectively. Values in parenthesis (.) are t-statistics. $lnOILP$ = natural log of the average spot price of UK Brent crude oil; $OILP \times CORR$ = oil price-corruption interaction; $lnINTS$ = natural log of domestic security spending.

Source: Authors' computation using R.

## 4.2 Results of Unit Root Tests

Before evaluating the role of corruption in the oil price-economic growth relationship, a unit root test was conducted to determine the properties of the underlying time series. To this end, we employ the traditional Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests, alongside the Zivot-Andrews (ZA) test of Zivot and Andrews (1992) and the Lee-Strazicich (LS) test (with two breaks) of Lee and Strazicich (2003).

The unit root test results reported in Table 3 present mixed outcomes. For instance, while the KPSS test indicates that all the series are stationary after taking their first difference, the ADF test demonstrates that, besides the corruption index and log of domestic security spending, all the series are integrated of order one (i.e. I(1)). Also, whereas the ZA test reveals that only agricultural output is stationary at level, the LS test shows that all the variables except real GDP growth rate, corruption index and agricultural output are stationary after taking their first difference. Nonetheless, since the ARDL bounds-testing procedure allows for series to have different orders of integration (provided it is not greater than order one), these findings provide some

**Table 3**: Results of Unit Root Tests

| | | *GDPG* | *lnOILP* | *CORR* | *AGR* | *lnINTS* | *UNEM* |
|---|---|---|---|---|---|---|---|
| ADF | level | -2.55 | -2.09 | -2.75$^{*}$ | -1.19 | -3.11$^{**}$ | 0.791 |
| | 1st Diff. | -3.22$^{**}$ | -3.31$^{**}$ | – | -4.06$^{***}$ | – | -4.701$^{***}$ |
| KPSS | level | 0.39 $^{*}$ | 0.78 $^{***}$ | 0.39$^{*}$ | 0.64$^{**}$ | 1.19*** | 0.20$^{**}$ |
| | 1st Diff. | 0.07 | 0.08 | 0.07 | 0.04 | 0.47 | 0.06 |
| ZA | level | -3.84 | -4.26 | -2.70 | -5.25$^{**}$ | -2.67 | -0.212 |
| | $T_b$ | 2001Q2 | 2014Q3 | 2004Q3 | 2001Q2 | 2004Q4 | 2018Q1 |
| | 1st Diff. | 6.09$^{***}$ | -5.57$^{***}$ | -6.14$^{***}$ | -5.37$^{***}$ | -5.80$^{***}$ | -5.39$^{***}$ |
| | $T_b$ | 2002Q3 | 2008Q2 | 2008Q2 | 2002Q3 | 2014Q3 | 2002Q3 |
| LS | Level | -3.67$^{*}$ | -3.37 | -3.59 $^{*}$ | -5.36$^{*******}$ | -3.34 | -2.75 |
| | $T_{b1}$ | 2003Q1 | 2009Q1 | 2005Q1 | 2003Q1 | 1998Q3 | 2003Q1 |
| | | 2003Q4 | 2014Q4 | 2009Q1 | 2004Q1 | 2012Q4 | 2017Q4 |
| | 1st Diff. | -5.95$^{***}$ | -5.27$^{***}$ | -7.58$^{***}$ | -5.69$^{***}$ | -9.57$^{***}$ | -7.57$^{***}$ |
| | $T_{b2}$ | 2003Q4 | 19999Q3 | 2008Q2 | 2003Q3 | strut2005Q3 | 1998Q3 |
| | | 2012Q4 | 2009Q4 | 2015Q3 | 2004Q3 | 2013Q4 | 2017Q3 |

Notes: ADF represents the Augmented Dickey-Fuller (1979) test, KPSS denotes Kwiatkowski et al. (1992) test, ZA is the Zivot and Andrews (1992) test with one break, and LS represents Lee and Strazicich (2003) test with two breaks. MacKinnon's (1996) critical values (CV) for ADF test (intercept only) are given as: -3.50, -2.89 and -2.58, at 1%, 5% and 10% levels, respectively. ZA's CV for structural change in the level shift are: -5.34 (1%), -4.93 (5%) and -4.58 (10%). KPSS asymptotic CV are: 0.74 (1%), 0.46 (5%), and 0.35 (10%). LS's CV for two shifts in level ("crash" model A) are: -4.545 (1%), -3.842 (5%), -3.504 (10%). ADF and ZA test the null hypothesis of unit root against the alternative hypothesis of a (trend-) stationary process (with one or two structural breaks). KPSS test the null of stationarity against the alternative hypothesis of a unit root. The optimal lag length selection in ADF and ZA is based on the Schwarz Information Criteria (SIC) of Schwarz (1978). For LS tests, the traditional general-to-specific approach is adopted. Setting the maximum lag-length to 8, the lag order at which the t-statistics exceeds the 10 percent asymptotic critical value (1.645). The bandwidth for the KPSS test is automatically determined based on the Newey-West method using the Bartlett kernel. Asterisks ($^{***}$), ($^{**}$), and ($^{*}$) denotes statistical significance at 1%, 5% and 10% levels, respectively. $T_b$ is the structural break-date.

Source: Authors' computation using *urca* R package (for ADF, KPSS and ZA tests) and *Rcode* (for L-S).

basis for employing the bounds-testing procedure within the bootstrap ARDL with Fourier function.

## 4.3 Results of Bootstrap Fourier ARDL Bounds-testing to Cointegration

Following the determination of the stationarity status of the series, we examine the cointegrating long-run relationship between the variables using the bounds-testing procedure within the framework of a bootstrap ARDL with a Fourier function. The optimal lag-length suggested by AIC (3,2,2,3,3,2,1), the optimal fractional Fourier frequency ($k^{*}$) that minimise the AIC (3.5799), the test statistics for testing the null hypothesis of the three tests (i.e. $F_1$, $t$, $F_2$), and the corresponding bootstrap-generated critical values are summarised in Table **??**. The results demonstrate that the value of the overall F-statistic ($F_1$), t-statistic on the lagged level dependent variable ($t$), and F-statistic on lagged level independent variables ($F_2$) all exceed the bootstrap-generated critical values at a 5 percent significance level. Thus, we can reject the null hypothesis of no cointegration between the series.

**Table 4**: Bootstrap Fourier ARDL Bounds-testing Result

| Lag Length | $k^*$ | Statistics | Values | Bootstrap-generated CVs | | |
|---|---|---|---|---|---|---|
| | | | | 1% | 5% | 10% |
| 3,2,2,3,3,2,1 | 3.5799 | $F_1$ | 4.614** | 8.705 | 4.455 | 4.164 |
| | | $t$ | -4.817** | -5.534 | -4.663 | -4.301 |
| | | $F_2$ | 5.259** | 8.301 | 4.986 | 4.652 |

Note: Asterisk (**) denotes significance at a 5% level based on critical values generated from the bootstrap procedure (with 1,000 replications) of McNown et al. (2018). $F_1$ represents the F-statistic for the lagged level variables $F_2$ denotes the F-statistic for the lagged level of the independent variables, and $t$ is the t-statistic for the lagged level of the dependent variable. The optimal lag-length is suggested by AIC. $k^*$ is the optimal value of the fractional frequency of the Fourier function, which is determined by grid-searching the value that minimises the AIC.

Source: Authors' computation using EViews 12.

## 4.4 Estimation Results of ARDL Model with Fourier Function

Since we have been able to establish a cointegrating relationship between the series using the bounds-testing procedure within the bootstrap ARDL model with the Fourier function, the results of the short- and long-run estimates of the selected ARDL model are presented in Table 4. The short-run and long-run estimates, alongside the marginal effects of oil price on economic growth and post-estimation diagnostics results, are summarised in panel A, panel B, panel C, and panel D of Table 4, respectively.

The results reveal that oil price has a significant and positive effect on economic growth both in the short- and long-run, suggesting that positive oil price shocks are growth-enhancing. This finding is in line with the outcome of prior research (Abubakar & Akadiri, 2022; Aliyu, 2009; Alley et al., 2014; Akinlo & Apanisile, 2015; Bala & Alhassan, 2018; Okoro, 2014; Yusuf, 2015). Also, the results indicate that control of corruption and economic growth are negatively related in the short- and long-term. This implies that reducing corruption (improvement in the control of corruption index) leads to the deceleration of economic growth. This finding lends support to the ones reported by previous studies (Olayugbo & Adediran, 2017; Rotimi et al., 2022).

Moreover, the results demonstrate that the oil price-corruption interaction has a significant and positive impact on economic growth, suggesting that the simultaneous increase in oil price and reduction in the level of corruption improves economic growth both in the short- and long-run. Beyond the net effects, the results of the marginal effect of a percentage increase in oil price on economic growth (panel C) were computed using the minimum, average, and maximum values of Nigeria's control of corruption index for the 1996-2020 period, alongside the highest (+2.50) and least (-2.50) control of corruption index score, demonstrate that the influence of oil price on economic

**Table 5**: Results of ARDL Model with Fourier Function

Panel A: ARDL(3,2,2,3,3,2,1) Long-run coefficient estimates–Dependent variable: $GDPG$

| $Cons$ | $lnOILP$ | $CORR$ | $OILP \times CORR$ | $AGR$ | $lnINTS$ | $UNEM$ |
|---|---|---|---|---|---|---|
| –49.538$^{***}$ | 9.799 $^{***}$ | –12.489 $^{***}$ | 0.045$^{*}$ | 0.579 $^{***}$ | –2.339$^{***}$ | –0.125$^{*}$ |
| (–7.743) | (5.033) | (–4.525) | (1.729) | (6.589) | (–4.152) | (–1.617) |

Panel B: ARDL(3,2,2,3,3,2,1) Short-run coefficient estimates – Dependent variable: $\Delta GDPG$

| Regressors | Lags | | |
|---|---|---|---|
| | 0 | 1 | 2 |
| $\Delta ECOG$ | | 0.544 (6.069)$^{***}$ | 0.274 (3.322)$^{***}$ |
| $\Delta lnOILP$ | 12.900 (5.821)$^{***}$ | –10.069 (–3.455)$^{***}$ | |
| $\Delta CORR$ | –26.399 (–6.012)$^{***}$ | 18.248 (3.440)$^{***}$ | |
| $\Delta(OILP \times CORR)$ | 0.118 (3.139)$^{***}$ | –0.105 (–2.520)$^{**}$ | 0.028 (1.737)$^{*}$ |
| $\Delta AGR$ | 0.712 (6.793)$^{***}$ | –0.353 (–2.913)$^{***}$ | –0.226 (–2.203)$^{**}$ |
| $\Delta lnINTS$ | –2.936 (–3.809)$^{***}$ | 2.052 (2.584)$^{**}$ | |
| $\Delta UNEM$ | –0.036 (–0.627) | | |
| $\gamma_1$ | 0.170 (1.390)$^{*}$ | | |
| $\gamma_2$ | –0.397 (–3.029)$^{***}$ | | |

Panel C: Marginal effect of $OILP$ on $GDPG$

| Levels of $CORR$ | | |
|---|---|---|
| Level | Values | Marginal Effect(s) of $OILP$ on $GDPG$ |
| Minimum | –1.438 | 0.0333 |
| Mean | –1.158 | 0.0459 |
| Maximum | –0.879 | 0.0584 |
| Highest control of corruption score | 2.50 | 0.2105 |
| Least control of corruption score | –2.50 | -0.0145 |

Panel D: Diagnostic test statistics

| $ECT_{t-1}$ | $\chi^2_{SC}$ | $\chi^2_{HET}$ | $\chi^2_{FF}(1)$ | $\chi^2_{J-B}$ | $\chi^2_{S-W}$ | $Adj.R^2$ |
|---|---|---|---|---|---|---|
| –0.415$^{***}$ | 0.107 | 30.598 | 0.601 | 99.572 | –0.919 | –0.709 |
| (–6.974) | [0.177] | [0.166] | [0.441] | [0.000] | [0.000] | |

**Notes:** The optimal lag-length is suggested by AIC. $\Delta$ represents the first difference operator. Asterisk ($^{***}$), ($^{**}$) and ($^{*}$) denote significance at 1%, 5%, and 10% level, respectively. In panels A and B, in parenthesis (.) are the t-ratio, and values in square parenthesis [.] in panel C are the probability values of the LM test statistics. $\gamma_1$ and $\gamma_2$ captures the amplitude and displacement of the frequency component, respectively. $\chi^2_{SC}$, $\chi^2_{HET}$, $\chi^2_{J-B}$, $\chi^2_{S-W}$ and $\chi^2_{FF}$ denote the Breusch-Godfrey serial correlation, Breusch-Pagan-Godfrey heteroscedasticity, Jarque-Bera normality, Shapiro-Wilk normality, and Ramsey RESET's functional form test statistics, respectively. The marginal effects of oil price on economic growth are calculated based on Equation 2

Source: Authors' computation using EViews 12.

growth varies with the level of corruption. The higher the level of corruption, the higher the marginal effect of oil prices on economic growth.

Furthermore, the results show that agricultural output is growth enhancing both in the short- and long-run. This finding is similar to those reported in earlier research (Adesoye et al., 2018; Olabanji et al., 2017; Oyakhilomen & Zibah, 2014). Also, the results indicate that domestic security spending has a significant and negative effect on economic growth in the short- and long-term. This finding is in line with prior researches (see d'Agostino et al., 2012; Dunne & Tian, 2015; Heo, 2010; Hou & Chen, 2013; Mylonidis, 2008; Yakovlev, 2007; Yang et al., 2011). In addition, unemployment is significant and negatively related to economic growth in the long term. The negative relationship between unemployment and economic growth is consistent with those reported in previous studies (Abu, 2017; Jibir et al., 2015). Further, the results illustrate that the coefficient of the error correction term lagged by one period ($ECT_{t-1}$) is less than unity, correctly signed and significant at a 1 percent level, implying that about 41.5 percent disequilibrium in economic growth in the short-run will be corrected within one quarter.

## 4.5 Results of Post-Estimation Diagnostics and Model Stability Tests

We conduct some post-estimation tests to ensure the adequacy of the estimated model for policy making. The results of the tests are summarised in panel D of Table 4. The results demonstrate that the estimated model is free from the problems of serial-correlation, heteroscedasticity, and misspecification error. However, the Jarque-Bera and Shapiro-Wilk test statistics suggest that the residuals in the estimated model are not normally distributed. Fortunately, evidence in the literature indicates that the errors' non-normality might not be an issue since such a scenario is a significant attribute of estimations involving a finite sample size (see Abu & Karim, 2021; Ahad et al., 2011). In addition, the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) plots of Brown et al. (1975) presented in Figure 1 and Figure 2 show that the parameters of the estimated model are stable in the long term. Moreover, the adjusted coefficient of determinant ($R^2$) indicates that oil price, corruption, their interaction, and the control variables incorporated explain considerable proportion of variations in real GDP growth rate variations. Thus, it can be concluded that the empirical outcome is suitable for policy making.

## 4.6 Simulations of the Response of Economic Growth to Changes in Oil price and Corruption

In addition to the long- and short-run estimates of the ARDL model, we also employ the recently proposed dynamic ARDL simulation technique of Jordan and Philips (2018) to project the response of growth to counterfactual changes (or shocks) in oil price and corruption over a 50-year period (i.e. from 2021 to 2070). The dynamic ARDL simulation procedure typically simulates and automatically visualises the effect of a counterfactual shock in one weakly exogenous regressor at a single point in time

(a) CUSUM plot

(b) CUSUMSQ plot

**Fig. 1**: CUSUM and CUSUMSQ Plots

using stochastic simulation techniques while holding all other regressors constant (Jordan & Philips, 2018). This procedure has been applied to predict the future outcomes of social, political, economic and climate indicators (see Abu et al., 2022; Abubakar & Akadiri, 2022; Ali et al., 2021; Khan et al., 2021; Olasehinde-Williams & Oshodi, 2021; Sarkodie & Owusu, 2020). The plots of the simulations of the impact of oil price and corruption on growth over a 50-year period are reported in Figure 3 and Figure 4, respectively. The simulation plot illustrates that a 10 percent positive shock in oil price in the fifth year (2026) leads to a significant increase in economic growth from about 0.5 percent in the pre-shock periods (2021-2025) to over 0.6 percent. Immediately after the hypothetical oil price shock, the plot indicates the decrease in economic growth rate to less than 0.6 percent. However, from 2028 through 2070, the predicted growth rate stabilised around about 6 percent over the long term.

Similarly, the simulation plot of a counterfactual change in corruption level (control of corruption index) on economic growth reported in Figure 4 demonstrates the deceleration in economic growth rate from about 5 percent during the 2021-2025 period to about 2.5 percent following a hypothetical improvement in the control of corruption score (reduction in corruption level) in 2026 by 10 units. The plot further indicates that, while the predicted economic growth rate improved immediately to about 3.5 percent in the two successive periods after the counterfactual shock, it took economic growth about 22 years after the shock (2048) before stabilising around 3.8 percent, a point lower than the 5 percent growth recorded during the pre-shock periods. Therefore, the simulation output indicates that, while the reduction in corruption level may hamper growth in the short-term, it tends to have a long-term positive influence on economic growth.

## 5 Discussions and Policy Implications

These empirical findings are quite revealing and have some implications. First, the positive effect of oil prices on economic growth demonstrates the importance of the oil sector to the survival of oil-dependent economies such as Nigeria. Since public expenditure in oil-dependent economies relies significantly on receipts from the sale of oil, the growth-enhancing effect of oil price can be better observed through the

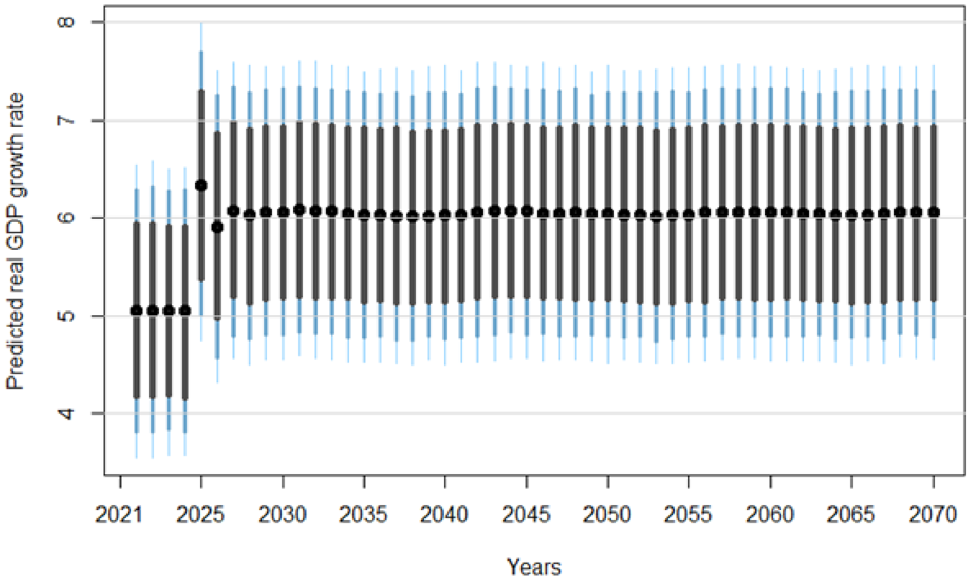

**Fig. 2**: Plot of a counterfactual shock in predicted real GDP growth rate with a 10% increase in oil price

**Notes:** The simulation is executed based on 10,000 replications. Black dots show the average predicted value, while shaded lines (from darkest to lightest) show the 75, 90, and 95 percentiles of the simulations' predictions, similar to a confidence interval.
**Source:** Authors' computation using *dynardl*() and *dynardl.simulation.plot*() functions in *dynamac* R package.

direct impact of oil price on public revenue. Therefore, an increase in oil price will raise public revenue, making available the much-needed financial resources for the government to invest in human and physical capital, thereby leading to economic growth and development. Interestingly, the plot of the simulated response of economic growth to counterfactual shock in oil prices over a 50-year term reported in Figure 3 indicate that while the post-shock economic growth rate may be lower than the oil price-induced growth rate, it is way greater than the rates during the pre-shock periods.[1] Analogously, it is indicative that a negative shock in oil price will push the growth level to points aways from the pre-shock periods.

Second, the adverse effect of lesser corruption on economic growth suggests that corruption is beneficial to the growth of Nigeria's economy. This finding clearly supports the "grease the wheel" hypothesis (see Huntington, 1968; Leff, 1964; Lui, 1985). Whereas this finding negates the popular opinion on the adverse effect of corruption on economic growth, a reduction in corruption can hamper growth through bureaucratic inefficiencies. For instance, the improvements in tracking and detecting corrupt practices and the prosecution of corrupt officials will generally frustrate the efforts of bureaucrats to extract bribes from businessmen/investors to avoid cumbersome

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[1] We appreciate the anonymous reviewer for pointing this out

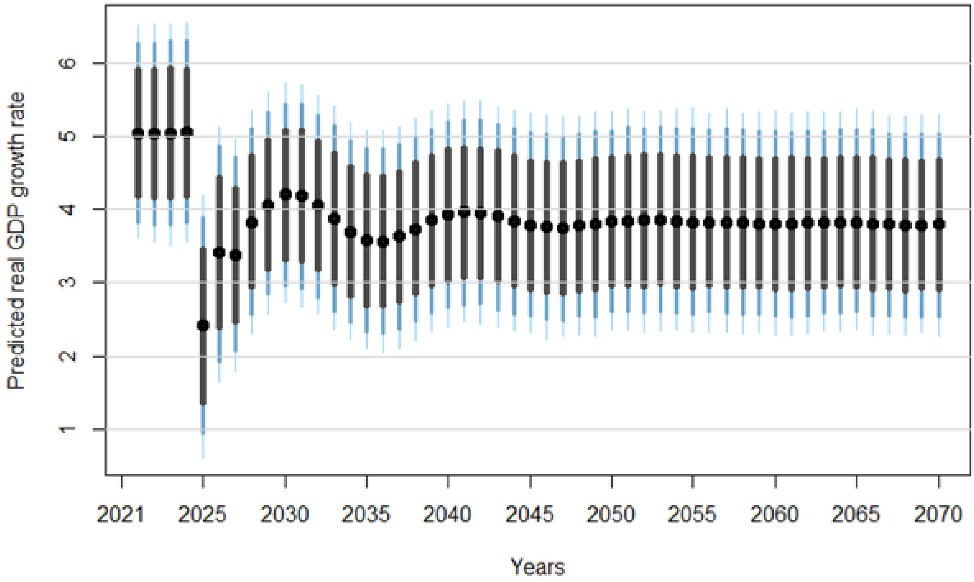

**Fig. 3**: Plot of a counterfactual shock in predicted real GDP growth rate following a 10% increase control of corruption score (reduction in corruption)

**Notes:** The simulation is executed based on 10,000 replications. Black dots show the average predicted value, while shaded lines (from darkest to lightest) show the 75, 90, and 95 percentiles of the simulations' predictions, similar to a confidence interval.
**Source:** Authors' computation using *dynardl*() and *dynardl.simulation.plot*() functions in *dynamac* R package.

bureaucratic delays and circumvent growth-retarding government policies. However, this will lead to inefficiency in the system, as the waiting period to obtain business permits, licenses, or approvals for contracts, which hitherto could be reduced through a bribe, is increased. By implication, planned investment and production of goods and services are delayed, leading to a decline in economic growth. Interestingly, some studies demonstrate that reducing corruption would often affect economic growth negatively in countries with a high incidence of corruption since it augments growth in such economies (see Ahmad et al., 2012; Swaleheen, 2011). However, the plot of the simulated response of economic growth to a counterfactual change in corruption level presented in Figure 4 suggests that, while the immediate effect of a significant reduction in the level of corruption is the deceleration in growth, sustained decline in corruption is expected to improve growth in subsequent periods but not to the pre-reduction rate.

Third, the positive sign of the oil price-corruption interaction term illustrates that oil price augments growth at a low level of corruption but influences economic growth adversely when perceived corruption is very high. Some studies have shown that the abundance of natural resources (such as crude oil) and their price are beneficial to long-term growth in countries with strong institutions (especially low levels of corruption) but slow growth in countries with weak institutional quality, including a high level of corruption (Acemoglu et al., 2002; Karabegović, 2009; Larsen, 2006; Olayungbo & Adediran, 2017). In Nigeria, for instance, the ubiquity of embezzlement and under-remittance of proceeds from oil sales, illegal diversion, and other sharp practices which pervade the oil and gas sector has often constrained the ability of the government to adequately invest in human capital and undertake development projects which are growth-enhancing regardless of changing oil price.

Fourth, the positive impact of the agriculture sector on economic growth reflects the sector's importance in augmenting economic growth in developing oil-dependent economies such as Nigeria. In fact, despite years of neglect and the underdevelopment of the sector, including the prevalence of subsistence agricultural production and the use of crude farming implements, the sector has continued to contribute an average of 22 percent to the country's GDP in addition to the employment of over 40 percent of the working population.

Fifth, the inverse relationship between domestic security spending and economic growth illustrates that higher public expenditure to curb overlapping but related security challenges in different parts of the country (including insurgency, banditry, kidnapping, et cetera) will slow down growth. This may not be surprising given that Nigeria's security sector is one of the most corruption-prone in the world. Moreover, empirical evidence has shown that rising security spending tends to retard growth by increasing budget deficit, inflation and shifting budgetary allocations away from some (or all) productive components of public spending – the "guns vs butter" trade-off (d'Agostino et al., 2012; Dunne & Tian, 2015; Heo, 2010; Hou & Chen, 2013; Mylonidis, 2008; Yakovlev, 2007; Yang et al., 2011).

Lastly, the negative relationship between unemployment and economic growth demonstrates the consequence of a high unemployment rate in an economy, which includes a reduction in income and savings, which thus leads to a drop in aggregate demand and production of goods and services, and consequently a decline in economic growth. Moreover, since the rising unemployment rate encourages individuals to engage in social vices such as prostitution, human trafficking, kidnapping, robbery, banditry, insurgency, and terrorism, among others, this creates an atmosphere of insecurity and uncertainty in the economy, leading to capital flight, a decline in domestic and foreign investment, and ultimately fall in output growth.

# 6 Conclusion and Recommendation

This study adopted the novel bootstrap ARDL augmented with a Fourier function and the dynamic ARDL simulation procedures to examine whether the effect of oil price on economic growth is contingent on the level of corruption. Using the Nigerian quarterly time-series dataset from 1996 to 2021, the bootstrap ARDL bounds-testing approach, which includes a Fourier function, presents the cointegration between economic growth and oil price, corruption and oil price-corruption interaction (alongside agricultural output, domestic security spending, and unemployment). Moreover, the results indicate that oil prices and corruption are growth-enhancing, but the effect of oil prices on economic growth is significantly dependent on the level of corruption. Further, evidence suggests that the marginal effect of oil prices on economic growth varies with the level of corruption. The lower the level of corruption, the higher the growth-inducing effect of oil prices on economic growth and vice versa. In addition, the dynamic ARDL simulations plots show a significant increase (decrease) in economic growth in the short-term following a counterfactual shock/increase in the oil price (corruption), which is then followed by a gradual decline (increase) in the long-term. These findings are a major departure from the existing studies which focused on the direct effects of oil prices and corruption on growth while ignoring the role of corruption in moderating the impact of oil prices on economic growth. Interestingly, the outcome demonstrates that the impact of oil prices on economic growth is significantly determined by the prevailing level of corruption.

Based on these findings, we recommend strategies to promote economic growth, improve agricultural output, and reduce corruption, unemployment, and insecurity. Particularly, policymakers are urged to implement policies to diversify the economy and public revenue away from oil. This can be achieved through increased investment in human and physical capital, as well as other non-oil sectors such as service, manufacturing et cetera, to spur sustained growth and development. Second, we encourage the government to adopt pragmatic measures to reduce corruption. Corruption can be reduced and growth enhanced by removing operational red tape and simplifying cumbersome regulations in the bureaucratic system. Also, the malaise can be curbed and economic growth stimulated by raising the income level and wages of civil servants, promoting greater freedom of expression, entrenching the rule of law and efficiency in the legal system, and the adequate funding of anti-graft agencies.

Third, since the level of corruption influences the effect of oil prices on economic growth, the government is advised to improve its efforts to reduce corrupt practices in the oil and gas industry. The investigation, arrest, and prosecution of individuals and groups involved in corrupt practices in the sector will go a long way in curbing corruption in the sector, and improving oil revenue and economic growth. Also, the efficiency of the oil and gas industry can be further enhanced by ensuring that state-owned oil companies imbibe a culture of accountability and transparency in their business conduct and dealings. Fourth, the government should pursue policies to develop and transform the agricultural sector, mainly through increased spending, access to credit facilities, improved seedlings, and the mechanisation of agricultural production.

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