Investigating the Pass-Through Effect of Global Oil Price Shock on Domestic Inflation in Selected African Countries

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Abstract

The large-scale war between Russia and Ukraine has increased global oil prices, signaling a new era of macroeconomic shock management for both developed and developing countries. Consequently, this study investigates the pass-through effect of oil prices on domestic inflation in selected African countries in a single estimation framework using the global vector autoregressive (GVAR) estimation technique. To achieve the objective of this study, country-specific data were gathered from twenty-one African countries and four foreign countries selected based on trade relations. The results from our estimation demonstrate that the domestic general price level in African countries responds to global oil price shocks. Also, like any other part of the world, a disparity-like response is observable for African countries. This is tightly connected to whether the country

is a metal-resource-rich, non-rich resource, or oil-rich country. The study thus concludes that positive shocks in the global price of crude oil will worsen the delicate position of the domestic general price level in non-oil-producing African countries. Efforts to minimize the impact of international oil shocks in these countries should center around investment in renewable energy and stabilization of the economy's supply side through proactive and effective macroeconomic management.

Keywords: macroeconomics, GVAR, inflation, Africa

JEL classification: E6, C5, E31, N17

1 Introduction

The emergence of a large-scale war between Russia and Ukraine has increased global oil prices, which signaled a new era of macroeconomic shock management for both developed and developing countries. This shock may be positive or negative depending on whether a country is a net importer or exporter of oil products. Despite a huge production of oil in many African countries, such as Libya, Nigeria, Algeria, Angola, Sudan, Egypt, Congo-Brazzaville, Uganda, Gabon, and Chad, some of them are still net importers of oil products. This may be related to poor investment along the crude oil value chain in many of these countries despite the natural resources, thus making them vulnerable to global oil price shocks. In African countries, just like many other developing countries, exchange rate and oil price channels have been identified as veritable shock transmission channels to macroeconomic variables (Oyelami & Olomola, 2016; Revelli, 2020; Aisen et al., 2021). Consequently, many studies have investigated the pass-through effect of exchange rates on domestic inflation. However, studies are scarce on the pass-through effect of global oil prices on domestic inflation. Investigations like this have become inevitable in light of the current war between Russia and Ukraine with serious consequences on global oil prices.

Price stabilization has been one of the major macroeconomic problems for many African countries, oil-producing and non-oil-producing alike (AfDB, 2017). A good number of African countries have faced unabated double-digit inflation in the last eight years (Sudan, Zimbabwe, South Sudan, Zambia, Angola, Sierra Leone, Nigeria, and Liberia). This has the potential to worsen the precarious poverty situation in many of these countries by eroding a substantial part of households' income and thus reducing their purchasing power. Apart from the immediate effect of oil price hikes through the general consumption of oil as domestic consumables in the form of gas and fuels, the oil price is central to production activities in both developed and developing countries. Thus, an increase in the price of this commodity can filter into the price of other commodities, which will further impact the cost of living of an average household within the economy. This underscores the importance of investigating the contributory effect of drivers of domestic inflation as part of the wider efforts to stem the exacerbating poverty position of many African countries.

In this study, in an attempt to properly investigate the pass-through effect of oil prices on domestic inflation in selected African countries in a single estimation framework, the global vector autoregressive (GVAR) estimation technique is employed. This provides the much-needed opportunity to determine the contributory effect of oil price shocks on domestic inflation in the respective countries and groups of countries under different classifications. The criteria for selection are generally based on whether a country is an oil-rich, metal-resource-rich, or non-rich resource country. More importantly, the model provides for macroeconomic interactions among countries and this gives the necessary framework to build the inherent macroeconomic interdependence into our analysis.

2 Literature Review

Pieces of evidence from previous studies have shown that, directly or indirectly, the oil price pass-through has effects on the domestic price index. However, the impacts can change over time due to the periods of study and country differences. These studies include the work of Sek and Chu (2019), who focused on the effect of the oil price pass-through on domestic prices for both producers and consumers, with a comparison of ten countries each, employing the pooled mean group technique (PMG) and the ARDL model. The analysis showed that oil price is not the core cause of domestic inflation, though there is a significant long-run impact of oil price on domestic inflation with minimal effect in the short run. This was not the case for Pakistan in the work of Khan and Malik (2016). Assessing how the pass-through rate of oil price affects both consumers and producers, using the vector autoregressive model (VAR), the study revealed that the oil price pass-through rate has a more significant impact on the producers than the consumers during a certain period. The study also concluded that there is an asymmetric impact of oil prices on the domestic price index.

In the same vein, exploring the irregularity in exchange rate pass-through to consumer prices in 40 selected countries in sub-Saharan African countries, Kassi et al. (2019) employed the nonlinear autoregressive distributive lag and a dynamic panel technique on data covering 1990Q1 to 2017Q4 for each of the countries under study. The findings revealed an asymmetrical exchange rate pass-through effect on consumer prices for all the countries in the short run. Also, the exchange rate was found to be higher in countries with depreciated local currencies and countries with a fixed exchange rate. Sek (2019) also used linear and nonlinear ARDL modelling to investigate how changes in global oil prices will affect domestic prices in Malaysia. The study revealed that though changes in oil prices will cause domestic inflation, this change will, however, positively affect an increase in production and have a minor effect on an increase in imports and the price of production in the long run.

To assess the pass-through effect of oil shocks on inflation in China, Chen and Yang (2021) employed the TVP-SVAR-SV model and the results showed that different

oil shocks affect inflation at different time horizons. For Zhao et al. (2016), the different oil shocks are determined by the political events in the OPEC countries and the findings revealed a mixed result for the oil shocks in both the short run and long run. This is not different from the study of Abounoori et al. (2014) in Iran. Using the dynamic error correction model, the findings showed both the short-run and long-run impact of oil price pass-through on the consumer price index.

In studying changes in oil prices affecting domestic inflation in 72 selected developed and developing countries from 1970 to 2015, Choi et al. (2018) used an unbalanced panel and the findings showed an asymmetrical effect of oil shocks on domestic inflation.

Exploring the effect of oil price pass-through, Anh et al. (2018) employed the structural vector autoregressive model to examine the exchange rate pass-through for selected member countries of the Association of Southeast Asian Nations (ASEAN). The findings revealed a non-complete pass-through of exchange rate to domestic inflation and the pass-through affected the producers more than the consumers. Similarly, to observe the determinant effect of exchange rate pass-through on the oil price of BRICS (Brazil, Russia, India, China, and South Africa), Salisu et al. (2020) used symmetric and asymmetric models for the study. The results showed that oil price is a key cause of exchange rate pass-through for BRICS. A similar study on oil price pass-through to exchange rates in BRICS was done by Balcilar and Usman (2021). The spillover index and rolling sample analysis were used. The results revealed a low spillover in Russia and the lowest for China.

Assessing the effects of oil price, exchange rate, and domestic price on consumer demand in the tourism sector of Pakistan, Meo et al. (2018) adopted the nonlinear autoregressive distributive lag (NARDL). From the findings of this study, there is an existence of a long-run asymmetric relationship between oil price, exchange rate, domestic price, and consumer demand in the tourism sector in Pakistan. A quantile regression technique was employed to examine the effects of oil price

shocks on Asian exchange rates in a study by Nusair and Olson (2019). The study revealed that global oil price shocks asymmetrically affect exchange rates with varying significance. In the same light, Kurtovic et al. (2021) estimated the asymmetric exchange rate pass-through to domestic prices in the manufacturing sector of Slovenia from 2007M1 to 2017M12. Applying the nonlinear autoregressive distribution lag (NARDL), the study found the existence of a long-run asymmetric pass-through effect of the exchange rate on domestic prices in the manufacturing sector of Slovenia.

The nonlinear autoregressive distribution lag was employed in the study of Baharumshah et al. (2017) in Mexico to examine the exchange rate pass-through to domestic prices in emerging economies. Their findings revealed the existence of volatility in exchange rate pass-through is caused by domestic prices. However, it occurs more in currency depreciation. Ozgur et al. (2021) assessed the pass-through effect of oil prices on domestic inflation in Turkey and employed the FAVAR model. The outcome of the study revealed that oil price pass-through is higher for producers than consumers. Likewise, Arsova (2021) established the existence of a long-run relationship between exchange rate pass-through and consumer prices in nineteen European countries. This is not different from the study of Ha et al. (2020). They used the FAVAR model to examine the exchange rate pass-through to domestic prices in 55 countries. The findings revealed the existence of a relationship between exchange rate pass-through and monetary policy shocks, while global shocks vary across the 55 countries.

To determine the asymmetric effect of oil price on the exchange rate in South Africa, Morocco, Côte d'Ivoire, Kenya, Ghana, and Senegal, Saidu et al. (2021) employed the ARDL and NARDL model on time series data for the periods 1983Q3 to 2018Q4. The results showed an asymmetric long-run and short-run relationship in Côte d'Ivoire, Ghana, and Senegal, while the unstable oil price is the cause of fluctuation in exchange rates. Also using the Bayesian VAR model, An et al. (2021) established, in their study of exchange rate pass-through to domestic inflation in Japan, that both the producer and consumer prices impact

the exchange rate. This is almost the same for Revelli (2020), who investigated the degree of effect of exchange rate pass-through to the consumer price index in Cameroon and Kenya from 1991 to 2013. Employing the structural VAR model, the results showed an incomplete and varying degree of pass-through for both countries in the short run, while in the long run, both countries exhibited the same extent of exchange rate pass-through. Despite this plethora of literature in this area of study, the major gap remains the lack of consensus among the findings and, more importantly, many of the studies focus on countries outside Africa. Also, the current war-induced oil price shock may introduce another dimension to oil prices and domestic inflation dynamics.

In another strand of literature, Choi et al. (2018) investigated oil prices and inflation dynamics in both developed and developing countries. Using panel data, the study established that a 10 percent price change in oil price will affect domestic inflation by 0.4 percent on impact and last for two years in both developed and developing countries. In Africa, Caceres et al. (2013) examined the inflation dynamics in the Central African Economic and Monetary Community (CEMAC) with the use of constructed datasets. The study found that imported commodity price shocks influenced domestic inflation. These two studies and other similar studies by Chang et al. (2023) and Hooker (2002) show how domestic inflation can be influenced by external commodity shocks.

3 Methodology and Data

To empirically estimate the pass-through effect of oil prices on domestic inflation in selected African countries, the global vector autoregressive (GVAR) estimation technique is adopted. The estimation technique as proposed by Pesaran et al. (2004) and extended by Dees et al. (2007) has been widely deployed for investigation in different areas of macroeconomic policy and financial analysis. GVAR as an estimation technique incorporates domestic variables and their foreign counterparts calculated as weighted averages using any variable of interest

such as trade and capital flows among the countries. In addition, global variables such as oil price, global commodity price index, and global metal price index are included to allow for global shock transmissions. Generally, a country-specific VARX*(1, 1) model of GVAR can be specified thus:

$$X_{it} = \delta_{i0} + \delta_{i1}t + \Phi_i X_{i,t-1} + \Lambda_{i0}X^*_{it} + \Lambda_{i1}X^*_{i,t-1} + \Gamma_{i0}d_t + \Gamma_{i1}d_{t-1} + \varepsilon_{it} \qquad (1)$$

In the equation, t represents the linear time trend, Φ is the $k \times k$ matrix of lagged dependent variables $X_{i,t-i}$, and Λ_{i0} and Λ_{i1} represent $k_i \times k_i^*$ matrices of coefficients of foreign variables X^*_{it} and $X^*_{i,t-1}$. Similarly, Γ_{i0} and Γ_{i1} represent $k_j \times k_j^*$ matrices of coefficients of global variables d_t and d_{t-1}. In the model as well, ε_{it} is a $k_1 \times 1$ vector of idiosyncratic shocks, while δ_{i0} and δ_{t1} are the intercept and trend, respectively.

3.1 Data

To achieve the objective of this study, country-specific data were gathered from twenty-one African countries and four foreign countries (United Kingdom, EURO[1], China, and the US) selected based on trade relations. The African countries are Angola, Botswana, Cameroon, Chad, Congo, Congo DR, Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Ghana, Guinea, Kenya, Namibia, Niger, Nigeria, Senegal, South Africa, Tanzania, Uganda, and Zambia. The selection was based on whether a country is an oil-rich, metal-resource-rich, or non-rich resource country. For oil-rich countries, the following countries were selected: Angola, Chad, Congo, Equatorial Guinea, Gabon, Ghana, and Nigeria. Further, the metal-resource-rich group of countries consists of Botswana, Congo DR, Guinea, Namibia, Niger, South Africa, and Zambia. Similarly, the non-rich resource group comprises Cameroon, Côte d'Ivoire, Ethiopia, Kenya, Senegal, Tanzania, and Uganda. For all the selected countries, the following country-specific variables were extracted: real GDP, inflation, real exchange rate, and

1 The term EURO used in this paper refers to all European countries (both EU and non-EU countries).

nominal interest rate from the World Bank's World Development Indicators (WDI) and International Finance Statistics. The data covered the period between the first quarter (Q1) of 1990 and the fourth quarter (Q4) of 2020. In an attempt to create room for the influence of global variables, oil price, global commodity price index, and global metal price constitute a critical part of the model. Thus, the global variables covering the same period as the domestic variables were introduced into the model. Global variables data were sourced from the St. Louis Fed.

4 Empirical Results

Investigating the preliminary time series properties of data employed in the analysis of GVAR is critical just like any other econometric model. However, presenting the unit root test and cointegration test for all the variables in twenty-five countries might just be boring, thus we restricted ourselves to preliminary analyses that are vital to the fitness and stability of GVAR, which are summarily discussed.

4.1 The Weak Exogeneity Test of Foreign Variables

Pesaran et al. (2004) identified three conditions that the model should satisfy for the assumption of weak exogeneity to hold for the star variables: (1) stability of the global model, (2) the use of relatively small weights in the construction of the foreign-specific variables, and (3) cross-sectionally weak correlation of individual country-specific shocks. Usually, these conditions are subjected to a direct test. However, the implications of this assumption are tested by looking at the non-significance of the cointegrating relationship of a country on its foreign star variable. This assumption can be tested by running a regression of the foreign variables in the first differences, including the error correction terms describing the cointegrating relationships as an independent variable. With a standard *F*-test, the joint null hypothesis that the parameters of the error correction terms are not significantly different from zero can be tested (Pesaran et al., 2004).

Generally, GVAR model estimation is based on the assumption that foreign variables are weakly exogenous. Consequently, a weak homogeneity test was performed using the joint significance of the estimated error correction terms for the country-specific foreign variable. This is in line with Dees et al. (2007) and the results are presented in Table 1. The results as presented show *F*-statistics associated with the weak exogeneity tests. For the set of African countries aggregated, the assumption of weak exogeneity of foreign variables is not rejected except for foreign interest in metal-resource-rich countries. This is not a serious violation of the assumption of weak exogeneity, since it is an isolated case, and it does not occur in a country considered to be an anchor country (United States).

4.2 Generalized Impulse Response Functions

Impulse Response Function in GVAR is considered the most empirically employed component of GVAR and this may be due to its amenability to dynamic analyses. It shows how variables respond to shocks in other variables within the model. Particularly, it demonstrates how a specific variable responds to shocks from domestic, foreign, and global variables. In addition, it provides the capability to visualize the extent of shock propagation within the identified quarter or longer period. To achieve the objective of this study, which is to empirically investigate the pass-through effect of oil prices on domestic inflation in selected African countries, we simulated one standard error positive and negative shocks to the global price of crude oil (POIL). Consequently, we observed the responses of domestic inflation to these shocks in African countries and their key trading partners. In Figure 1, the first row shows the responses of African countries grouped into metal-resource-rich, non-rich resource, and oil-rich countries to one standard error positive shock, which is equivalent to (a 0.13 percent) increase in the price of crude oil. The responses of the groups of countries differ.

In metal-resource-rich countries, a positive shock to oil prices will bring about a decrease in domestic price at the point of impact, sharply followed by an increase in the medium term and a decrease in the long term. In non-rich resource countries,

Table 1: *Test for Weak Exogeneity*

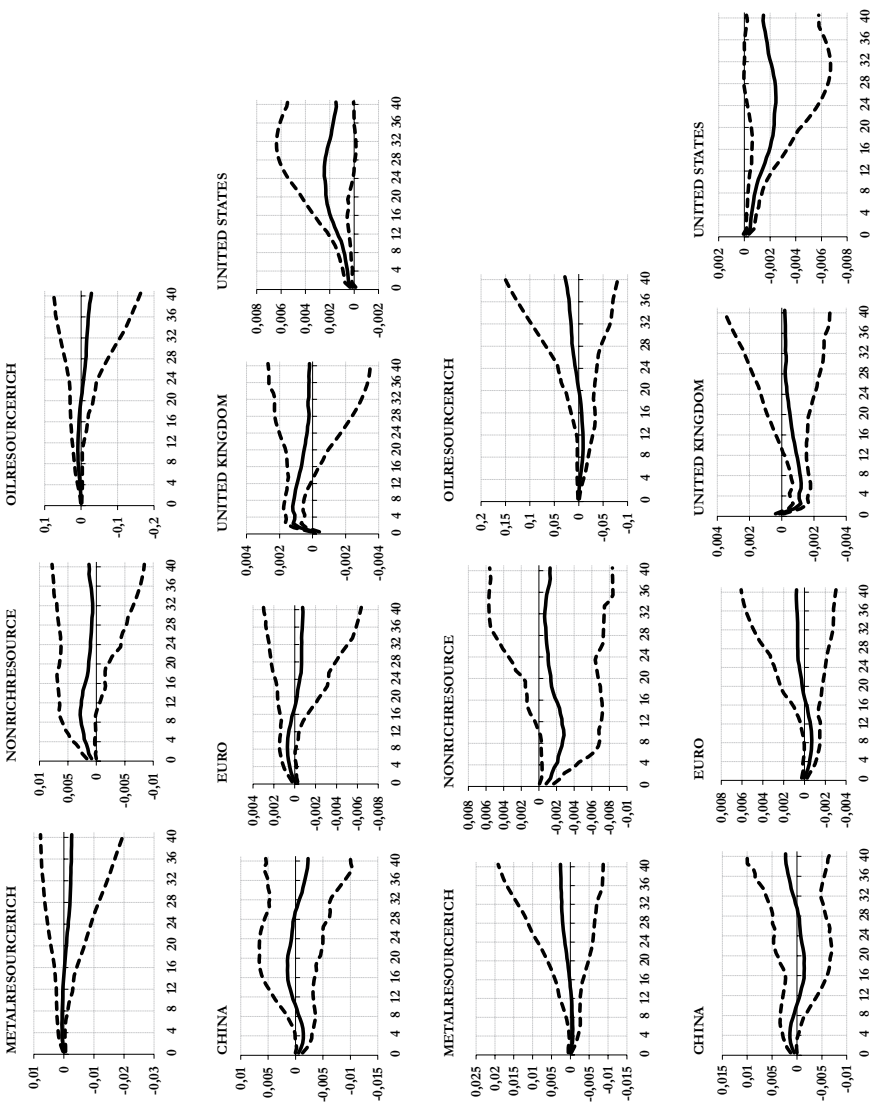
Country	*F*-test	Fcrit_0.05	ys	Dps	eps	rs	Poll	pm	metal
CHINA	*F*(2,107)	3.081193	2.854242	0.106358	0.162609	1.196333	0.048959	0.69136	1.618532
EURO	*F*(3,106)	2.690303	1.396286	1.631284	1.186529	2.574887	0.642987	1.198723	0.571884
METALRESOURCERICH	*F*(1,108)	3.929012	2.073869	8.3783**	0.658057	6.5442**	0.209014	1.002901	0.007565
NONRICHRESOURCE	*F*(2,107)	3.081193	0.910994	0.290648	0.023397	0.001786	1.284866	1.540024	0.080871
OILRESOURCERICH	*F*(2,107)	3.081193	6.5747**	0.291677	0.624397	0.422278	0.014516	0.418309	1.603406
UNITED KINGDOM	*F*(2,107)	3.081193	0.201315	1.70587	1.073964	0.389657	0.461192	0.811574	1.284997
UNITED STATES	*F*(3,106)	2.690303	1.773409	2.273282	2.524063	1.48063	1.555294	0.835024	1.996906

Note: ***, **, * significant at 1%, 5%, and 10%.
Source: Authors' computation.

an increase of 0.13 percent in the price of crude oil as simulated will increase the domestic price by 0.008 percent at the point of impact. This increases steadily in the medium term and decreases minimally in the longer term. However, persistent increases in domestic price levels are observable across the periods in this group of countries. In oil-rich countries, the trajectory is similar to metal-resource-rich countries, that is, a decrease at the point of impact followed by an increase in the medium term and a decrease in the long term. This may suggest that despite the tendency of an increase in the price of crude oil to increase domestic prices in resource-rich countries (metal and oil), governments in these countries have means to operate subsidy regimes to mitigate the pass-through effect of global oil price increase on domestic price. This further suggests that non-rich resource countries in Africa will experience persistent increases in their domestic price level if there is a continuous increase in global oil prices. This particularly makes them more vulnerable to global oil price movement than their counterparts that are resource-rich countries (metal and oil). Similarly, in the second row, it is observable that domestic prices in key African partner countries (China, EURO, UK, and the US) will also experience an increase and this may portend another round of inflation pass-through for African countries through trade.

To establish consistency in this model, we simulated a negative shock of one standard error to the global price of crude oil. The results are presented in the second section of Figure 1, with the first row for African countries and the second row for their key trading partners. The results show that non-rich resource African countries benefit more when there is a decrease in the global price of crude oil as this orchestrates a similar decrease in the domestic price level in this group of countries. The general implication from this is that the domestic general price level in many African countries can be externally influenced. The nature of influence is determined by the availability of resources to mitigate external factors.

Figure 1: *Generalized Impulse Response Functions (Country Group)*



Source: Authors' computation (bootstrap median estimates with 90 percent bootstrap error bounds).

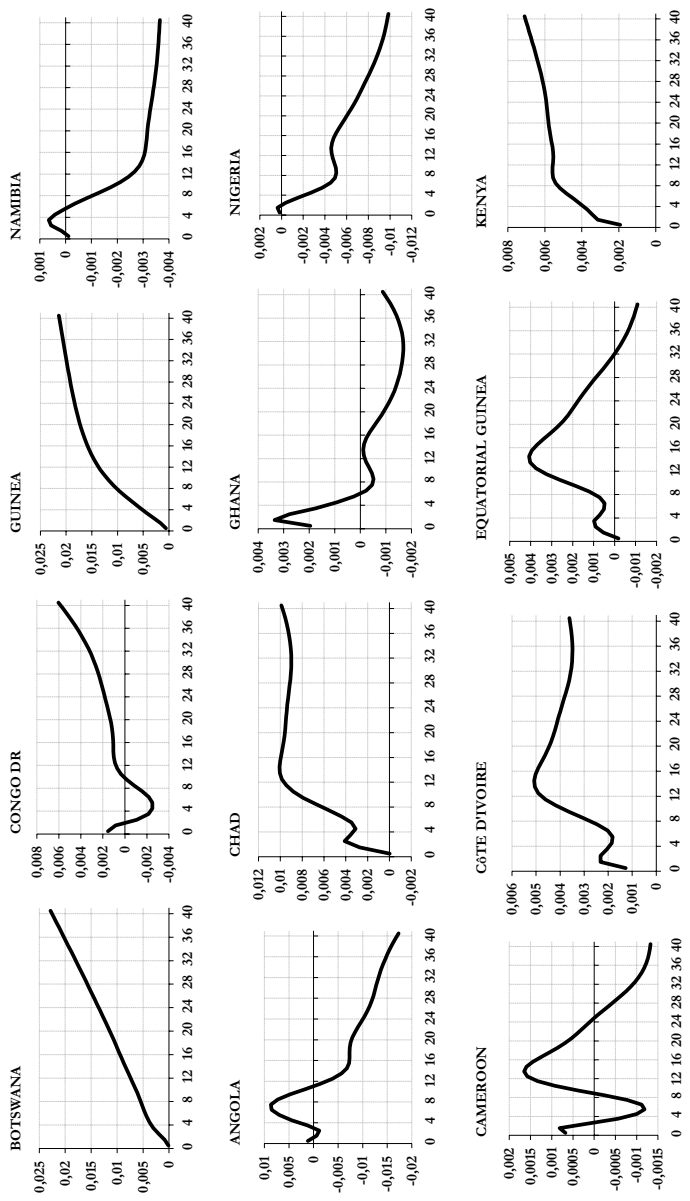
4.3 Country Case Analysis

Figure 2 presents the country-specific analysis of the effect of the positive price shock of crude oil on domestic price levels in selected African countries. Moving away from group analysis, four countries were selected from the groups of metal-resource-rich, oil-rich, and non-rich resource countries. For metal-resource-rich countries, Botswana, Congo DR, Guinea, and Namibia were selected and they are presented in the first row in Figure 2. Similarly, the second row comprises countries from the oil-rich group of African countries (Angola, Chad, Ghana, and Nigeria). The last row comprises countries from the non-rich resource group of African countries (Cameroon, Côte d'Ivoire, Equatorial Guinea, and Kenya).

The results from the impulse response indicate that Botswana will experience a persistent increase in the domestic general price level as a result of a positive shock (increase) in the global price of crude oil. A similar situation is observed in Congo DR and Guinea. However, the situation in Namibia is different, as a positive shock (increase) in the global price of crude oil induces a decrease in the domestic general price level and this may suggest a sound macroeconomic management in the country. Despite this result, there is a general tendency that metal-resource-rich countries in Africa are more likely to experience an increase in the domestic general price level as a result of a positive shock (increase) in the global price of crude oil, especially at the point of impact.

In the case of oil-rich countries, Angola responds with a decrease in the general price level as a result of a positive shock (increase) in global oil prices despite the initial increase. However, the situation in Chad is different. The country witnesses an increase in the domestic general price level as a result of a positive shock (increase) in global prices. This may be somewhat attributable to low activities in the oil and gas sector in the country. This suggests that the country has yet to maximize the benefits associated with oil production. Apart from Chad, other oil-producing countries (Ghana and Nigeria) exhibit a decrease in the general price level as a result of a positive shock (increase) in global prices almost at the point of impact and sustained afterwards. This reflects the general tendency of

Figure 2: *Generalized Impulse Response Functions (Country-Specific)*



Source: Authors' computation (bootstrap median estimates with 90 percent bootstrap error bounds).

oil-producing countries in Africa to be more inclined to experience a decrease in the general price level as a result of a positive shock (increase) in global oil prices.

In the case of non-rich resource countries, the situation in Cameroon looks somewhat unpredictable, but Côte d'Ivoire, Equatorial Guinea, and Kenya show substantial increases in their domestic price as a result of a positive shock (increase) in global oil prices. The increment in domestic price in the case of Côte d'Ivoire and Kenya is persistent, which suggests that there must be deliberate macroeconomic policy efforts to bring the situation under control. Generally, in Africa, it is evident that non-rich resource countries are likely to experience more inflation in their economies as a result of a positive shock (increase) in global oil prices.

5 Conclusions and Policy Recommendations

Generally, scarce empirical efforts were observed in the review of literature on the nexus between global oil prices and domestic inflation in many countries, especially African countries. Thus, apart from this study, many other countries' specific studies may still be required to properly situate this important relationship in many countries. A causal observation of macroeconomic data obtained for estimation for twenty-one African countries indicates some macroeconomic turbulence, especially in the area of growth and price stability. The primary investigation into the stability of the model deployed for the study produced a positive result showing that the model is stable and fit for estimation as proposed. The results from our estimation demonstrate that domestic price in African countries responds to global oil price shocks. Also, just like in any other part of the world, there is a disparity-like response observable in domestic prices for African countries and this is tightly connected to whether the country is a metal-resource-rich, non-rich resource, or oil-rich country. For oil-producing countries, the study produced evidence to demonstrate that a positive shock (increase) in the global oil price tends to bring about a reduction in domestic prices. This may

be attributed to the inclination on the part of many oil-producing countries in Africa to subsidize local oil prices with proceeds from global oil price increases. However, metal-resource-rich countries tend to experience an increase in the domestic general price level as a result of a positive shock in global oil prices, as do non-rich resource countries. The study thus concludes that global positive shocks in the global price of crude oil will worsen the delicate position of the domestic general price level in non-oil-producing African countries. This may further impact their precarious poverty situation.

In the short term, efforts to minimize the impact of the global oil price on the domestic general price level should center around investment in renewable energy in non-oil-producing African countries and this will reduce dependence on fossil fuel consumption. In the long run, concerted efforts should be made to build robust production activity within the economy and stabilize the supply side, in general, to withstand shocks through proactive and effective macroeconomic management.

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