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External shocks and macroeconomic responses in Nigeria: A global VAR approach

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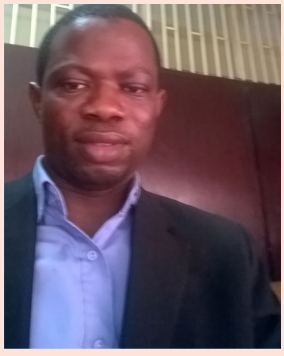
Abstract: This study investigates the macroeconomic responses of Nigerian economy to external shock between 1986 and 2014. Specifically, we examine the effect of oil price shocks and macroeconomic shocks from developed trading partners on Nigerian macroeconomic performances in order to establish pattern of reactions to these shocks in the country. We employ global vector autoregression (GVAR) comprising of the US, EU, China, Japan and Nigeria as the reference country. The adoption as of this method of estimation is necessitated by its capability to effectively model complex high-dimensional system and also offers adequate tools to deal with the curse of dimensionality that can arise from a study of this nature. Having critically examined the econometric properties of our GVAR model, the results from our estimation based on impulse response function show that oil price shocks have direct effect on real gross domestic product and exchange rate in Nigeria but variables like inflation and short-term interest rate do not show immediate response to the shocks. The results also indicate that macroeconomic variables such as short-term interest and inflation show immediate responses to shocks to counterpart variables in developed countries. Based on this, the study concludes that Nigerian economy is vulnerable to external shocks and such shocks are not limited to oil price shocks. Other form of shocks such as growth spillover and financial shocks from developed countries are also relevant in shaping the macroeconomic performances in Nigeria.



Lukman Oyeyinka Oyelami

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PUBLIC INTEREST STATEMENT

The whole world has become a global village as result of increasing globalization in recent time and this provides platform for interaction of macroeconomic variables among the countries of the world, especially trading partners. Apart from this cross-country interaction of macroeconomic variables, there exist global variables that influence macroeconomic variables across economies such as price of crude. Changes in all of these variables at one time or the other create shocks which macroeconomics variables in different economies must respond to. Thus, in this study, we examined the responses of Nigerian economy to vagaries of shocks from trading partners as a result of monetary and fiscal policies and crude oil price. The results show that macroeconomic variables in Nigeria does not only respond to oil price shocks but also respond to macroeconomic shocks from critical trading partners and policy-makers in the country must take this into cognizance.

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Subjects: International Finance; Macroeconomics; Monetary Economics

Keywords: macroeconomics; GVAR; shock and price

1. Introduction

African countries in general are highly dependent on the volatile prices of primary commodities and aid flow Raddatz (2008). Thus, a thorough understanding of macroeconomic fluctuations in African economies requires a good grasp of the impact of external shocks (Kose & Riezman, 2001). The sources of such shocks may include fluctuations in the prices of exported primary commodities, imported capital goods, intermediate inputs and financial shocks, especially the world real interest rate. In Africa, Nigeria is biggest economy though at the global level the country can be considered a small open economy with strong tendency to respond to global macroeconomic shocks. Nigerian is an oil producing country and depends heavily on proceeds from the sales of crude oil to generate foreign earnings to finance her import. Also, the country depends heavily on importation of capital goods and consumable goods from developed and emerging economies of the world to cater for industrial and household needs and as such the economic fortunes of the country is inextricably tied to global economic activities thus making the country vulnerable to external shocks.

External shocks on small, open economies can lead to booms and bursts in employment and output, balance of payment crises and exchange rate instability (Gafar, 1996). Based on this, effective management of external shocks can be considered as one of the key issues in macroeconomic management, especially in developing countries. In Nigeria, studies have examined the effect of oil price shocks on macroeconomics variables in the country (Akpan, 2009; Ayadi, 2005; Olomola & Adejumo, 2006). Unfortunately, most of these studies focused on oil price volatility as the only source of external shocks to the Nigeria economy.

While it might be difficult to contest the fact that oil price change and its volatility as the most important source of shock to Nigerian economy, it is also difficult to ascribe all macroeconomic fluctuation to oil price shocks. As a result of this, it is important to take into consideration the implication of monetary and fiscal policy shocks of important trading partners, especially developed and emerging economies in any serious discussion of external shocks in Nigeria. Thus, it is pertinent to examine other sources of shocks vis-a-vis oil price shocks within the global interdependent framework and more importantly to determine the relative contribution of external and internal shocks to macroeconomic performances in the country and that is what this study seeks to achieve. To expand the scope of previous studies, the study focused on the effect of global variables (oil price and world price of raw materials index) and foreign variables from critical trading partners (the US, Euro, China and Japan). Apart from this general introduction, the rest of the paper is structured as follow. Section two gives general overview of macroeconomic characteristics and performances in Nigeria, section three presents literature review, while the methodology is presented in section four and section five discusses the results and findings.

2. Overview of macroeconomic characteristics and performances in Nigeria

The Nigerian economy has over the year heavily relied on export of crude oil for foreign exchange earnings and revenues. Particularly, sales of crude oil accounts for over 95% of export earnings and about 85% of government revenues. Despite this, the sector only contribution to 17.85% to GDP. According to Energy Information Administration (2009), Nigeria's effective oil production capacity to be around 2.7 million barrels per day. However, the country has continued to import refined petroleum products since the collapse of local refineries in the late 1980s. According to Nigerian National Petroleum Corporation 2014 report, the country imports almost 85% of refined products for local consumption.

Generally, the economy has experienced a persistent growth in output in recent time especially since the advent of democracy. The average growth rate of real output within the reference period stands at 5.33% as against world real output growth of (2.72%). Also, inflation rate in the economy

Figure 1. Author's computation (interest rate).

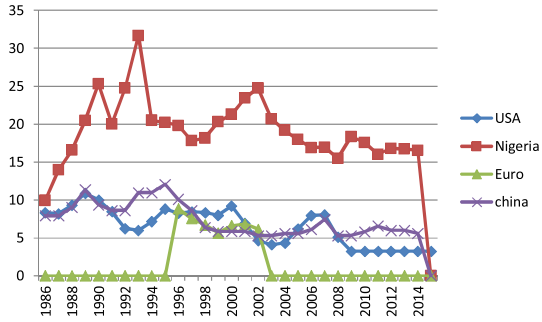
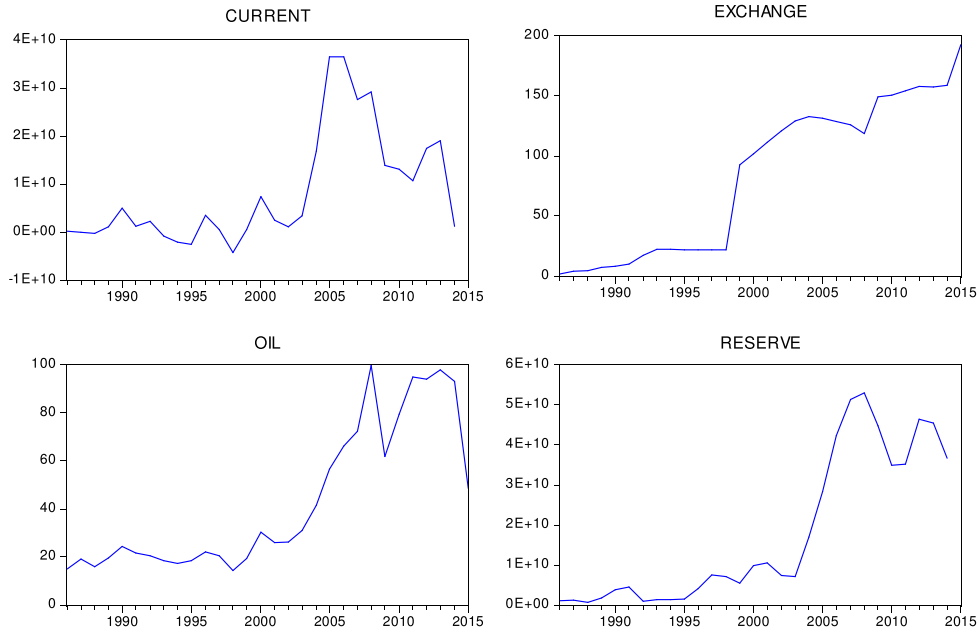


Figure 2. External sector and oil price.



stands at 20.29% as against (4.3) at the global level and (2.0) in the US and (2.1) Euro area which are the most important trading partners before the emergence of China in recent time. The interest rate in the economy is also far above what obtained at global level, but is gradually coming down as shown in Figure 1 though is still above what obtains in other trading economies like China, the US and Euro area and this might altogether questions proper linkage of Nigerian economy to rest of the world. To get a clearer picture, we plotted three macroeconomic variables that can quickly show the level of external dependence of the economy (exchange rate, foreign reserve and current account balance). The three variables are presented in Figure 2 together with oil price.

3. Empirical literature

Many studies in the past focused on effect of oil price shocks on macroeconomic performances of either oil exporting countries or oil importing countries, with little attention to other sources of external shocks. To achieve a comprehensive review of literature, we examined studies that focus on oil price shocks and studies that focus on other sources of external shocks, especially growth spillover.

One of the consequences of recent global financial crisis is the growing number of studies on transmission of business cycle, especially from developed countries such as the US, European Union, Japan, China, India, to other countries majorly the developing ones. Starting with the work of Bayoumi and Swiston (2009), in their study using vector autoregressions of real growth, they

estimated growth spillovers between the US, the Euro area, Japan and an aggregate of smaller countries proxying for global shocks. They found out that the US and global shocks generate significant spillovers in developing countries, but those from the Euro area and Japan are small comparing to the US). Similarly, study by Vamvakidis and Arora (2010) examined the growth spillover of China's economy in recent time employing vector autoregressions approach and they concluded that spillover effects of China's growth have increased in recent decades and long-term spillover effects are also significant and have extended in recent decades beyond Asia and this has serious implication for a developing country like Nigeria that have serious trade relations with china. Array of similar studies by Samake and Yang (2011), Ding and Masha (2012) and Poirson and Weber (2011) came to similar conclusion on growth spillover.

Furthermore, a lot of studies have been carried out on the macroeconomic effect of oil price shocks in oil-producing countries, Nigeria inclusive. Starting with the one of the earlier studies by Hamilton (1983) who argued that several post-war recessions in the US were preceded by oil price shocks other studies by (Ayadi, 2005; Brown & Yücel, 2002; Burbidge & Harrison, 1984; Darby, 1982; Khan & Hampton, 1990) corroborate this assertion in the US or other countries but the major bone of contention is the channels of transmission of the oil price shocks.

Considering the study by Abel and Bernanke (2001), they argue that increases in oil prices cause the general price level to rise. Thus, they consider the price as transmission mechanism through which oil prices influences the macroeconomic situations in a typical oil consuming country. Other theories that focus on the production function corroborate this assertion.

In another study by Finn (2000), he asserts that an oil price shock create a sharp and simultaneous decreases in energy consumption and capital utilization. Thus, the resulting decline in energy consumption permeates through the production function, directly resulting to a decrease in output and labour's marginal product. Consequently, the fall in labour's marginal product brings about reduction in wages, which, in turn, leads to a reduction in the labour supplied.

In addition, there exist array of studies in Nigeria with divergent views on the roles of oil shocks in Nigerian economy. While Ayadi (2005) concludes that oil price shocks does not have significant effect on industrial production, Akpan (2009) submits that there exists a marginal impact of oil price fluctuation on industrial output growth in the country. Olomola and Adejumo (2006) conclude that oil price shocks (positive) do not have a direct effect on output and inflation except via real exchange rate and money supply. Apart from this little controversy in the literature of oil price shock in Nigeria, it also important to investigate how other external shocks affect Nigerian economy, especially the growth spillover from other advanced economies of the world.

4. Research methodology

Generally, in the literature of VAR, three main approaches have been commonly developed for modelling data-sets with a large number of variables which this type of study requires. They are augmented VARs, Bayesian VARs and the global VARs. Out of the three approaches, global VARs has proven to be handier and intuitively appealing (Pesaran and Chudik, 2014). For proper theoretical underlying of GVAR, Pesaran, Schuermann, and Weiner (2004), Dees, di Mauro, Pesaran and Smith (2007) and Pesaran and Chudik (2014) provide a detailed guide.

The global VAR (GVAR) approach, developed in Pesaran et al. (2004) was employed to investigate the dynamic interaction of external shocks and macroeconomic performances in Nigeria. The adoption of this methodology is based on the fact that it provides a relatively simple and effective way of modelling complex high-dimensional system and also offers adequate tools to deal with the curse of dimensionality that can arise from a study of this nature. It also provides opportunity to explore different sources of shocks to an economy and this makes the method suitable for a study of this nature with primary goal of exploring different sources of shocks to Nigerian economy.

Table 1. Description of variables

	Proxy	Measurement	Data source
q_{it}	$RGDP_{it}$	Nominal gross domestic product of country *i* during period *t*	WDI
p_{it}	CPI_{it}	Consumer price index for country *i* at time *t* (with the base year at 100)	WDI
e_{it}	EXH_{it}	Exchange rate of country *i* currency at time *t* in US dollars	IFS
i_{it}	INT_{it}	Nominal short-term interest rate per annum, in per cent	IFS
P_t^W	$WCPI_{it}$	World commodity price index	WTO
P_t^o	$OILP_{it}$	World oil price	IMF
r_{it}	RSV_{it}	Foreign exchange reserves expressed in terms of at least 6 months of imports	IMF

Source: Author's computation.

According to Pesaran et al. (2004), the global VAR model can be developed in two stages. The first stage starts with country-specific VARX* models, which is just VAR models augmented by weakly I (1) variables such as domestic variables and cross-section averages of foreign variables. This is further estimated for each country/region separately. In the second stage, the estimated coefficients from the country/region-specific models are stacked and solved in one big system this referred to as global VAR (Table 1).

Given a country-specific model which is a VARX* model for each individual country/region, in each country VARX* model, country-specific domestic variables are related to deterministic variables, such as time trend, country-specific foreign variables and global variables. Introducing common endogenous variables in country-specific model of the GVAR:

$$q_{it} = \ln(GDP_{it}/CPI_{it})$$

$$p_{it} = \ln(CPI_{it}) - ln(CPI_{i,t-1})$$

$$e_{it} = \ln(E_{it}/CPI_{it})$$

$$i_{it} = \ln(i_{it})$$

$$r_{it} = \ln(r_{it})$$

$$P_t^W = \ln(P_t^W)$$

$$P_t^o = \ln(P_t^o)$$

where GDP_{it} = nominal gross domestic product of country *i* during period *t* (in local currency), CPI_{it} = consumer price index for country *i* at time *t* (with the base year at 100), e_{it} = exchange rate of country *i* currency at time *t* in US dollars, *i* = nominal short-term interest rate per annum, in per cent, r_{it} = foreign exchange reserves, p_t^W = World price of raw materials, p_t^o = World oil price.

In our GVAR model, the US is indexed as country 0 and the exchange rate of the US—E_{0t}—is taken to be 1. In the country-specific model for each country, the endogenous variables are; $(q_{it}, p_{it}, i_{it}\ e_{it}\ f_{it}\ r_{it})$ and $(q_{it}^*\ p_{it}^*\ i_{it}^*\ e_{it}^* f_{it}^* r_{it}^*,)$ represents foreign variables and it contains variables from important trading partners majorly G4 (the US, Euro Zone, Japan and China). In addition to the foreign variables, the GVAR model contained some global variables, namely oil price (p_t^o) and world commodity price index (p_t^W). The GVAR model thus allowed for interactions among the different economies through three separate but interrelated channels: the contemporaneous dependence X_{it} on X_{it}^* and X_{it-m}^*; dependence of the country-specific variables on common global exogenous

variables, $d = (p_t^W \text{ and } p_t^W)$ and nonzero contemporaneous dependence of shocks in country *i* on the shocks in country *j*, measured via the cross-country covariances $\sum_{ij}$. The (weak) exogenous variables in the country-specific VARX* models trade weighted foreign core macrovariables (denoted by an "*"). In most country-specific models, foreign variables are constructed as follows:

$$y_{it}^* = \int_{j=0}^{N} w_{ij} y_{jt},\ \pi_{it}^* = \int_{j=0}^{N} w_{ij} \pi_{jt},\ e_{it}^* = \int_{j=0}^{N} W_{ij} e_{jt}, \tag{1}$$

$$q_{it}^* = \int_{j=0}^{N} w_{ij} q_{jt},\ r_{it}^* = \int_{j=0}^{N} w_{ij} r_{jt} \tag{2}$$

The weights w_{ij} for $i, j = 0, 1, \ldots, N$ are trade weights between country *i* and country *j* which will be computed using the simple average of monthly total trade of a country during the 1990–2013 period. w_{ii} is 0 for any country *i*. Also, for robustness check a time-varying weight will also computed and employed to determine the sensitivity of our model to changing trade relationship between foreign economies and Nigerian economy. Furthermore, It is assumed that variables are I (1), the country-specific exogenous variables are weakly exogenous, and that the parameters of the country-specific models remain stable over time. Also, the order of the individual country VARX*(p_i, q_i) models, where p_i denotes the lag order of endogenous variables (or domestic variables) and q_i denotes the lag order of exogenous variables (or foreign variables) selected. The values of a VARX*(1, 1).Then, for all countries the country-specific VARX*(1, 1) models can be written as follows:

$$X_{it} = \delta_{i0} + \delta_{i1} t + \Phi_i X_{i,t-1} + \Lambda_{i0} X_{it}^* + \Lambda_{i1} X_{i,\,t-1}^* + \Gamma_{i0} d_t + \Gamma_{i1} d_{t-1} + \varepsilon_{it} \tag{3}$$

where *t* is the linear time trend. In line with Pesaran et al. (2004), the country-specific

VARX* models was estimated individually with the restriction that both the foreign and global variables are weakly exogenous I(1) variables. Assuming the weak exogeneity of the foreign variables implies that each country, with the exception of the US, is considered as a small open economy. The global variables, $d = (p_t^o \text{ and } p_t^W)$, were thus treated as endogenous in the US model. The exogeneity assumptions hold in practice depends on the relative sizes of the countries/regions in the global model and on the degree of cross-country dependence of the idiosyncratic shocks, ε_{it} as captured by the cross-covariances $\sum_{ij}$ (Pesaran et al., 2004). The weak exogeneity in the context of co-integrating models implies no long run feedback from X_{it} to X_{it}^* without ruling out lagged short run feedback between the two sets of variables (Dées, Karadeloglou, Kaufmann, & Sánchez, 2007).

Consider the V ARX* model for country-specific model without the global variables and group both the domestic and foreign variables as $Z_{it} = \left(X_{it}', X_{it}^{*'}\right)$. Such country-specific model could be written as follows:

$$A_i Z_{it} = a_{io} + a_{i1} t + B_i Z_{i,\,t-1} + \varepsilon_{it} \tag{4}$$

where $A_i = \left(I_{ki}, \Lambda_{i0}\right)$, $B_i = \left(\Phi_i, \Lambda_{i1}\right)$ and B_i are $K_i \times (K_i + K_i^*)$, and A_i has a full row rank- rank $(A_i) = K_i$.

Collecting all the country-specific variables together in the $K \times 1$ global vector

$$X_{it} = \left(X_{0t}', X_{1t}', \ldots X_{Nt}'\right)', \tag{5}$$

where $k = \sum_{i=0}^{N} K_i$ the total number of the endogenous variables, the country-specific variables can be written as follows:

$$Z_{it} = W_i x_t,\ i = 0, 1, 2, \ldots, N \tag{6}$$

where W_i is a $\left(k_i + k_i^*\right) \times k$ country-specific link matrix constructed on the basis of trade weights that allows the country-specific models to be written in terms of the global variable vector. Substituting Equation (4) in (5), we have

$$A_i W_{ixt} = a_{io} + a_{i1} t + B_i W_{i,x\,t-1} + \varepsilon_{it} \tag{7}$$

Stacking all the equations yields

$$G_{x_t} = a_0 + a_1 t + H x_{t-1} + \varepsilon_{it} \tag{8}$$

where $a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \cdots \\ a_{N0} \end{pmatrix}$, $a_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ \cdots \\ a_{N1} \end{pmatrix}$, $\varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ \varepsilon_{1t} \\ \cdots \\ \varepsilon_{Nt} \end{pmatrix}$ and

$$G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \cdots \\ A_N W_N \end{pmatrix}, \; H = \begin{pmatrix} B_0 W_0 \\ B_1 W_1 \\ \cdots \\ B_N W_N \end{pmatrix}$$

where G is a $k \times k$—dimension matrix with full rank and hence non-singular. As a result, G matrix could be inverted to obtain the GVAR model in its reduced form as follows:

$$X_t = G_{a_0}^{-1} + G_{a_1}^{-1} t + G^{-1} H x_{t-1} + G^{-1} \varepsilon_t \tag{9}$$

The GVAR model in Equation (9) can be solved recursively and the dynamic properties of the model will be analysed using generalized impulse response functions (GIRFs).

5. Definition and measurement of variables

In order to examine the dynamic interaction between external shocks and macroeconomic performances of Nigeria, the study utilized quarterly data over the period of 1990–2014. In all, six endogenous variables were employed for Nigeria. The variables are nominal gross domestic product of each country, consumer price index, exchange rate of country *i* currency at time *t* in US dollars, foreign direct investment as percentage of GDP, nominal short-term interest rate per annum, the real equity price and foreign exchange reserves.

Similarly, seven foreign variables were employed in the model as weak exogenous variables. The variables were nominal gross domestic product of each country, consumer price index, exchange rate of country *i* currency at time *t* in US dollars, nominal short-term interest rate per annum in per cent, the real equity price to GDP and foreign exchange reserves expressed in terms of at least 6 months of imports. Also, two global variables were included in the model, which are oil price and world commodity price index. In the US model, exchange rate was excluded and the global variables are treated as endogenous variables thus making the variables in the model nine. Apart from foreign reserve and foreign direct investment introduced as endogenous variables in Nigerian model, all other macroeconomic and financial variables have been widely employed in similar studies outside Zone Pesaran, Shin, and Smith (2000), Pesaran et al. (2004), Pesaran, Schuermann, and Smith (2009), Han and Ng (2011) and Gurara and Ncube (2013).

6. Econometrics properties of the data

6.1. Unit root tests

Weighted symmetric augmented Dickey–Fuller (WS-ADF) unit root test performed on all the domestic variables. The results indicate that the variables in the models are I (1) and this suggests that while the hypothesis of non-stationarity is rejected at level but accepted at first difference. Thus, it is assumed that all our variables are suitable for estimation of GVAR. The results is included in Appendix 1

Similarly, WS-ADF unit root test performed on all the foreign variables and the results also indicate that the variables are I (1). Also, WS-ADF unit root test was employed to test the stationarity of global variables and the results also indicate that the variables in the models are I (1). The results are presented in Appendices 2 and 3.

*6.2. Choice criteria for selecting the order of the VARX**

For lag order of domestic variables (*p*) and foreign variables (*q*), AIC and SBC were used to select lag order for each country-specific VARX* models. Maximum lag orders of two are allowed for both (*p*) and (*q*). The test results indicate VARX*(2, 1) for all countries-specific VARX* models. The results also contains choice criteria for selecting the order of the VARX* models together with corresponding residual serial correlation F-Statistics. The results are presented in Appendices 4 and 5, respectively.

6.3. Cointegration results

By default, the GVAR program will create the worksheet coint_max&traceVARX. It contains both the trace and maximum eigenvalue statistics used for determining the dimension of the cointegration space of the individual models, as well as the critical values for the trace statistic. Tests are usually conducted using the trace statistic at the 5% level of significance. The critical values for models including weakly exogenous variables are obtained from Mackinnon, Haug and Michelis (1999). In this model, estimate of VARX* was performed for each country in the GVAR system, based on the number of cointergrating vector imposed according to the result of the trace statistics with the lag selected by AIC. The results from cointegrating tests indicate five cointegrating relations for Nigeria and Japan, and four for USA. It indicates three cointegrating relations for China and Euro. The detail of the results are presented in Appendix 6.

7. Model estimation

In line with the objective of the study which is to investigate the macroeconomic responses of Nigerian economy to external shocks, we analysed the time profile of the effects of a one standard shocks to foreign variables on Nigerian macroeconomic variables. We investigated the implications of two different external shocks: one standard error negative shocks to real output in the US, China, Euro and Japan and one standard error positive shocks to global oil price. To achieve our objective, we employed the GIRF proposed in Koop, Pesaran, and Potter (1996), developed further in Pesaran and Shin (1998) for vector error-correcting models. This is because there is no strong a priori information to identify the short run dynamics of our system couple with the fact that large restrictions it would require for proper identification. Also, this prevents the model from being sensitive to ordering of variables and country which is very important in big macroeconomics model.

In panel two of Figure 3, consider the effect of one standard negative shocks to the US real output which is equivalent to a fall of around 0.3–0.4% in real output at the point of impact in the US. The transmission of the shock takes effect in Nigeria decreasing real output in the country by 0.1% at the beginning and average of 0.6% over the period of two years and it is statistically significant for the country. Also, in panel three, one standard negative shocks to Euro real output which amount to a fall of around 0.06% on the average in real output in Euro area over the period of two years. The shock is transmitted to Nigerian economy by decreasing real output by 0.24% immediately and average of 0.36% over the rest of the period. The results also show that the effect of the shock is

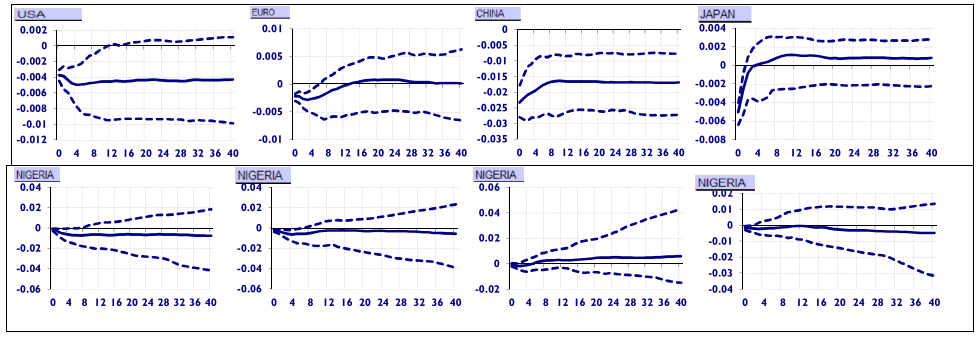


Figure 3. Response of Nigerian economy to one standard error negative shocks to real output in the US, China Euro and Japan.

Source: Author's computation from GVAR (Bootstrap median estimates with 90% bootstrap error bounds).

statistically significant for the country. The implication of this is that if any contractionary policy action either monetary or fiscal is set in motion by the US and Euro authority to combat inflation such that it reduces real output in anyway, the ripple effect of such policy action will resonate in a far distance place like Nigeria. From the results, it is clear that Nigerian economy is more susceptible to shocks from the US and Euro.

Furthermore, in panel two one standard negative shock to real output in China produces a fall of around 0.23% in Chinese economy over a period of two years. The shock is transmitted to Nigerian economy by decreasing the real output in the country by 0.08% at the point of impact and reach its peak in sixteenth quarter (0.3%). Subsequently, it moves around the average of 0.26% over the rest of the period and it seems to have persistent effect on Nigerian economy. Similarly, Nigerian economy response to real output shocks in Japan is inconsistent. It witnesses a decrease of 0.04% at the point of impact and turns positive towards the last quarter.

In Figure 4 panel two presents the responses of Nigeria to one standard error positive shocks to world oil price which is equivalent to about 10–11% increase in price of crude in international market. In line with our expectation, Nigeria that is an oil producing country shows positive response to one standard error positive shocks to world oil price. The Nigerian economy shows immediate response as the real output increases by 0.06% and move up to its peak of 0.45% in fourth quarter and, subsequently, move on the average rate of 0.2% per quarter. The results show that Nigerian economy is very sensitive to oil price shocks and the channel can serve a major link through which global shocks can permeate into the Nigerian Economy. Also, the results demonstrate an economically meaningful interdependence that exists between the Nigerian economy and the global economy.

Similarly, other macroeconomic variables show responses. Inflation does not show immediate response, it only responds in fourth quarter with a slight decrease of 0.02% and assumes expected response in 12th quarter with an increase of 0.03% which seems to be sustained throughout. This suggest that there is no immediate impact of oil price shocks on inflation but it only occurs via other channels possibly exchange rate and government spending. The oil price shocks seem not to have a noticeable impact on domestic interest rate in Nigeria as the variable simply oscillates around a particular point. This might suggests that the variable administratively determined or only influenced by other financial variables both inside and outside Nigerian economy. While the responses

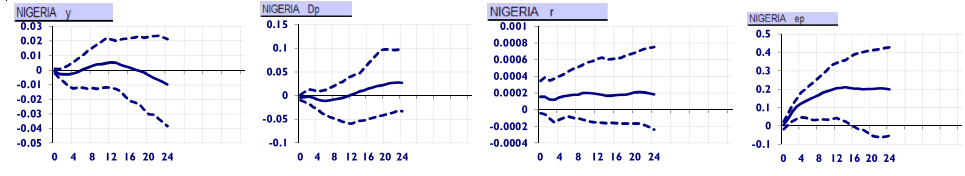


Figure 4. Response of Nigerian macroeconomic variables to one standard error positive shocks to world oil price.

Source: Author's computation from GVAR (Bootstrap median estimates with 90% bootstrap error bounds).

from other macroeconomic variable could be considered mild, the biggest response of oil price shocks is from exchange rate as the variable shows persistent increase before settling down in fifth quarter with a sustained increase of 0.2%.

In Figure 5 panel two, given a policy action in the US that bring about one standard error positive shocks to the US inflation rate which translate to 0.19% increase in inflation rate in the country of origin (the US) and average of 0.07% within the space of two year. This policy shock in the US will have impacts on Nigerian inflation rate. Specifically, such policy action will increase inflation rate in Nigerian economy by 0.01% at point of impact but this will increase astronomically to 0.4 and 0.6% in the next two quarters and average of 0.5% over a period of two years which is far more than what obtains in the country where the policy originated and this suggests a serious inbuilt multiplier within the Nigerian economy and how critical inflation bias policy actions in the US can impact on inflation rate in Nigeria. Similarly, one standard error positive shocks to inflation in Euro translates to 0.1% at the initial stage in the country of origin and average of 0.7% in remaining quarters. The shocks produce quick effect on Nigerian economy by increasing inflation rate in the country by 0.3% come down to 0.1% in the next two quarters but oscillate around the average of 0.5% subsequently.

In another simulation as shown in panel two Figure 5, one standard error positive shocks to inflation in China which translates to 0.7% at initiation and average of 0.33% afterwards can also create a substantial impact on Nigerian inflation. Starting with Nigerian economy responds with an increasing inflation rate of 0.5% as immediate effect and come down in the next two quarters but move up again to an average of 0.5% in subsequent quarters within the space of two years. The simulation of one standard error positive shocks to inflation in Japan in panel two Figure 4 which translate to 0.2% at initiation and average of 0.17% have moderate effect on Nigerian economy. The economy responds with an increasing inflation rate of 0.23% immediately and move up to the peak of 0.9% in sixth quarter and come down to average of 0.1% in subsequent quarters within the space of two years.

Furthermore, Figure 6 shows the response of short-term interest rate in Nigeria to positive shocks of short-term interest rate in the US, Euro, China and Japan. Contrary to expectation, short-term interest rate fails to produce appropriate response to interest shocks in these countries and this suggests that the variable is administratively determined.

8. Conclusion and recommendations

Based on the results obtained, it can be concluded that Nigerian economy is vulnerable external shocks and such shocks is not limited to oil price shocks. Other form of shocks such as growth spillover and financial shocks from developed countries are also relevant in shaping the macroeconomic performances in Nigeria. In addition, while macroeconomic variables such as inflation and short interest rate do not show immediate response to all oil price shocks they show immediate response to shocks to similar variables in developed countries. Thus, it indicates that oil price shock does not

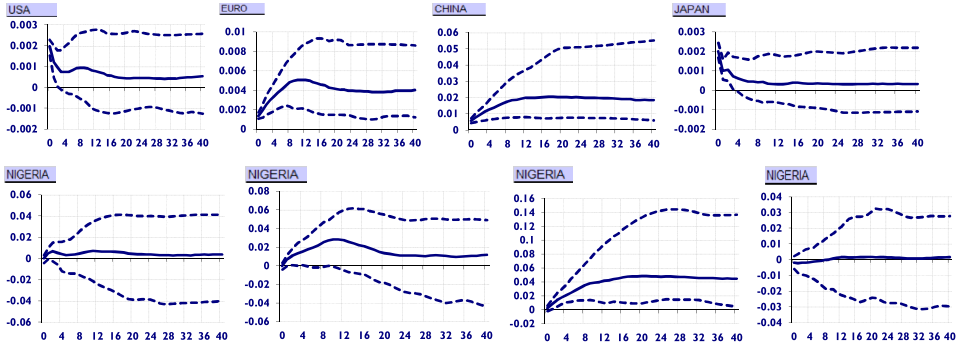


Figure 5. Response of Nigeria inflation to one standard error positive shocks to inflation in the US, China, Euro and Japan.

Source: Author's computation from GVAR (Bootstrap median estimates with 90% bootstrap error bounds).

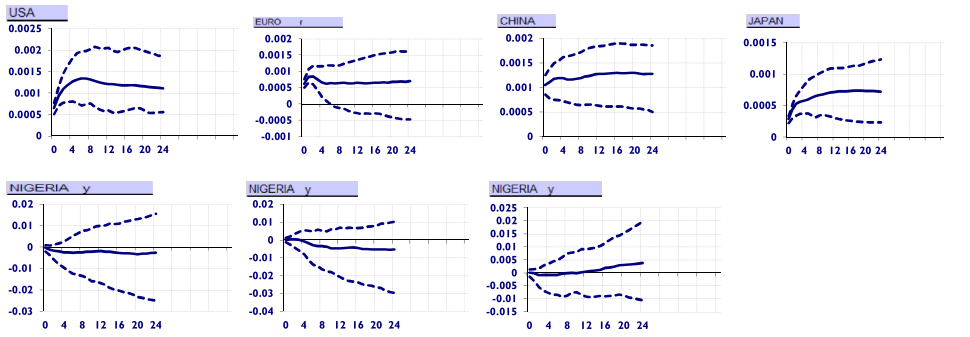


Figure 6. Response of Nigerian short-term interest rate to one standard error positive shocks to short-term interest rate the US, Euro, China and Japan.

Source: Author's computation from GVAR (Bootstrap median estimates with 90% bootstrap error bounds).

have direct effect on all the key macroeconomic variables in Nigeria and it is not the sole determinant of Nigerian macroeconomic outlook. The implication of this is that Nigeria is vulnerable to external shocks from different angles and this poses a serious challenge for macroeconomic management in the country.

As a result of the foregoing conclusion, there is need for a strong macroeconomic team that pay prompt attention to macroeconomic happenings in trading partners countries and design counteracting policies to cushion shocks that might emanate from such macroeconomic events. Also, it is imperative for Nigerian economy to be diversified as to attract multiple trade partners and this will provide opportunity for risk diversification in macroeconomic management.

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Appendix 1.

Unit root tests for the domestic variables at the 5% significance level

Domestic variables	Statistic	Critical value	China	Euro	Japan	Nigeria	USA
y (with trend)	ADF	−3.45	−1.64649	−1.05069	−3.23994	−2.47284	−0.71248
y (with trend)	WS	−3.24	−1.90882	−1.32626	−3.11449	−1.76287	−1.13912
y (no trend)	ADF	−2.89	−0.83566	−1.75573	−1.50521	−1.02966	−1.95318
y (no trend)	WS	−2.55	1.746754	0.296872	−0.04041	1.3224	0.208789
Dy	ADF	−2.89	−8.14828	−4.17265	−6.39563	−4.03518	−3.92642
Dy	WS	−2.55	−8.33843	−4.32141	−6.0188	−3.82592	−3.82971
DDy	ADF	−2.89	−12.6709	−8.3301	−10.9752	−5.07148	−8.1116
DDy	WS	−2.55	−12.969	−8.5163	−10.9405	−5.25166	−8.18034
Dp (with trend)	ADF	−3.45	−3.53619	−3.1141	−4.57156	−1.92188	−1.7391
Dp (with trend)	WS	−3.24	−2.74846	0.40501	1.049537	−0.18162	−0.62837
Dp (no trend)	ADF	−2.89	−3.00197	−3.2998	−4.12484	−3.99579	−2.191
Dp (no trend)	WS	−2.55	−0.97297	0.914771	1.247736	1.305333	1.373796
DDp	ADF	−2.89	−1.9224	−2.54843	−4.30781	−2.60333	−6.17532
DDp	WS	−2.55	−2.17771	−1.90114	−3.22157	−2.71566	−5.93157
DDDp	ADF	−2.89	−5.15091	−10.8349	−12.2597	−11.8518	−10.6703
DDDp	WS	−2.55	−5.32715	−10.8211	−12.3217	−12.1493	−10.7926
eq (with trend)	ADF	−3.45		−2.24595	−1.79277	−2.00208	−1.61272
eq (with trend)	WS	−3.24		−2.29955	−2.08116	−2.30127	−1.59734
eq (no trend)	ADF	−2.89		−1.9812	−1.8809	−1.41829	−1.98244
eq (no trend)	WS	−2.55		−1.10833	−2.12242	0.034843	−0.63574
Deq	ADF	−2.89		−6.26714	−4.36095	−3.85218	−5.5247
Deq	WS	−2.55		−6.33851	−4.51299	−4.02681	−5.69676
DDeq	ADF	−2.89		−11.3199	−9.38279	−7.67174	−10.4692
DDeq	WS	−2.55		−11.5375	−9.63697	−7.85797	−10.6783
ep (with trend)	ADF	−3.45	−3.10697	−2.40589	−2.23371	−1.94447	
ep (with trend)	WS	−3.24	−1.80331	−2.20623	−1.42003	−2.19228	
ep (no trend)	ADF	−2.89	−1.17119	−2.46034	−0.53946	−1.93098	
ep (no trend)	WS	−2.55	−1.23532	−1.835	−0.83102	−2.11754	
Dep	ADF	−2.89	−6.48035	−6.15555	−4.31345	−6.01778	

Domestic variables	Statistic	Critical value	China	Euro	Japan	Nigeria	USA
Dep	WS	−2.55	−6.44709	−6.31601	−4.44723	−6.16364	
DDep	ADF	−2.89	−9.80796	−10.9144	−15.4383	−11.8398	
DDep	WS	−2.55	−9.84699	−11.1324	−15.2312	−12.0688	
r (with trend)	ADF	−3.45	−1.67468	−3.09572	−2.31659	−1.98856	−3.59216
r (with trend)	WS	−3.24	−1.75218	−2.9006	−2.52672	−2.04475	−3.78379
r (no trend)	ADF	−2.89	−1.31001	−1.14562	−2.04911	−1.95617	−2.44109
r (no trend)	WS	−2.55	−1.47965	−1.26696	−2.06293	−0.79699	−2.23453
Dr	ADF	−2.89	−5.65915	−5.001	−3.39392	−7.3293	−4.24762
Dr	WS	−2.55	−4.01334	−4.69962	−3.28645	−7.50711	−3.85382
DDr	ADF	−2.89	−8.79401	−7.55471	−6.88656	−9.58175	−6.26716
DDr	WS	−2.55	−8.8693	−7.76937	−7.08296	−9.35402	−6.20166
fd (with trend)	ADF	−3.45	−2.48099	−3.86829	−3.54236	−4.39022	−5.9948
fd (with trend)	WS	−3.24	−2.66216	−4.08919	−3.5649	−4.23944	−6.17962
fd (no trend)	ADF	−2.89	−1.62352	−3.31118	−2.54837	−3.81716	−3.23376
fd (no trend)	WS	−2.55	−1.75954	−3.35773	−2.77796	−3.06611	−2.97971
Dfd	ADF	−2.89	−4.67849	−3.11717	−3.97152	−5.55042	−5.45163
Dfd	WS	−2.55	−4.83463	−3.32218	−4.03051	−4.83803	−5.62481
DDfd	ADF	−2.89	−4.97932	−7.62985	−7.92346	−4.9154	−5.01149
DDfd	WS	−2.55	−5.183	−7.81492	−8.10857	−5.04376	−5.21222
rv (with trend)	ADF	−3.45	−2.08081	−2.72312	−2.15014	−2.23574	−1.91577
rv (with trend)	WS	−3.24	−1.93816	−2.35823	−2.01773	−1.83882	−1.98189
rv (no trend)	ADF	−2.89	−0.3511	−1.65561	−0.68681	−0.76049	−0.78486
rv (no trend)	WS	−2.55	−0.56727	−1.90847	−1.00628	−1.15308	−1.07182
Drv	ADF	−2.89	−7.10592	−7.90911	−7.70506	−8.13501	−7.0891
Drv	WS	−2.55	−7.28699	−8.14139	−7.88583	−8.36644	−7.26938
DDrv	ADF	−2.89	−9.53708	−10.7598	−10.0854	−11.5423	−9.65531
DDrv	WS	−2.55	−9.79191	−11.0387	−10.3176	−11.8188	−9.90589

Appendix 2.

Unit root tests for the foreign variables at the 5% significance level

Foreign variables	Statistic	Critical value	China	Euro	Japan	Nigeria	USA
ys (with trend)	ADF	−3.45	−1.19115	−2.67124	−1.22587	−0.16077	−1.04353
ys (with trend)	WS	−3.24	−1.38155	−2.52915	−1.59072	−0.68315	−1.39081
ys (no trend)	ADF	−2.89	−1.53621	−1.19235	−1.24058	−1.94081	−1.52096
ys (no trend)	WS	−2.55	0.736806	1.742494	1.66544	1.128745	1.552867
Dys	ADF	−2.89	−4.87231	−6.01701	−7.67606	−5.13202	−6.25643
Dys	WS	−2.55	−4.94343	−6.2218	−7.8336	−5.29104	−6.46768
DDys	ADF	−2.89	−7.20936	−8.71781	−12.3799	−9.94977	−10.6891
DDys	WS	−2.55	−7.39855	−8.95957	−12.6793	−10.2101	−10.9567
Dps (with trend)	ADF	−3.45	−2.74329	−1.35627	−2.95084	−1.63895	−3.11283
Dps (with trend)	WS	−3.24	1.14273	−0.14146	−2.03615	0.230438	−1.59952
Dps (no trend)	ADF	−2.89	−3.88286	−2.95941	−2.5256	−3.31159	−2.84825
Dps (no trend)	WS	−2.55	1.702338	1.076145	−0.20112	1.066354	−0.08018
DDps	ADF	−2.89	−4.05798	−1.91482	−2.1292	−3.58179	−1.89338
DDps	WS	−2.55	−3.18485	−2.18448	−2.38253	−3.52265	−2.13549

Foreign variables	Statistic	Critical value	China	Euro	Japan	Nigeria	USA
DDDps	ADF	−2.89	−10.6633	−9.58246	−7.61321	−9.83265	−8.47646
DDDps	WS	−2.55	−10.7281	−9.78127	−7.75032	−10.0045	−8.61541
eqs (with trend)	ADF	−3.45	−1.78492	−1.53469	−1.75767	−1.79373	−2.1294
eqs (with trend)	WS	−3.24	−1.93547	−1.75186	−1.75507	−1.8265	−2.26036
eqs (no trend)	ADF	−2.89	−1.92911	−1.71482	−1.94455	−1.91275	−1.99113
eqs (no trend)	WS	−2.55	−1.31075	−0.68396	−0.70419	−0.77077	−1.36193
Deqs	ADF	−2.89	−6.0403	−5.82507	−5.77178	−5.84369	−6.22952
Deqs	WS	−2.55	−6.19954	−6.00117	−5.93997	−6.00565	−6.32658
DDeqs	ADF	−2.89	−11.4354	−11.1466	−10.7756	−10.8975	−8.79184
DDeqs	WS	−2.55	−11.6556	−11.3503	−10.9936	−11.1171	−9.03226
eps (with trend)	ADF	−3.45	−1.92542	−1.89825	−3.17379	−3.16944	−2.79248
eps (with trend)	WS	−3.24	−1.26363	−2.18045	−1.67247	−1.65886	−2.25469
eps (no trend)	ADF	−2.89	0.060273	−1.57528	−1.25453	−3.13824	−2.7897
eps (no trend)	WS	−2.55	−0.37771	−1.46396	−1.21546	−1.65999	−2.26593
Deps	ADF	−2.89	−4.2351	−5.9525	−6.39403	−6.38295	−7.47171
Deps	WS	−2.55	−4.32641	−6.12671	−6.3651	−6.56055	−7.64243
DDeps	ADF	−2.89	−17.5777	−8.29352	−9.88521	−9.56826	−10.1483
DDeps	WS	−2.55	−17.401	−8.4605	−9.90561	−9.63205	−10.2723
rs (with trend)	ADF	−3.45	−3.09395	−2.69049	−2.48478	−2.90601	−2.16763
rs (with trend)	WS	−3.24	−3.11019	−2.53329	−2.47349	−2.65554	−1.96842
rs (no trend)	ADF	−2.89	−1.48488	−1.33148	−1.18759	−1.11425	−1.01218
rs (no trend)	WS	−2.55	−1.40348	−1.52957	−1.1895	−1.18279	−1.10937
Drs	ADF	−2.89	−4.03968	−4.61346	−5.49394	−4.10943	−5.04587
Drs	WS	−2.55	−2.91397	−4.41473	−3.10068	−2.65182	−3.63014
DDrs	ADF	−2.89	−6.29488	−6.99473	−8.47367	−6.62539	−8.09486
DDrs	WS	−2.55	−6.30605	−7.14396	−8.37619	−6.47803	−8.17128
fds (with trend)	ADF	−3.45	−4.28364	−3.04828	−4.13303	−4.15254	−3.99468
fds (with trend)	WS	−3.24	−4.49341	−3.11154	−4.3454	−4.36343	−4.21258
fds (no trend)	ADF	−2.89	−2.51838	−1.84885	−2.06469	−2.37478	−3.19873
fds (no trend)	WS	−2.55	−2.45964	−1.94008	−1.81144	−2.17303	−3.26406
Dfds	ADF	−2.89	−3.59218	−5.45739	−4.218	−3.82971	−3.21246
Dfds	WS	−2.55	−3.75588	−5.61554	−4.39602	−4.00453	−3.40966
DDfds	ADF	−2.89	−7.81196	−4.89492	−5.10927	−7.96635	−7.69979
DDfds	WS	−2.55	−7.99813	−5.0995	−5.31433	−8.15409	−7.88462
rvs (with trend)	ADF	−3.45	−2.2345	−1.90547	−2.0451	−2.22957	−2.41961
rvs (with trend)	WS	−3.24	−1.89621	−1.82362	−1.77763	−1.92106	−1.99347
rvs (no trend)	ADF	−2.89	−0.87027	−0.8823	−0.43063	−0.8969	−1.02623
rvs (no trend)	WS	−2.55	−1.2395	−1.24521	−0.80105	−1.26187	−1.37685
Drvs	ADF	−2.89	−8.13158	−8.01205	−7.5071	−8.18687	−7.5707
Drvs	WS	−2.55	−8.31815	−8.1797	−7.69046	−8.37576	−7.79816
DDrvs	ADF	−2.89	−10.6095	−10.7847	−10.1062	−10.6833	−10.639
DDrvs	WS	−2.55	−10.8817	−11.057	−10.3704	−10.9623	−10.9139

Appendix 3.

Unit root tests for the global variables at the 5% significance level

Global variables	Test	Critical value	Statistic
poil (with trend)	ADF	−3.45	−2.65371
poil (with trend)	WS	−3.24	−1.51367
poil (no trend)	ADF	−2.89	−0.83716
poil (no trend)	WS	−2.55	−1.24184
Dpoil	ADF	−2.89	−4.77851
Dpoil	WS	−2.55	−5.01184
DDpoil	ADF	−2.89	−8.49038
Dpoil	WS	−2.55	−8.67356
pmat (with trend)	ADF	−3.45	−2.48389
pmat (with trend)	WS	−3.24	−2.68366
pmat (no trend)	ADF	−2.89	−1.86129
pmat (no trend)	WS	−2.55	−2.0775
Dpmat	ADF	−2.89	−7.26762
Dpmat	WS	−2.55	−7.44684
DDpmat	ADF	−2.89	−10.0536
Dpmat	WS	−2.55	−10.2226

Appendix 4.

VARX* order of individual models

	p	*q*
China	2	1
Euro	2	1
Japan	2	1
Nigeria	2	1
USA	2	1

Source: *p*: lag order of domestic variables, *q*: lag order of foreign variables.

Appendix 5.

Country	China	Euro	Japan	Nigeria	USA
Detailed cointegration results for the maximum eigenvalue statistic at the 5% significance level					
# endogenous variables	6	7	7	7	6
# foreign (star) variables	8	8	8	8	7
$r = 0$	78.9202	122.1013	103.9452	121.0383	79.06888
$r = 1$	66.60998	74.22136	80.66769	86.32578	64.42501
$r = 2$	57.48288	67.20414	58.37289	63.10249	61.12445
$r = 3$	35.04075	50.76612	50.46779	54.35957	41.0228
$r = 4$	27.99926	38.36555	45.25905	48.97911	30.78174
$r = 5$	24.58472	26.53633	35.64912	30.51452	21.05921
$r = 6$		15.84632	24.96751	21.54006	

Country	China	Euro	Japan	Nigeria	USA
Detailed cointegration results for the trace statistic at the 5% significance level					
# endogenous variables	6	7	7	7	6
# foreign (star) variables	8	8	8	8	7
$r = 0$	290.6378	395.0411	399.3292	425.8598	297.4821
$r = 1$	211.7176	272.9398	295.384	304.8215	218.4132
$r = 2$	145.1076	198.7185	214.7163	218.4957	153.9882
$r = 3$	87.62474	131.5143	156.3435	155.3933	92.86375
$r = 4$	52.58399	80.7482	105.8757	101.0337	51.84095
$r = 5$	24.58472	42.38265	60.61662	52.05458	21.05921
$r = 6$		15.84632	24.96751	21.54006	
Critical values for trace statistic at the 5% significance level (MacKinnon, Haug, & Michelis, 1999)					
# endogenous variables	6	7	7	7	6
# foreign (star) variables	8	8	8	8	7
$r = 0$	223.88	273.21	273.21	273.21	210.8
$r = 1$	178.46	223.88	223.88	223.88	167.47
$r = 2$	136.94	178.46	178.46	178.46	128
$r = 3$	99.12	136.94	136.94	136.94	92.29
$r = 4$	64.91	99.12	99.12	99.12	60.22
$r = 5$	33.87	64.91	64.91	64.91	31.35
$r = 6$		33.87	33.87	33.87	

Appendix 6.

Choice criteria for selecting the order of the VARX* models together with corresponding residual serial correlation F-statistics

	p	*q*	AIC	SBC	logLik			Fcrit_0.05	*q*	*p*	*e*	*i*	*f*	*R*
China	1	1	1684.746	1498.629	1828.746		F(4,70)	2.502656	8.189651	1.564907		2.462695	9.183939	6.135149
China	2	1	1688.599	1455.952	1868.599		F(4,64)	2.515318	6.773907	2.511887		4.804452	12.69236	8.063808
Euro	1	1	2108.48	1882.296	2283.48		F(4,69)	2.504609	3.694212	2.770983	2.055817	4.710312	4.519165	1.885145
Euro	2	1	2149.579	1860.063	2373.579		F(4,62)	2.520101	1.264306	3.200754	2.885382	1.420919	6.268444	2.963375
Japan	1	1	2079	1852.816	2254		F(4,69)	2.504609	2.326133	2.105789	3.623013	10.14303	3.891195	3.83714
Japan	2	1	2120.381	1830.864	2344.381		F(4,62)	2.520101	3.014501	1.563412	8.332579	4.695485	2.778412	1.176284
Nigeria	1	1	1364.221	1138.037	1539.221		F(4,69)	2.504609	12.05326	7.611088	4.156059	1.982354	6.000239	3.085369
Nigeria	2	1	1417.941	1128.425	1641.941		F(4,62)	2.520101	12.8129	3.498573	4.47379	3.134451	8.969576	1.06387
USA	1	1	1853.366	1682.758	1985.366		F(4,72)	2.498919	0.557548	4.84741	3.685563	4.627759	14.39122	2.771737
USA	2	1	1866.493	1649.356	2034.493		F(4,66)	2.510833	0.836394	3.087703	4.148998	0.853242	17.78231	1.341592

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