Prague Economic Papers
2023, Volume 32, Issue 4
https://doi.org/10.18267/j.pep.836

VŠE / PRAGUE UNIVERSITY OF ECONOMICS AND BUSINESS

Symmetric or Asymmetric: How is Economic Growth Responding to Global Economic Uncertainty in Africa's Oil Exporters?

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Abstract

Motivated by the persistent fall in oil prices due to incessant uncertainty-inducing events in recent years, this study empirically examined if economic growth in Africa's top five oil exporters (Algeria, Angola, Egypt, Libya, and Nigeria) is responding asymmetrically to changes in global economic uncertainty as well as uncertainties from U.S., Europe and China using nonlinear ARDL framework from 1997Q1 to 2021Q4. We find that rising global uncertainty hampers economic growth in these economies, while declining global uncertainty significantly enhances growth in Nigeria, Angola and Libya in the short run, but becomes growth-retarding in the long run. Thus, economic growth responds asymmetrically to global uncertainty, especially in the short run. The findings are robust to U.S., Europe, and China uncertainties, except that economic growth in Libya and Algeria remained unresponsive to U.S. and China uncertainties respectively. We concluded that Africa's oil exporters should embrace policies that can strengthen their resilience to global economic uncertainty as well as uncertainties from U.S., Europe, and China.

Key words: global economic uncertainty, economic growth, oil exporters; nonlinear ARDL model, Africa

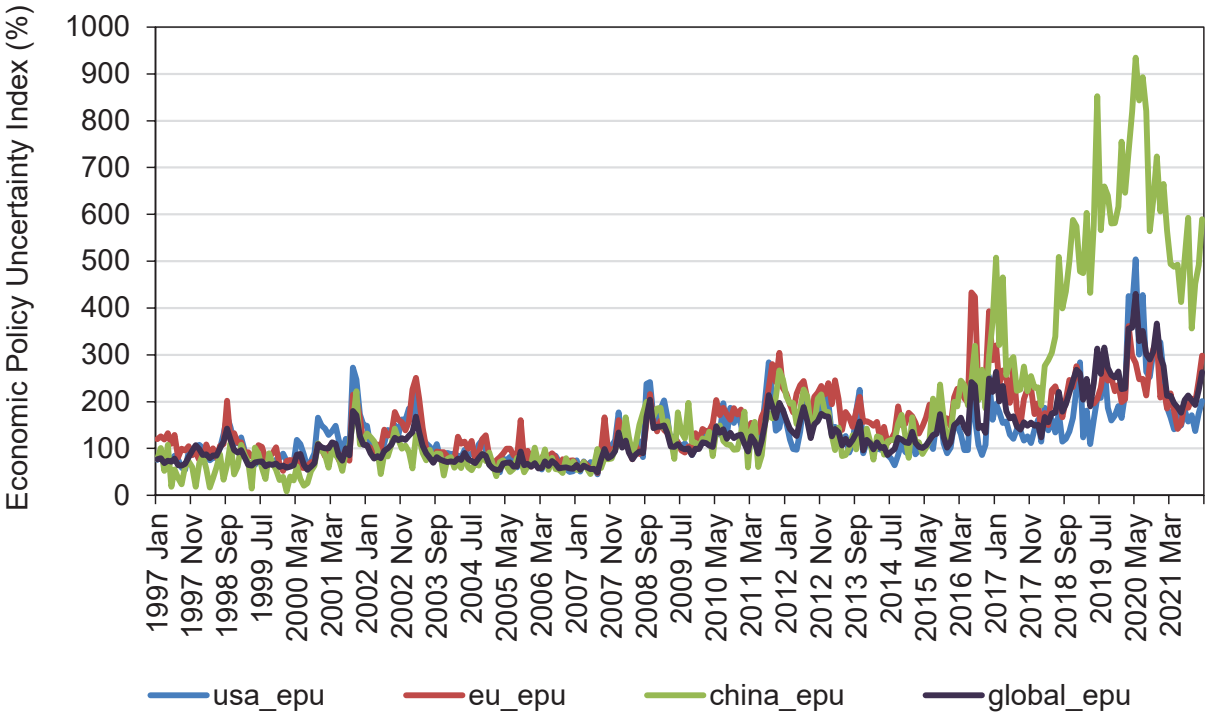
JEL Codes: D80, O40, N57, C22, O55

1. Introduction

The global economy has witnessed several uncertainty-inducing events, especially in the last two decades. Examples of such events that have been blamed for rising global economic uncertainty include the 2008–2009 Global financial crisis; the 2010–2012 Arab Spring crisis that ravaged

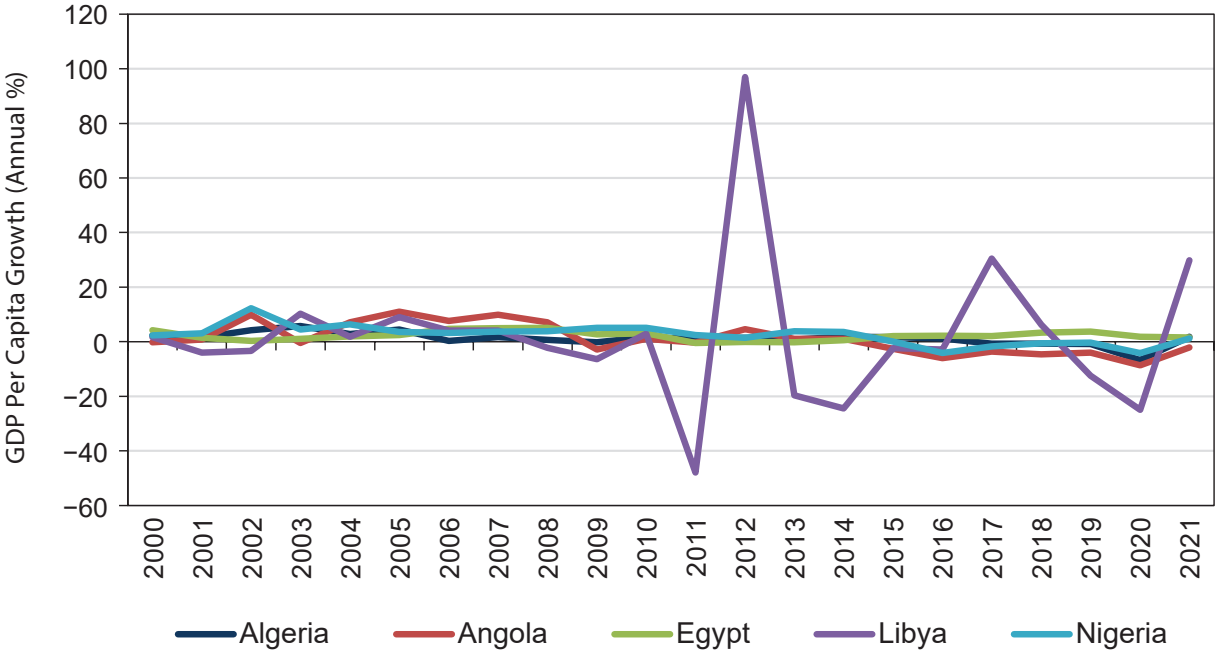
many countries in the Middle East and North Africa; the Euro area sovereign debt crisis; the persistent global trade disputes, particularly the trade tensions between U.S. and China, which could lead to the U.S. imposing tariffs on African sectors; the 2015–2016 commodity price shock, especially the fall in oil prices; the UK-EU Brexit vote; the Covid-19 pandemic, which crippled economic activities across the globe; and the ongoing Russia-Ukraine war (Ekeocha et al., 2023). The Covid-19 pandemic particularly brought with it the realities of restrictions on economic activities, imposition of lockdowns and social distancing, and shifts in production and consumption patterns across the globe, among others (Altig et al., 2020). These realities drastically increased the level of uncertainty in the global economy. Figure 1 illustrates the increase in global economic policy uncertainty (EPU) during the Covid-19 pandemic as well as the remarkable increase in uncertainty from China, which is the originator of the crisis. As a result of the pandemic, Sub-Saharan Africa experienced its first economic recession in over twenty-five years as economic activities in the region contracted by nearly five percent. Among the top oil exporters in Africa, the worst hit was Libya, as it recorded negative annual GDP growth of −24.9% in 2020 on per capita basis. As shown in Figure 2, other top oil exporters in Africa, like Angola and Nigeria, also witnessed sharp declines in their GDP per capita growth. Figure 2 also shows that Libya witnessed significant decline in GDP per capita during the Arab Spring crisis.

Figure 1: Plots of Economic Policy Uncertainty Index, January 1997 – December 2021



Notes: global_epu: global EPU, usa_epu: USA EPU, eu_epu: European EPU, china_epu: China EPU.
Source: authors' computation, with data from the Economic Policy Uncertainty Group (Davis, 2016)

Figure 2: Plots of GDP Growth Per Capita (Annual %), 2000–2021



Source: World Development Indicators (World Bank, 2022a)

Apart from the foregoing events that have generally increased global uncertainty, African economies have also witnessed region-specific as well as country-specific economic uncertainty issues. Region-specific uncertainty-inducing issues in Africa in recent years include the tensions created by the transition from one government to another in various African countries, the take-off of the African Continental Free Trade Area that was postponed severally, the persistent problem of terrorism and xenophobic violence on the continent, and the recurring economic recessions in many African countries. In Nigeria, which is Africa's largest oil exporter, economic uncertainty in recent years has been shaped by several domestic issues, such as the delays in the submission and approval of national budgets; the fuel subsidy debacle; banking sector crises leading to several episodes of bank failures; the power sector reforms that began in 2001; the perennial ethnic tensions from nomadic herdsmen attacks on farmers; the economic recession of 2016; the Boko Haram insurgency that started in 2009; the 2020 EndSARS protest against police brutality; and the ongoing currency redesign policy of the Central Bank of Nigeria, among others. In Egypt, high inflationary pressures, the continued decline in domestic oil production, and low capital investment by private oil firms are important sources of uncertainty in the local economy (Devaux, 2021). In Libya, domestic sources of economic uncertainty are political instability and security developments that usually result in conflicts, oil export port blockades and pipeline shut-ins, labour disputes, and inflationary pressures caused by increasing food and energy prices

(U.S. Energy Information Administration, 2022; World Bank, 2022b). In Angola, apart from the civil war that ended in 2002, the domestic economy has been facing the challenges of inequalities, corruption, and macroeconomic mismanagement that have continued to threaten the peace and stability of the country, thereby increasing uncertainty in the economy (UNCTAD, 2022). Thus, Africa's top oil exporters face global, region-specific and country-specific uncertainty issues.

However, an important feature of these global uncertainty issues is that they are usually accompanied by fall in oil prices. Such crash in oil prices in turn induces crisis in oil exporting countries. For instance, the 2016 and 2020 economic recessions in Nigeria have been largely attributed to the fall in oil prices that started in 2013Q3 and the tumbling in oil prices following Covid-19 Pandemic, respectively. Thus, there is need for policymakers and other stakeholders to understand how economic growth is responding to global economic uncertainty in Africa's oil producers. Interestingly, a handful of studies in the extant literature have examined the effect of uncertainty on economic performance indicators in Africa. Specifically, Ekeocha et al. (2023), Ogbonna et al. (2022), Kisten (2020), Balakeffi et al. (2019), and Redl (2018) used various econometric methods like the generalize method of moments (GMM), quantile regressions, vector autoregression (VAR), autoregressive distributed lag (ARDL), and generalised autoregressive conditional heteroskedasticity (GARCH) modeling methods to show that economic uncertainty adversely affects economic performance in Africa. However, these methodologies do not account for the asymmetric effects of uncertainty. Hence, two important gaps have remained unresolved in the literature. First, none of these existing studies focused exclusively on Africa's oil exporters. Second, none of these existing studies investigated the asymmetric effect of uncertainty in a manner akin to Shin et al. (2014). We contribute to the literature by addressing these gaps, since Bahmani-Oskooee and Nayeri (2018) has shown that macroeconomic variables may respond differently to an increase in uncertainty as compared to a decrease in uncertainty.

Against the foregoing background, this study focused on three specific objectives, which are to: (i) ascertain if economic growth in oil exporting African countries responds asymmetrically to changes in global economic uncertainty; (ii) establish if there are variations in the response of economic growth in these countries to uncertainties emanating from U.S., Europe and China; and (iii) determine other significant macroeconomic drivers of growth in these countries. To achieve these objectives, this study adopted the nonlinear ARDL (NARDL) approach of Shin et al. (2014). The top five African oil exporters investigated in this study are: Nigeria, Angola, Algeria, Libya, and Egypt. These countries were selected because they are the top five oil producers/exporters in Africa (BP, 2021; Global Firepower, 2023). We investigated how these economies are responding to uncertainties from U.S., Europe and China based on two reasons. The first reason is that U.S., Europe, and China are the main sources of global economic

uncertainty, while the second reason is that they are Africa's top trade partners, particularly in the last few decades (Baker et al., 2016; African Union, 2020). Thus, it would be interesting for policymakers in Africa and other stakeholders to understand how Africa's top oil exporters are responding to uncertainties from these sources.

2. Overview of the Literature

2.1 Theoretical literature

Some economic theories in the literature are relevant to this study. Some of these theories are theories of economic growth, while others are theories of uncertainty. The classical growth theory posits that the path to economic growth is through increases in productive activities caused by technological advancement and population growth (Smith, 1776; Malthus, 1820; Ricardo, 1951). The theorists emphasized the roles of labour, capital stock, quantity of natural resources and technological advancement in the growth process. The Harrod-Domar growth theory posits that the growth rate of an economy is mainly determined by the level of national saving and the productivity of capital investment (Harrod, 1939; Domar, 1946). The theorists argue that economic growth takes place due to savings and investments, which in turn brings about increase in capital and production. The Neoclassical growth theory used the aggregate production function to show that economic growth occurs through the combination of capital, labour and technology (Solow, 1956; Swan, 1956). The theorists recognized the roles of capital accumulation, labour and technical change, which are exogenously determined. The endogenous growth theory recognized the rate of technological advancement and population growth rate as endogenous factors in the growth model so that economic growth is essentially driven by internal forces rather than external forces as postulated by the neoclassical growth theory (Romer, 1986, 1990; Lucas, 1988). The endogenous growth theorists explain that investments in human capital and innovation enhance productivity and growth.

The theory of real options channel is an uncertainty theory which recognizes that firms have sequences of real options on possible irreversible investments to embark upon. An irreversible investment is one for which an investor must face a high cost to disembark from. According to the theorists, uncertainty causes firms to be cautious regarding their actions when employing and investing, especially when the costs of adjustment make investments to be costly to reverse. The theory of real options channel is generally associated with Bernanke (1983), Brennan and Schwartz (1985), McDonald and Siegel (1986), and Dixit and Pindyck (1994). The theory of precautionary savings channel explains that uncertainty dampens economic growth because uncertainty induces households to embark on precautionary savings, which in turn decreases consumers' spending and demand in the domestic economy; economic agents in the domestic economy to invest their savings in foreign countries, thereby decreasing

investments in the domestic economy; and firms to be more cautious with investments that are long-term in nature (Bansal and Yaron, 2004; Fernandez-Villaverde et al., 2011; Baker and Bloom, 2013). The theory of risk premia is another theory of uncertainty which explains that rising risk premia is an important channel through which uncertainty hurts economic growth (Baker et al., 2014). The theorists recognize that uncertainty increases investment financing cost, raises the cost of financing debt by increasing the default probability, hikes interest rates charged by banks and other lenders, and lowers the confidence of economic agents in the overall economy. These, in turn, induce economic agents, especially firms, to reduce employment and cut back on investment and production.

2.2 Empirical literature

Some studies in Africa have examined the effect of uncertainty on economic growth (e.g., Ekeocha et al., 2023; Ogbonna et al., 2022; Kisten, 2020; Balakeffi et al., 2019; Aye, 2019; Redl, 2018). Ekeocha et al. (2023) used system GMM and quantile regressions for the period 2010 to 2019 to find that while global uncertainty and uncertainties from USA, China, and Canada exert substantial effect on economic performance in Africa, the impacts of domestic uncertainty and uncertainties from UK, Japan, Russia, and Europe were negligible. Ogbonna et al. (2022) also used the GMM framework over the period 2010–2019 to find that global EPU impacts adversely on Africa's FDI inflow and governance institutions intensify this effect rather than alleviate it. Kisten (2020) used the VAR framework to find that while rising uncertainty impacts adversely on industrial production and real effective exchange rate in South Africa, it also increases the general price level and 10-year government bond yield. Balakeffi et al. (2019) used the ARDL and GARCH techniques over the period 1997–2016 to find that global EPU impacts adversely on Nigeria's export earnings. Aye (2019) also used the GARCH framework to show that real economic activity of South Africa, measured in terms of real GDP, responds asymmetrically to fiscal policy uncertainty. Redl (2018) constructed an index for economic uncertainty in South Africa and used a VAR framework to show that a rise in this index is associated with a decline in the country's GDP, industrial production, investment, and private sector employment. It also established that shocks to the uncertainty index are inflationary.

Outside Africa, some recent studies have also examined the effect of uncertainty on economic growth. Kasal and Tosunoglu (2022) used a VAR model to find that fiscal policy uncertainty in Turkey has adverse and long-lasting effect on the country's economy. Sheikh et al. (2021) used ARDL approach to find that trade openness mitigates the effects of global uncertainty on growth in India. Saleem et al. (2018) used ARDL model to show that innovation and growth rate of GDP are negatively affected by EPU in China. Hardouvelis et al. (2018) constructed an EPU index for Greece and found that the index impacts adversely on household

deposits, GDP, industrial production, investment, employment, and the stock market. Istiak and Serletis (2018) used nonlinear structural VAR to show that EPU impedes real output growth among the G7 economies, and that industrial production in U.S., Italy and France respond asymmetrically to EPU. Čižmešija et al. (2017) performed Toda-Yamamoto Causality test between aggregate economic activity and EPU index for U.S., UK, Germany, France, Italy, and Spain. The findings showed bi-directional causality for USA alone, and uni-direction causality for Germany and France. Saxegaard et al. (2022) applied VAR model to find that rising EPU in Japan caused decline in employment, investment, and output performance. Butkus et al. (2022) found that uncertainty moderates the debt-growth relationship such that higher uncertainty engenders increased adverse effect of debt on growth. Baker et al. (2016) used VAR framework to show that policy uncertainty innovations foreshadow drops in investment, employment, and output in the USA. Lensink et al. (1999) used various econometric techniques and a panel of 138 countries to find that uncertainty impacts negatively on economic growth.

Some studies have also examined the effects of uncertainty on other macroeconomic variables. Zhu and Yu (2022) used panel data from China's industry to find that technological progress significantly moderates the adverse impact of EPU on industrial output. Loermann (2021) used nonlinear threshold VAR to find that exchange rate uncertainty impacts on exports, while Jia et al. (2020) used a gravity model to show that economic policy uncertainty impacts negatively on exports. Erer and Erer (2020) used threshold VAR to find that macroeconomic variables in Turkey, such as exchange rate, industrial production and inflation rate, respond considerably to U.S. EPU. Alqahtani and Martinez (2020) used the ARDL technique to find that stock prices in Kuwait and Bahrain are significantly and negatively influenced by both U.S. and global EPUs. For a panel of 20 countries, Olanipekun et al. (2019) found that regardless of the exchange rate regimes an economy is operating, be it flexible, fixed or intermediate, EPU affects its foreign exchange market significantly. Using a structural VAR, Ghirelli et al. (2021) found that private consumption and capital goods investment were negatively affected by EPU and financial uncertainty shocks in Spain. Jeon (2018) used VECM model to show that EPU of four major Asian countries (Japan, China, Korea, and Hong Kong) impact adversely on Korea housing market returns. Bahmani-Oskooee and Xu (2022) found that rising economic policy uncertainty in U.S. and China hurt the trade balance of both countries.

Hoque and Zaidi (2020) used both linear and nonlinear models to establish that global economic policy uncertainty impacts negatively and asymmetrically on Malaysian stock market. Scarcioffolo and Etienne (2018) used VAR to find that both U.S. crude oil and natural gas markets returns were affected by the lag of EPU. Riaz et al. (2018) used ARDL approach to find that stock returns of the transportation sector in the U.S. are negatively affected by domestic and international EPU. Bordo et al. (2016) used an ARDL model to show that EPU impacts adversely on bank credit growth in U.S. Iyke and Ho (2020) found that

inflation uncertainty inhibits domestic investment in Ghana. Dibiasi and Iselin (2021) found that Knightian uncertainty depresses investment persistently. Krol (2017) used OLS method to show that rising EPU decreases investment and employment, while the expansion decisions of small businesses are hindered. Schweitzer and Shane (2011) also found that the decisions of small business owners to hire and make capital expenditures are significantly and negatively affected by EPU. Arouri et al. (2016) also used OLS regression to find that an increase in policy uncertainty decreases stock returns significantly in the U.S., while Gulen and Ion (2016) also found that EPU depressed U.S. corporate investment. Ukwueze et al. (2018) used a multinomial logistic regression model to show that uncertainty impacts negatively on medium and large enterprises in Nigeria, while CBN (2015) used GARCH framework to show that in the period 2000Q1–2015Q1, monetary policy effectiveness in Nigeria was not significantly undermined by macroeconomic uncertainty.

In the same moment, a strand of the literature has used the NARDL framework to study the macroeconomic effects of EPU, since it has been established that macroeconomic variables may respond differently to an increase in uncertainty as compared to a decrease in uncertainty (Shin et al., 2014). Ogbuabor et al. (2023) used this framework to find that rising uncertainty significantly increases retail energy prices both in the short run and long run, particularly in Europe, Japan and UK, while the asymmetric patterns show that many of the markets respond more to rising uncertainty than declining uncertainty. Ogbuabor et al. (2022) also used the NARDL approach to find that rising uncertainty hampers aggregate and sectoral output growth, and discourages investment, employment, and private consumption, and increases consumer prices significantly in Brazil, India, China and South Africa. It also found significant asymmetric effects in the response of real sector variables to EPU. Bahmani-Oskooee and Nayeri (2020) used NARDL model to show that changes in EPU have both long-run and short-run asymmetric effects on the demand for money in Japan, while Bahmani-Oskooee and Saha (2019) used the same model to find that EPU has both long-run and short-run asymmetric effects on stock prices in USA, Canada, UK, Korea and Japan. Rajput et al. (2019) used the NARDL approach to find that uncertainty impacts asymmetrically on foreign remittances in Russia, Brazil, and India. Bahmani-Oskooee and Nayeri (2018) and Bahmani-Oskooee et al. (2016) used NARDL framework to find evidence of both short-run and long-run asymmetric effects of EPU on money demand in USA.

A number of gaps are obvious from this overview of the literature. First, none of the studies reviewed above examined the effect of global economic uncertainty on Africa's oil exporters. Second, even though macroeconomic variables may respond differently to an increase in uncertainty as compared to a decrease in uncertainty, none of the studies reviewed above accounted for the asymmetric effect of uncertainty on economic growth in oil exporting African economies in a manner that is consistent with Shin et al. (2014). Thus, the extant

literature appears to be biased against African economies since majority of the studies that have used the NARDL framework of Shin et al. (2014) have generally focused on other regions of the world. Third, in spite of the fact that policy uncertainties emanating from U.S., China and Europe may have remarkable effects on economic growth in African economies since they are Africa's top trade partners, the response of economic growth in Africa's oil exporter to EPU originating from U.S., China and Europe remains unknown. This study addressed these gaps in the literature in order to foster a more comprehensive understanding of the effects of global economic uncertainty, especially in Africa.

3. Methodology and Data

3.1 Theoretical framework

The theoretical framework for this study, which provides the basis for our model specification, is anchored in the Neoclassical growth theory. This theory recognizes that labour productivity (which stems from growth in human capital, that is, accumulation of skills and knowledge), accumulation of physical capital, and technical change (which comes from adopting new and better production methods) are important in explaining economic growth (Solow, 1956; Swan, 1956). Thus, the aggregate production function may be defined as:

$$Y = Af(K, L) \tag{1}$$

where: Y is output, K is capital, L is labour, and A is the level of technology. Following Tumwebaze and Ijjo (2015) and Ogbuabor et al. (2019a), we assume a Cobb-Douglas production function combining labour and capital with constant returns to scale so that Equation (1) can be expressed as follows:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{2}$$

Hence, the annual economic output growth is derived from Equation (2) as:

$$y = \alpha + \alpha k + (1 - \alpha)l \tag{3}$$

where: y, α, k and l denote the growth rates of Y, A, K and L, respectively.

Following the assumption of non-diminishing returns to the accumulation of physical and human capital in Equation (3), this framework is able to predict the long-term growth effects of EPU. Hence, in what follows, we model the asymmetric growth effect of EPU by extending the economic growth function in Equation (3) to include the EPU variable.

3.2 The model

To ascertain if economic growth in oil exporting African countries is responding asymmetrically to changes in global EPU, we begin by re-specifying Equation (3) as an asymmetric cointegrating relationship as follows:

$$GDP_t = \gamma + \theta^{+'} EPU_t^+ + \theta^{-'} EPU_t^- + \varphi Capital_t + \psi Labour_t + \phi Trade_t + \varepsilon_t \tag{4}$$

so that EPU_t is decomposed as:

$$EPU_t = EPU_0 + EPU_t^+ + EPU_t^- \tag{5}$$

where: $EPU_t^+ = \sum_{j=1}^{t} max\ (\Delta\ EPU_j,\ 0)$ and $EPU_t^- = \sum_{j=1}^{t} min\ (\Delta\ EPU_j,\ 0)$ are the partial sum processes of positive and negative changes in EPU_t; EPU_0 is the initial threshold value assumed to be zero following Ogbuabor et al. (2023; 2019b), Ogbonna and Ichoku (2022), Shin et al. (2014), and Greenwood-Nimmo and Shin (2013); Δ is the first difference operator; and ε_t is the error term. The decomposition of *EPU* into partial sum processes in Equation (5) splits the EPU variable in the ratio 49:51 in favour of the negative regime. The decomposition of uncertainty indexes of U.S., Europe and China also follow this pattern, which generally indicate that there is no problem of bias in favour of either positive or negative regime.

The NARDL(p,q) associated with Equation (4) is then expressed in its level form as follows:

$$\begin{aligned} GDP_t = {} & \gamma + \sum_{j=1}^{p} \alpha_j GDP_{t-j} + \sum_{j=0}^{q} \left(\theta_j^{+'} EPU_{t-j}^+ + \theta_j^{-'} EPU_{t-j}^- \right) + \\ & + \sum_{j=0}^{q} \left(\varphi_j Capital_{t-j} + \psi_j Labour_{t-j} + \phi_j Trade_{t-j} \right) + \varepsilon_t \end{aligned} \tag{6}$$

where: α_j are the autoregressive parameters; θ_j^+ and θ_j^- are the asymmetric distributed lag parameters. To aid the evaluation of long-run and short-run asymmetries, we follow Greenwood-Nimmo and Shin (2013) by specifying the NARDL(p,q) in Equation (6) in its error correction form as follows:

$$\begin{aligned} \Delta GDP_t = {} & \gamma + \rho GDP_{t-1} + \theta^{+'} EPU_{t-1}^+ + \theta^{-'} EPU_{t-1}^- + \varphi Capital_{t-1} + \psi Labour_{t-1} + \\ & + \phi Trade_{t-1} + \sum_{j=1}^{p-1} \alpha_j \Delta GDP_{t-j} + \sum_{j=0}^{q-1} \left(\pi_j^{+'} \Delta EPU_{t-j}^+ + \pi_j^{-'} \Delta EPU_{t-j}^- \right) + \\ & + \sum_{j=1}^{q-1} \left(\upsilon_j \Delta Capital_{t-j} + \tau_j \Delta Labour_{t-j} + \delta_j \Delta Trade_{t-j} \right) + e_t \end{aligned} \tag{7}$$

where: ρ is the speed of adjustment; e_t is a white noise process; $\beta^+ = -\frac{\theta^+}{\rho}$, and $\beta^- = -\frac{\theta^-}{\rho}$ are the asymmetric long-run parameters; while $\sum_{j=1}^{q-1}\pi_j^+$ and $\sum_{j=1}^{q-1}\pi_j^-$ are the additive short-run parameters for the EPU variable; while $\sum_{j=1}^{q-1}\upsilon_j$, $\sum_{j=1}^{q-1}\tau_j$ and $\sum_{j=1}^{q-1}\delta_j$ are the additive short-run parameters for *Capital, Labour*, and *Trade*, respectively. To guarantee that the dynamics of the cointegrating relationship is not arbitrary misspecified in Equation (7), we used the general-to-specific lag selection process beginning with an initial maximum lag length of 4 (since our data is at quarterly frequency) with a unidirectional 5% decision rule. This is consistent with Greenwood-Nimmo and Shin (2013) and Ogbuabor et al. (2019b). We used the standard Wald test to check for: (i) long-run asymmetry under the null hypothesis, H_0: $\beta^+ = \beta^-$; and (ii) short-run additive asymmetry under the null hypothesis, H_0: $\sum_{j=1}^{q-1}\pi_j^+ = \sum_{j=1}^{q-1}\pi_j^-$. These symmetry tests were conducted to find out if economic growth responds differently to increases and decreases in uncertainty.

The choice of the NARDL technique for this study is based on several reasons. First, the NARDL framework ensures that we are able to capture the response of economic growth to increasing uncertainty separately from decreasing uncertainty. Second, our NARDL model is easily estimable by ordinary least squares (OLS) technique since it is linear in parameters. Third, the NARDL framework accommodates combinations of both stationary and non-stationary variables, and the existence of cointegration relationship between the levels of the variables is effortlessly tested using the bounds-testing approach of Pesaran et al. (2001) and the t_{BDM}-statistic of Banerjee et al. (1998), notwithstanding whether the regressors are stationary (i.e. integrated of order zero, I(0)), non-stationary (i.e. integrated of order one, I(1)) or mutually cointegrated. In addition, the NARDL framework corrects perfectly for weak endogeneity of non-stationary regressors as explained by Greenwood-Nimmo and Shin (2013) and Shin et al. (2014). Hence, to address this potential problem in this study, we lagged our regressors by 4 periods under a general-to-specific modeling approach.

3.3 The data and preliminary descriptive statistics

The data for this study consists of quarterly observations from 1997Q1 to 2021Q4, since the global EPU data started from 1997Q1. We used the global EPU index and the EPU indexes for U.S., Europe, and China, taken from Davis (2016). Other variables included in the study are *GDP* (measured in current U.S. dollars), *capital* (measured as gross fixed capital formation in current U.S. dollars), labour (measured as the working population aged 15–64 years), and *trade* (% of GDP). The data for these variables were taken from World Bank (2022a). African countries investigated in this study are Nigeria, Angola, Algeria, Libya, and Egypt. These

countries were selected because they are the top five oil producers/exporters in Africa (BP, 2021; Global Firepower, 2023). While the uncertainty data were converted from monthly to quarterly using the period average, the data for other variables were converted from annual to quarterly using the quadratic match average option. Thereafter, the entire data were indexed to 2010 base year in order to achieve uniform scaling, and logged prior to estimation. The descriptive statistics of the data shows that the data exhibited some variability, while the Phillips-Perron unit root tests shows that all the variables are either I(0) or I(1), which is consistent with the NARDL framework. To conserve space, we do not present the tables of the descriptive statistics and the Phillips-Perron unit root tests here, but they are available on request.

4. Results and Discussions

We recall that the specific objectives of this study are to: (i) ascertain if economic growth in Africa's oil exporters responds asymmetrically to changes in global economic uncertainty; (ii) establish if there are variations in the response of economic growth in these countries to uncertainties emanating from U.S., Europe, and China; and (iii) determine other significant macroeconomic drivers of growth in these countries. To achieve these objectives, we estimated the NARDL model in Equation (7) using global EPU as the measure for global economic uncertainty. The results are shown in Table 1. Similarly, Tables 2, 3, and 4 report the estimation of the same model using the EPU indexes of U.S., Europe, and China, respectively. The notations in these Tables follow the labeling in Equation (7).

To begin, we focus on the column for Nigeria in Table 1. The results indicate that the speed of adjustment is in line with theoretical expectation since it has a negative coefficient of −0.11 and it is also statistically significant at the 1% level. This is consistent with Bahmani-Oskooee and Nayeri (2018), who reported a speed of adjustment of 2%. Indeed, the speed of adjustment in Table 1 ranges between 4% and 13%. The speeds of adjustment in Tables 4, 5, and 6 follow similar patterns. The long-run asymmetric parameter β^{+}, which captures the effect of increasing uncertainty, has a negative value of −0.20 and it is also statistically significant at the 5% level. This indicates that in the long run, rising uncertainty impacts negatively and significantly on economic growth in Nigeria. Interestingly, the results further indicate that the long-run asymmetric parameter β^{-}, which captures the effect of decreasing uncertainty, also has a negative value of −0.76, which is statistically significant at 1% level. This indicates that the impact of declining uncertainty on economic growth in Nigeria is also negative and significant in the long run. In fact, the results indicate that in the long run, both rising and declining uncertainty impact adversely on economic growth in Nigeria. This finding is consistent with some studies (e.g., Bhagat et al., 2014; Stockhammar and Osterholm, 2016), which also found that uncertainty impacts significantly and negatively on economic growth.

These results are also consistent with those of Angola, Egypt, and Libya in Table 1, except that the effect of increasing uncertainty in Angola is insignificant and the effect of decreasing uncertainty in Libya is also insignificant at the 5% level. In the case of Algeria, the long-run asymmetric parameters remained statistically insignificant throughout, indicating that the long-run effect of uncertainty on economic growth in this economy is negligible.

For now, we have established some long-run effects of uncertainty in Nigeria, Egypt, Angola and Libya. Subsequently, we assess if those effects are asymmetric. The long-run symmetry tests in Table 1 indicate that there is significant long-run asymmetry in Nigeria and Libya. The pattern of this asymmetry shows that economic growth in these two economies respond more swiftly to declining uncertainty than to increasing uncertainty since the absolute size of the decreasing asymmetric long-run parameter is higher than that of the increasing asymmetric long-run parameter for both countries.

The additive short-run coefficient $\sum_{j=1}^{q-1}\pi_j^{+}$, which captures the effect of rising global uncertainty on economic growth in the short run, has a value of −0.13, which is statistically significant at the 5% level. This finding is similar to Rice (2020), which found that real economic activity in Ireland responds negatively and persistently to policy uncertainty shocks. Indeed, the results indicate that in the short run, the effect of increasing global uncertainty on economic growth is negative and significant in all the countries under study. However, the additive short-run coefficient $\sum_{j=1}^{q-1}\pi_j^{-}$, which shows the response of economic growth to decreasing global uncertainty in the short-run, is positive and significant in Nigeria, Angola, and Libya, while it is negligible in Algeria and Egypt. This means that in the short run, declining uncertainty enhances growth in Nigeria, Angola, and Libya. This finding is consistent with economic expectation since economic agents find it easier to make investment and production decisions in an atmosphere of reduced uncertainty as explained by the theory of real options of Bernanke (1983) and the theory of risk premia of Baker et al. (2014). The symmetry tests also indicate that in the short run, there is significant short-run asymmetry in all the countries. This shows that in the short run, economic growth in these countries respond asymmetrically to global EPU.

Table 1: NARDL Estimation Results with Global EPU

	Nigeria	Algeria	Angola	Egypt	Libya
Long-run Coefficients					
ρ (speed of adjustment)	−0.11***	−0.08***	−0.07**	−0.04**	−0.13***
β^+ (asymmetric parameter)	−0.20**	0.04	−0.22	−0.21**	−0.43***
β^- (asymmetric parameter)	−0.76***	0.29	−1.06**	−0.05**	−0.67*
Capital	0.99***	0.61**	0.50	0.76**	−0.13*
Labour	−4.73**	2.29	−4.34**	3.75*	6.45*
Trade	0.59***	0.73*	0.36	−0.26	1.16
Short-run Coefficients					
$\sum_{j=1}^{q-1}\pi_j^+$ (asymmetric parameter)	−0.13**	−0.04**	−0.10**	−0.02**	−0.17**
$\sum_{j=1}^{q-1}\pi_j^-$ (asymmetric parameter)	0.26***	0.00	0.099**	0.00	0.08**
$\sum_{j=1}^{q-1}\upsilon_j$ (Capital)	0.08***	0.18***	0.51***	0.12***	0.36***
$\sum_{j=1}^{q-1}\tau_j$ (Labour)	−17.08***	−9.43*	0.00	0.14***	−7.79***
$\sum_{j=1}^{q-1}\delta_j$ (Trade)	−0.13**	0.24***	−0.20**	−0.10**	0.00
Symmetry Tests					
$H_0: \beta^+ = \beta^-$	15.29***	1.11	0.74	0.64	13.59***
$H_0: \sum_{j=1}^{q-1}\pi_j^+ = \sum_{j=1}^{q-1}\pi_j^-$	33.19***	5.98**	7.79***	3.99**	6.18**
Diagnostic Checks					
t_{BDM} statistic	−5.21***	−3.04*	−3.23**	−4.18***	−3.30**
Bounds Test (F_{PSS})	18.68***	4.85*	5.75**	10.74***	5.81**
BG Test (NR^2)	1.72	1.64	1.51	1.15	0.52
ARCH Test	0.07	0.01	0.38	0.25	0.01
Durbin-Watson *d* statistic	1.89	2.20	1.93	2.10	1.88
Adjusted R^2	0.86	0.85	0.80	0.82	0.74

Notes: The notations for the estimated coefficients relate to the NARDL model in Equation (7). The BG Test is the Breusch–Godfrey serial correlation test, while the ARCH Test is the standard Heteroskedasticity Test. F_{PSS} is the F-statistic from the bounds-testing approach of Pesaran et al. (2001), while the t_{BDM}-statistic follows Banerjee et al. (1998). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Source: authors' computations

Table 2: NARDL Estimation Results with U.S. EPU

	Nigeria	Algeria	Angola	Egypt	Libya
Long-run Coefficients					
ρ (speed of adjustment)	−0.06***	−0.10***	−0.09**	−0.04**	−0.14***
β^+ (asymmetric parameter)	−0.63***	−0.21**	−0.45*	−0.03*	−0.09
β^- (asymmetric parameter)	−0.81***	0.40***	−0.43*	−0.35*	−0.41
Capital	1.21***	0.43*	0.75**	0.98**	−0.42
Labour	−1.34	9.18***	−1.76	−6.17**	−7.59***
Trade	1.19***	−0.82*	0.47*	0.27*	1.75***
Short-run Coefficients					
$\sum_{j=1}^{q-1}\pi_j^+$ (asymmetric parameter)	0.00	0.00	−0.38***	0.00	−0.13*
$\sum_{j=1}^{q-1}\pi_j^-$ (asymmetric parameter)	0.07***	0.00	0.27**	−0.08**	−0.16*
$\sum_{j=1}^{q-1}\upsilon_j$ (Capital)	0.15***	0.14***	0.43***	0.23***	0.67***
$\sum_{j=1}^{q-1}\tau_j$ (Labour)	−14.37***	12.19**	0.00	0.42***	−15.30***
$\sum_{j=1}^{q-1}\delta_j$ (Trade)	−0.14**	0.54***	−0.23**	−0.06**	0.34*
Symmetry Tests					
$H_0: \beta^+ = \beta^-$	0.51	9.08***	0.00	1.13	2.06
$H_0: \sum_{j=1}^{q-1}\pi_j^+ = \sum_{j=1}^{q-1}\pi_j^-$	17.89***	0.00	17.75***	11.46***	0.08
Diagnostic Checks					
t_{BDM} statistic	−4.40***	−3.96***	−3.56**	−3.69**	−4.22***
Bounds Test (F_{PSS})	12.86***	8.99***	5.92**	6.01**	10.55***
BG Test (NR^2)	2.15	1.97	1.51	1.05	1.07
ARCH Test	0.02	0.77	0.01	1.11	0.06
Durbin-Watson d statistic	1.72	1.87	1.79	2.13	1.92
Adjusted R^2	0.83	0.85	0.77	0.83	0.79

Notes: The notes in Table 1 apply.

Source: authors' computations

Table 3: NARDL Estimation Results with European EPU

	Nigeria	Algeria	Angola	Egypt	Libya
Long-run Coefficients					
ρ (speed of adjustment)	−0.05**	−0.08***	−0.07**	−0.06**	−0.05**
β^+ (asymmetric parameter)	−0.08**	−0.17**	−0.16*	−0.23**	−0.34*
β^- (asymmetric parameter)	−0.45**	−0.07**	−0.13*	−0.42***	−0.65*
Capital	1.27***	0.71***	0.86**	–2.59	−0.92***
Labour	–5.36	–2.38	–1.05	0.84	–0.41
Trade	0.59***	1.04**	0.26	−0.53**	1.77**
Short-run Coefficients					
$\sum_{j=1}^{q-1}\pi_j^+$ (asymmetric parameter)	−0.17**	−0.04**	−0.08**	−0.07**	−0.24***
$\sum_{j=1}^{q-1}\pi_j^-$ (asymmetric parameter)	0.16***	0.00	0.00	−0.05**	0.78***
$\sum_{j=1}^{q-1}\upsilon_j$ (Capital)	0.36***	0.16***	0.45***	0.27***	0.50**
$\sum_{j=1}^{q-1}\tau_j$ (Labour)	–25.16***	0.00	0.00	0.25***	–8.24**
$\sum_{j=1}^{q-1}\delta_j$ (Trade)	−0.07***	0.15***	−0.18*	−0.12***	0.00
Symmetry Tests					
$H_0: \beta^+ = \beta^-$	2.03	0.22	0.00	0.15	2.09
$H_0: \sum_{j=1}^{q-1}\pi_j^+ = \sum_{j=1}^{q-1}\pi_j^-$	29.80***	6.04**	4.61**	0.31	10.29***
Diagnostic Checks					
t_{BDM} statistic	–5.18***	–4.39***	–2.93*	–3.36**	–4.21***
Bounds Test (F_{PSS})	11.96***	8.99***	4.82*	6.88**	7.86***
BG Test (NR^2)	1.33	1.56	1.93	1.58	1.07
ARCH Test	1.68	0.02	0.04	0.29	0.34
Durbin-Watson d statistic	1.90	2.27	1.77	2.16	1.76
Adjusted R^2	0.84	0.84	0.78	0.84	0.73

Notes: The notes in Table 1 apply.

Source: authors' computations

Table 4: NARDL Estimation Results with China EPU

	Nigeria	Algeria	Angola	Egypt	Libya
Long-run Coefficients					
ρ (speed of adjustment)	−0.08***	−0.12***	−0.04**	−0.04**	−0.19***
β^+ (asymmetric parameter)	−0.41***	−0.09	−0.81**	−0.16*	−0.20
β^- (asymmetric parameter)	−0.59***	0.24**	−1.17**	0.05**	0.88***
Capital	1.13***	0.39**	0.39	0.81**	−0.14*
Labour	−0.40	6.52**	−0.43	5.23***	19.66***
Trade	0.83***	0.20	0.68	−0.21	−0.67*
Short-run Coefficients					
$\sum_{j=1}^{q-1}\pi_j^+$ (asymmetric parameter)	−0.50***	0.00	−0.41***	0.00	0.00
$\sum_{j=1}^{q-1}\pi_j^-$ (asymmetric parameter)	0.04**	0.00	0.49***	−0.03***	−0.67**
$\sum_{j=1}^{q-1}\upsilon_j$ (Capital)	0.29***	0.22***	0.59***	0.13***	0.33***
$\sum_{j=1}^{q-1}\tau_j$ (Labour)	−19.27***	−14.82***	−0.22**	0.23***	−7.84***
$\sum_{j=1}^{q-1}\delta_j$ (Trade)	−0.15**	0.24***	0.00	−0.10**	0.00
Symmetry Tests					
H_0: $\beta^+ = \beta^-$	1.43	8.91***	0.27	1.68	22.50***
H_0: $\sum_{j=1}^{q-1}\pi_j^+ = \sum_{j=1}^{q-1}\pi_j^-$	61.19***	0.00	51.83***	8.42***	13.00***
Diagnostic Checks					
t_{BDM} statistic	−5.21***	−4.49***	−3.42**	−3.78**	−5.41***
Bounds Test (F_{PSS})	12.80***	10.90***	5.82**	6.31**	13.34***
BG Test (NR^2)	1.84	1.93	1.07	1.10	1.34
ARCH Test	0.07	0.06	0.29	1.05	0.01
Durbin-Watson d statistic	1.97	2.04	1.95	2.21	1.76
Adjusted R^2	0.83	0.85	0.77	0.83	0.75

Notes: The notes in Table 1 apply.

Source: authors' computations

The results indicate that the effect of capital is positive and significant in all cases in the short run, but in the long run, it is positive and significant only for Nigeria, Algeria, and Egypt. These results suggest that capital accumulation is an important channel for driving growth in these African oil exporters. This is consistent with the Neoclassical growth theory, which emphasized the role of capital accumulation in the economic growth process. It is also consistent with Ogbuabor et al. (2019a), which found that capital is an important driver of growth in the West African Economic and Monetary Union (WAEMU) region. In the case of labour, its role is mainly negative and significant in Nigeria and Libya in the short run, but in the long run, it is negative and significant only in Nigeria and Angola. This is contrary to economic and theoretical expectations. The role of labour remained muted in Algeria, while it is positive and significant in Egypt in the short run. Our findings reinforce the need for improvement in human capital development in these African economies. The results indicate that trade significantly enhances growth in Nigeria and Algeria in the long run and short run, respectively. We also find significant evidence of trade impeding growth in Nigeria, Angola and Egypt in the short run, while its role in Libya remained muted throughout.

At this point, some important patterns have emerged in our results on the response of economic growth to changes in global uncertainty. These patterns can be summed up as follows. First, rising global uncertainty hampers economic growth in Nigeria, Angola, Egypt, and Libya both in the long run and short run; however, this effect is not significant in Angola in the long run. Rising global uncertainty significantly impedes growth in Algeria only in the short run. These findings are consistent with Ogbuabor et al. (2022), which also used the NARDL approach to find that rising uncertainty hampers aggregate and sectoral output growth in Brazil, India, China, and South Africa. Second, declining global uncertainty significantly enhances growth in Nigeria, Angola, and Libya in the short run, but becomes growth retarding in the long run. The effect of declining global uncertainty remained negligible in Algeria and Egypt (in the short run). Third, the results indicate that economic growth responds asymmetrically to global uncertainty, especially in the short run. Lastly, the effect of capital is mainly positive and significant, while the effects of labour and trade are mainly negative and significant, particularly in the short run.

To see how economic growth in the African oil exporters is responding to uncertainty from U.S., we replaced global EPU with U.S. EPU in the underlying model. The results are shown in Table 2. We find that the patterns established for global EPU are still applicable, except that in the short run, the effect of rising U.S. uncertainty is mainly muted and Libya is not significantly affected by U.S. uncertainty. Rising U.S. uncertainty significantly impedes growth only in Angola in the short run. In fact, the results indicate that: (i) rising U.S. uncertainty significantly hampers growth in Nigeria and Algeria in the long run; (ii) declining U.S. uncertainty impedes growth in Egypt and Libya both in the long run and short run, but

for Nigeria and Angola, it significantly enhances growth in the short run and becomes growth retarding in the long run; and (iii) economic growth significantly responds asymmetrically to U.S. uncertainty either in the long run or short run in all the countries except Libya. It is indeed remarkable that Libya is the only country whose economic growth is not significantly affected by U.S. uncertainty. The results further indicate that capital significantly enhances growth in all the countries in the short run and in Nigeria, Angola, and Egypt in the long run; the effect of labour remained mainly negative or muted in Nigeria, Angola, and Libya; trade mainly enhances growth in the long run and impedes growth in the short run, especially in Nigeria, Angola, and Egypt.

To determine how economic growth in the Africa's oil exporters is responding to European EPU, we also used European uncertainty index in place of global EPU in the underlying model. The results are presented in Table 3. Again, we find that the patterns earlier established with global EPU are still prevalent. For instance, rising European uncertainty significantly hampers economic growth in all the countries in the short run; but in the long run, the negative effect is only significant in Nigeria, Algeria, and Egypt. Declining European uncertainty significantly enhances growth in Nigeria and Libya in the short run, but significantly impedes growth in Nigeria, Algeria, and Egypt in the long run. In fact, in the long run, the effect of declining European uncertainty is negative throughout. Furthermore, the results indicate that economic growth responds asymmetrically to European uncertainty in the short run in all cases except Egypt. The results also show that capital significantly enhances growth in all the countries in the short run, and in Nigeria, Algeria and Angola in the long run; the effect of labour remained either negative or muted, except in Egypt where labour significantly enhances growth in the short run; trade mainly impedes growth in the short run, but predominantly enhances growth in the long run.

We also investigated how economic growth in Africa's top oil exporters is responding to China EPU. The results are presented in Table 4. Indeed, the results are consistent with the patterns earlier established with global EPU. We find that rising uncertainty from China significantly hampers economic growth in Nigeria and Angola both in the short run and long run. This finding reflects the rising role of China in Nigeria and Angola, particularly in the last decade (African Union, 2020). We find that declining uncertainty from China significantly enhances growth in Nigeria and Angola in the short run as well as in Algeria, Egypt, and Libya in the long run. However, in the long run, declining uncertainty from China significantly impedes growth in Nigeria and Angola. The results indicate that uncertainty from China does not significantly impede growth in Algeria both in the short run and long run. Furthermore, the results indicate that economic growth responds asymmetrically to uncertainty from China in the long run in Algeria and Libya, but in the short run, asymmetric effect is observed in all the countries except Algeria. The results also show that capital mainly enhances growth both

in the short run and long run; the effect of labour is predominantly negative and significant in the short run, but in the long run, it is positive and significant in Algeria, Egypt and Libya; trade significantly enhances growth in Nigeria (in the long run) and Algeria (in the short run), but significantly impedes growth in Egypt and Nigeria in the short run.

The foregoing results are generally consistent with the dynamics of the economies under investigation. For instance, the Libyan economy has witnessed several wars and sanctions, including oil blockades, especially in the last two decades. However, with significant domestic oil refining activity in the years after 2000, the Libyan economy posted favorable growth rates and one of the highest GDP per capita in Africa. Besides, most of Libya's crude oil exports go to European countries like Italy, Germany, and Spain, as well as China (U.S. Energy Information Administration, 2022). This means that in spite of its challenges, Libya remained resilient and unresponsive to U.S. uncertainty as shown in our results. This is unlike the Nigerian economy, which has weak and poorly developed manufacturing and agricultural sectors, and thus depends largely on imports, including imports of refined petroleum products. These features generally render the Nigerian economy vulnerable to global uncertainties as shown in our results. Angola and Algeria are also highly dependent on oil exports, with the oil sector continuously accounting for at least 90% of export earnings, which in turn constantly renders them vulnerable to uncertainties arising from oil price shocks. Our results aptly reflected these realities. The short-run adverse effect of global EPU on all the countries clearly captured the high level of uncertainty arising from the various global uncertainty-inducing events enumerated in Section 1, especially the Covid-19 pandemic that led to a sharp decline in global oil prices. Our finding that China EPU has insignificant effect on growth in Algeria is consistent with the fact that the major export destinations for Algeria's crude oil are European countries like France, Spain, and Italy (U.S. Energy Information Administration, 2023).

In terms of diagnostic checks, the Breusch-Godfrey serial correlation test and the ARCH test are not statistically significant in all cases, indicating the absence of autocorrelation and heteroskedasticity in the results. The adjusted r-squared indicate that the variations in economic growth have been adequately accounted for in all the models. The bounds test results and the t_{BDM} statistics mainly indicate the presence of equilibrium relationship in the models.

5. Concluding Remarks and Policy Recommendations

This study investigated whether economic growth in African oil exporting economies is responding symmetrically or asymmetrically to changes in global economic uncertainty. The study became necessary following the occurrence of numerous uncertainty-inducing events in recent years that generally resulted in the collapse of oil prices, thereby stimulating crises in oil exporting countries. The NARDL framework and data from Africa's top five oil exporters (Nigeria,

Angola, Algeria, Libya, and Egypt) were used over the period 1997Q1–2021Q4. We find that rising global uncertainty hampers economic growth in Nigeria, Angola, Egypt, and Libya both in the long run and short run, and in Algeria in the short run. We also find that declining global uncertainty significantly enhances growth in Nigeria, Angola, and Libya in the short run, but becomes growth retarding in the long run. Our results indicate that economic growth responds asymmetrically to global uncertainty, especially in the short run. These findings remained qualitatively unchanged when we used U.S., Europe, and China EPUs in the modeling framework, except that economic growth in Libya and Algeria remained unresponsive to U.S. and China EPUs, respectively. Lastly, we find that capital predominantly enhances growth in these economies, while the roles of labour and trade are mainly negative or muted.

The foregoing results have some policy implications. First, the results indicate that there is need for policy reforms to safeguard these top African oil exporters from the adverse effects of global economic uncertainty. Such policy reforms should mainly target the diversification of these economies to reduce their dependencies on oil and insulate them against global economic uncertainty. The diversification efforts should target expanding the export destinations of crude oil and refined petroleum products from these economies, deepening investments in their petroleum downstream sector, and exploring other sectors like manufacturing, agriculture, and tourism. Our results suggest that policymakers should make conscious efforts to keep the policy environment stable, since policy inconsistencies can have adverse effects on economic growth. Furthermore, we recommend that during periods of economic crises, which usually lead to increased global uncertainty, policymakers and leaders in Africa's oil exporters should take steps to safeguard their economies. Policy instruments that will ensure that economic activities do not grind to a halt during such crises periods can be deployed, while policy inconsistencies at such periods should be kept to the barest minimum. Our results also suggest that policymakers and leaders in these African oil exporters should make conscious efforts towards increased human capital development and capital accumulation in order to drive sustainable economic growth. In addition, barriers to trade in these economies should be addressed in order to ensure that trade contributes towards the growth of these economies. Overall, African oil exporters are encouraged to embrace policies that can reinforce their resilience to global economic uncertainty as well as uncertainties originating from their established trade partners like U.S., Europe and China.

In terms of the limitations of this study, some recent studies like Dvouletý et al. (2018), Dvouletý (2018), Henrekson and Sanandaji (2020), and Ogbonna et al. (2022) indicate that control variables like entrepreneurship, institutional quality, and unemployment rate may impact considerably on economic growth in developing countries. These variables were not included in our models. Hence, we recommend that future research should examine the effects of these variables subject to data availability, especially the moderating roles of entrepreneurship

and institutional quality in the uncertainty-economic growth nexus. Other estimators, like the instrumental variable estimator, can also be considered by future research to address the potential problem of endogeneity.

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