Trade Shock Transmission: A Study of Selected African Economies, the BRIC and the Rest of the Global Economy

Ekeocha, Patterson C. PhD
Central Bank of Nigeria, Research Department
p.ekeocha04@fulbrightmail.org; pcekeocha@cbn.gov.ng
+2348035487968

&

Jonathan E. **Ogbuabor PhD**
Department of Economics, University of Nigeria, Nsukka, Nigeria
jonathan.ogbuabor@unn.edu.ng
+2348035077722

Abstract

This study investigated trade shock transmission between Africa, the BRIC and the rest of the global economy with a view to understanding the likely disposition of African economies towards trade shocks. The study extended the network approach of Diebold and Yilmaz (2009) by constructing generalized trade linkage measures at various degrees of aggregation. The results indicate that the trade linkage between Africa and the rest of the global economy is quite substantial, with the total trade linkage index having an average value of 87%. We find also that China, USA, UK, Japan, EU, and Canada dominate Africa's trade and therefore have the potential to spread trade shocks to it. The results further indicate that apart from the BRIC, other regional trading blocs such as Asia, the Americas, and Europe play influential roles in Africa's trade. Overall, the findings show that African economies are predominantly net receivers of trade shocks originating from the aforementioned dominant sources. The study therefore concludes that the patterns of cross-country trade shock spillovers obtained in this study would likely influence Africa's move from globalization to regional integration or multi-polarity in the years to come.

Keywords: Globalization; Trade Shock Transmission; Global VAR; Africa; the Global Economy

JEL Classification: F42; F43; C32; N77; N70

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Introduction

Intra-Africa's trade performance (import and export) is very infinitesimal compared to the rest of the world (African Trade Statistics Yearbook 2017). The same trend reflects the characteristics of African countries intra and extra - African trade. For instance, Nigeria's Intra-Africa import trade is far below its trade with the rest of the world from 2010 – 2016. While Nigeria's import from the rest of the world averaged US$42,642.77 million or 94.8 per cent during the same period, it was US$2,293.85 million or 5.2 per cent within Africa. Similarly, Nigeria's intra-African export trade averaged US$10,465.65 million or 12.0 per cent of total export during 2010 to 2016, while the export to the rest of the world averaged US$81,240.03 or 88.0 per cent of total export. The low intra-Africa trade may have necessitated the move for Africa's trade integration to fast-track its development. Little wonder, Free Trade Agreements (FTAs) have become important elements in economic integration amongst most countries of the world. It provides avenues for nations to enter into bilateral or regional trade agreements to eliminate tariffs and non-tariff barriers to trade among member countries. African is currently establishing the African Continental Free Trade Area (AfCFTA) treaty to create a single continental market for goods and services in member nations of the African Union (AU), with free movement of business persons and investments using a single currency.

The AfCFTA is gathering momentum because globalization remains a contentious subject due to the mixed benefits and opportunities it presents to participating countries. In particular, it makes countries vulnerable to external shocks. Granted that shocks often occur, and granted further that African countries largely have significant trade linkage with the rest of the world, it is important to model the sources of foreign influence on domestic economies, particularly the BRIC (Brazil, Russia, India, and China) economies, whose trade linkage with Africa is enormous. In fact, not only does Africa trade significantly with the BRIC countries, the latter also represent a model of economic development exemplified by strong economic growth and an enormous capacity to compete in a globalized world. Besides, trade linkage has been adjudged an important feature of global economic integration between countries. However, following literature, there is no common view on whether intense global trade linkages would lead to more or less business cycle harmonization. Again, World Bank's Global Economic Prospects report, posits that growth in emerging market and developing economies is expected to remain flat in 2019. Growth in many other economies is also anticipated to decelerate; with risks growing that growth could be even weaker than anticipated. This phenomenon may invariably worsen the growth prospects of developing economies in the event of trade shocks.

Broadly, this study therefore examines trade shock propagation between Africa, the BRIC economies and the rest of the global economy. Specifically, the study seeks to: (i) measure the degree of trade linkage between Africa, the BRIC and the rest of the global economy; (ii) determine the BRIC countries and other countries in the rest of the world that are dominating Africa's trade and therefore have the potential to spread trade shocks to Africa and thus minimize its growth (iii) determine the African economies that are most susceptible to trade shocks originating from the BRIC countries and the rest of the global economy; (iv) determine other trade blocs outside the BRIC that exert dominant influence on Africa and therefore have the prospects of spreading trade shocks to it.

To achieve the above objectives, the paper employs the normalized generalized forecast error variance decompositions (NGFEVDs) distilled from an underlying global vector autoregressive model (Global VAR) to build measures of trade linkage and shocks transmission between Africa, the BRICS countries and the rest of the global economy over the period 1970Q1 – 2017Q4. The underlying model is estimated using the total trade statistics of the countries. The time series properties of the data are examined using the Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests, as well as the Johansen cointegration test, in order to determine the form of the model to be estimated. If the variables are overwhelmingly stationary at levels, then a basic VAR would be appropriate. However, if the variables are nonstationary, then a VAR in first differences becomes tenable in the absence of equilibrium relationship, otherwise a vector error correction model (VECM) would be estimated. A key innovation in this study would be the use of the NGFEVDs to build various measures of trade linkages between Africa and the rest of the global economy at different levels of aggregation. The generalized nature of the FEVDs means that they would be invariant to the reordering of the variables in the system. The choice of the global VAR framework is mainly due to its ability to explicitly model the source of foreign influences on domestic economies in Africa and the contributions of these domestic economies to the rest of the world in a transparent and coherent manner. It allows for the impact of shocks to be consistently quantified, aggregated and assessed so that interactions between countries/regions can be analyzed. Simply put, our proposed framework measures both the direction and the strength of linkages among entities in the system, while identifying systemically important or vulnerable entities within the system. Several studies in the literature have exploited this framework in the study of macroeconomic linkages with great success. Examples include: Pesaran, Schuermann and Weiner (2004); Dees, di Mauro, Pesaran and Smith (2007); Dees, Holly, Pesaran and Smith (2007); and more recently Greenwood-Nimmo, Nguyen and Shin (2015). We are adopting same framework using some selected African economies and since the data for the study are quarterly, the measures of trade linkages would be computed over a 24-period horizon, so that the long-run results are better captured.

The rationale for assessing the impact of trade between Africa, the BRIC and the rest of the world is to bring to the fore the potential trade shock impact between Africa and other trade blocks with which it has significant trade linkages, even as it makes concerted efforts towards signing of the African Continental Free Trade Area (AfCFTA) through a treaty by all the countries concerned. Nigeria, which is Africa's largest economy by size of GDP, is currently understudying the tenets of AfCFTA treaty preparatory to signing it. The AfCFTA is to create a single continental market for goods and services in member nations of the African Union (AU), with free movement of business persons and investments using a single currency. The AfCFTA is intended to be the external cordon protecting the African countries' domestic markets. Thus, while AU member states are signing the treaty, it is important to be aware of the potential trade shocks that may emanate from the significant trade linkages between Africa and the rest of the world.

The rest of the paper is organized as follows. Section 2 undertakes a brief review of relevant literature. Section 3 presents the data and methodology, detailing some preliminary data analysis, while Section 4 discusses the empirical results. Section 5 concludes the study and provides some policy implications that the patterns of cross-country trade shock spillovers obtained in this study would likely influence Africa's move from globalization to regional integration or multi-polarity in the years to come.

2. Brief Review of Literature

The impact of trade shocks in large advanced countries on emerging market economies — dubbed spillovers — is hotly debated in global and national policy circles. Kose and Reizman (1999) examined the role of external shocks in explaining macroeconomic fluctuations in African countries. They constructed a quantitative, stochastic, dynamic, multi-sector equilibrium model of a small open economy calibrated to represent a typical African economy. In their framework, external shocks consist of trade shocks, modeled as fluctuations in the prices of exported primary commodities, imported capital goods and intermediate inputs, and a financial shock, modeled as fluctuations in the world real interest rate. Results from their analysis indicated that while trade shocks accounted for roughly 45 percent of economic fluctuations in aggregate output, financial shocks play only a minor role. They also found that adverse trade shocks induce prolonged recessions.

Çakir and Kabundi (2011) examined the trade linkages between South Africa and the BRIC (Brazil, Russia, India, and China) countries. They applied the global vector autoregressive model (global VAR) to investigate the degree of trade linkages and shock transmission between South Africa and the BRIC countries over the period 1995Q1-2009Q4. The model contained 32 countries and had two different estimations: the first one consists of 24 countries and one region, with the 8 countries in the euro area treated as a single economy; and the second estimation contains 20 countries and two regions, with the BRIC and the euro area countries respectively treated as a single economy. The results suggest that trade linkages exist between our focus economies; however the magnitude differs between countries. Shocks from each BRIC country are shown to have considerable impact on South African real imports and output.

Greenwood-Nimmo, et al. (2015) developed a technique to evaluate macroeconomic connectedness among entities in sophisticated multi-country and global macroeconomic models. Their methodology is highly adaptable and may be applied to any model with an approximate VAR representation. They applied their technique to a global vector autoregressive model containing 169 macroeconomic and financial variables for 25 countries. They derived vivid representations of the connectedness of the system and found that the US, the Eurozone and the crude oil market exert a dominant influence over conditions in the global macroeconomy and that China and Brazil are also globally significant economies. Recursive analysis over the period of the global financial crisis shows that shocks to global equity markets are rapidly and forcefully transmitted to real trade flows and real GDP.

Pesaran, et al., (2004) posit that financial institutions are ultimately exposed to macroeconomic fluctuations in the global economy and thus they built a compact global model capable of generating forecasts for a core set of macroeconomic factors (or variables) across a number of countries. Their model explicitly allows for the interdependencies that exist between national and international factors. Individual region-specific vector error-correcting models were estimated in which the domestic variables were related to corresponding foreign variables constructed exclusively to match the international trade pattern of the country under consideration. The individual country models were then linked in a consistent and cohesive manner to generate forecasts for all of the variables in the world economy simultaneously. Their global model was estimated for 25 countries grouped into 11 regions using quarterly data over 1979Q1–1999Q1. The degree of regional interdependencies was investigated via generalized impulse responses where the effects of shocks to a given variable in a given country on the rest of the world were provided. The model was then used to investigate the effects of various global risk scenarios on a bank's loan portfolio.

Dees, et al., (2007) presented a quarterly global model combining individual country vector error-correcting models in which the domestic variables were related to the country-specific foreign variables. Their global VAR (GVAR) model was estimated for 26 countries, the Euro area being treated as a single economy, over the period 1979–2003. They provided a theoretical framework where the GVAR was derived as an approximation to a global unobserved common factor model. Using the average pair-wise cross-section error correlations, their GVAR approach was shown to be quite effective in dealing with the common factor interdependencies and international co-movements of business cycles. They developed a sieve bootstrap procedure for simulation of the GVAR as a whole, which is then used in testing the structural stability of the parameters, and for establishing bootstrap confidence bounds for the impulse responses. Finally, in addition to generalized impulse responses, their paper considered the use of the GVAR for 'structural' impulse response analysis with focus on external shocks for the Euro area economy, particularly in response to shocks to the US.

In another study, Dees, et al., (2007) focused on testing the long run macroeconomic relations for interest rates, equity, prices and exchange rates suggested by arbitrage in financial and goods markets. They used the global vector autoregressive (GVAR) model to test for long run restrictions in each country/region conditioning on the rest of the world. They employed Bootstrapping to compute both the empirical distribution of the impulse responses and the log-likelihood ratio statistic for over-identifying restrictions. Their paper also examined the speed with which adjustments to the long run relations would take place via the persistence profiles. They found strong evidence in favour of the uncovered interest parity (UIP) and to a lesser extent the Fisher equation across a number of countries, but their results for the purchasing power parity (PPP) were much weaker. Also the transmission of shocks and subsequent adjustments in financial markets were much faster than those in goods markets.

Ogbuabor et al., (2016) examined the real and financial connectedness of selected African economies with the global economy using a network approach. They found that the connectedness of African economies with the global economy is quite sizable, with the global financial crisis increasing the connectedness measures above their pre-crisis levels. Their results show that U.S., EU and Canada dominate Africa’s equity markets, while China, India and Japan dominate Africa’s real activities. Their results suggest that African economies are predominantly small open economies, deeply interconnected but systemically unimportant and vulnerable to headwinds emanating from the dominant economies in the overall global economy.

Lubik and Teo (2003) found that world interest rate shocks are the main driving forces of business cycles in small open economies while terms of trade shocks are not. Thus, they challenged the existing results on the contribution of terms of trade and world interest rate shocks to output fluctuations in small open economies which had been found to range from less than 10 per cent to almost 90 per cent. They argue that an identification problems lies at the heart of existing vastly different results. They overcame this by estimating a DSGE model using a structural Bayesian estimation approach applying their methodology to five developed and developing economies. The approach enabled them to efficiently exploit cross-equation restrictions implied by the structural model.

Huidrom et al., (2017) provide empirical estimates of the cross border spillovers from Seven largest emerging market economies (China, India, Brazil, Russia, Mexico, Indonesia, and Turkey) using a Bayesian vector autoregression model. Their results indicate that; first, spillovers from EM7 are sizeable: a 1 percentage point increase in EM7 growth is associated with a 0.9 percentage point increase in growth in other emerging and frontier markets and a 0.6 percentage point increase in world growth at the end of three years. Second, sizeable as they are spillovers from EM7 are still smaller than those from G7 countries (Group of Seven of advanced economies). Specifically, growth in other emerging and frontier markets, and the global economy would increase by one-half to three times more due to a similarly sized increase in G7 growth. Third, among the EM7, spillovers from China are the largest and permeate globally. Their study was based on the phenomenon that their growth could have significant cross-border spillovers based on their size and integration. The seven largest emerging market economies - China, India, Brazil, Russia, Mexico, Indonesia, and Turkey - was adjudged to constitute more than one-quarter of global output and more than half of global output growth during 2010–15.

This study contributes to this emerging literature in several ways. First, it quantifies the degree of trade linkage between Africa, the BRIC and the rest of the global economy. Two, apart from exposing the patterns of trade shock spillovers between Africa and the rest of the world using total trade statistics, this study also disaggregates the trade shock spillovers using exports and imports statistics. This provides deeper insights into the trade linkages between Africa and the rest of the world. Besides, the study extended the empirical method by constructing trade linkage measures in a coherent and transparent manner for ease of replication.

3. Data and Methodology

The data for this study consists of the log of exports, imports, and total trade for the period 1990Q1-2016Q4. The choice of this period is based on data availability for some of the African economies and for Russia whose trade data in the World Development Indicators started in 1990. The BRICS economies in this study are Brazil, Russia, India, China, and South Africa. The selected African economies included in this study are DR Congo, Egypt, Ghana, Morocco, Nigeria, Tanzania, and Tunisia; while the rest of the global economy is accounted for by Australia, Canada, the Eurozone (EU), Indonesia, Japan, Malaysia, United States of America (USA), and United Kingdom (UK). These economies account for the larger chunk of Africa's trade; while the selected African economies together with South Africa account substantially for Africa's GDP. The entire data were taken from the World Development Indicators (WDI) based on the following indicator names: exports of goods and services (constant 2010 US$) as measure for exports; imports of goods and services (constant 2010 US$) as measure for imports; and exports plus imports as measure for total trade (or simply trade).

To ensure that there are enough observations for the analysis, the data were converted from annual to quarterly using Eview's quadratic match average option. This is in line with the methodology used in compiling the Global VAR database used by Greenwood-Nimmo, Nguyen and Shin (2015) the connectedness of the global economy. Other studies that have successfully used the same methodology are Ogbuabor, Eigbiremolen, Aneke and Manasseh (2018) and Ogbuabor, Orji, Aneke and Erdene-Urnukh (2016). Also, to reduce noise and ensure uniform scaling, the entire data were converted into indices (2010Y = 100) and logged prior to estimation. Appendix 1 summarizes the descriptive statistics of the data based on the log transformation of the data. Focusing on Panel 1 which reports for total trade, we find that among the African economies, Ghana, DR Congo, and Tanzania are the most volatile as seen from their standard deviations while China, India and Russia are the most volatile among the BRICS economies. Among all the countries in the sample, Japan, Canada and UK are the least volatile and also recorded the highest mean values. The maximum and minimum values do not suggest the presence of outliers in the data. The time series plots of the data for all the economies in the sample are presented in Appendix 2 based on the log transformation of the data. A close examination of the plots show close comovement among all the countries, indicating that the series track themselves closely. The implication of this is that the data may be cointegrated, which will in turn affect the form of the underlying model to be estimated in this study. Thus, we shall subject the series to cointegration test as part of the empirical procedures in this study.

3.1 The Choice of Diebold and Yilmaz (2009) Network Framework

A number of methodologies have been employed in the study of macroeconomic linkages among entities in the global economy, particularly in the study of shock propagation among countries. For instance, cross-country correlations-based measures have been used to characterize macroeconomic linkages among countries (Kehoe et al., 1995; Kose et al., 2003; Bollerslev, 1990; Engle et al., 1990; Mantegna, 1999; Tumminello et al., 2005; Taylor, 2007; Gray & Malone, 2008; Engle, 2009; Engle & Kelly, 2012). The pitfalls of this approach are twofold, namely: correlation is simply a pairwise measure of association and it is non-directional. This means that correlation-based approach cannot handle such questions as "what is the degree of trade linkage between Africa, the BRICS and the rest of the global economy?" Unlike the correlation-based measures of macroeconomic linkage, the network approach of Diebold and Yilmaz (2009) is non-pairwise, yet directional. Granger Causality measures have also been used characterize networks so that the macroeconomic linkages among entities in the global economy can be described and understood (Caraiani, 2013; Hiemstra & Jones, 1994; Dahlhans & Eichler, 2003; Shojaie & Michailidis, 2010; Billio et al., 2012). The main weakness of the Granger Causality approach is that it captures only pairwise relations and may not be useful in answering important questions like "what is the degree of trade linkage between Africa, the BRICS and the rest of the global economy?"[1]

Furthermore, as noted by Diebold and Yilmaz (2016), these alternative methodologies generally dwell exclusively on testing rather than measurement and estimation of macroeconomic linkages, which are the key issues in this paper. This study therefore follows the network approach of Diebold and Yilmaz (2009) based on its ability to transparently use the size and direction of shocks to build both directional and non-directional trade linkage measures over a given forecast horizon. According to Ogbuabor et al (2016), studies using this approach have four common features, namely: (i) they are generally based on connectedness measures distilled from forecast error variance decompositions (FEVDs) of an approximating vector autoregressive (VAR) model; (ii) they measure the direction and strength of linkages among entities in the system; (iii) they can identify systemically important entities in the system; and (iv) they can study the dynamic nature of shock propagation among entities in the system. In what follows, the underlying VAR model for this study and the construction of the generalized trade linkages measures (GTLMs) are presented to guide the ensuing analysis.

3.2 Model Specification: The Vector Autoregression (VAR) Model

The broad objective of this study is to examine the propagation of trade shock between Africa, the BRICS economies and the rest of the global economy. Let $\boldsymbol{Z_t}$ be the log of total trade for all the countries selected for this study so that $\boldsymbol{Z_{jt}}$ stands for the logged total trade of the $\boldsymbol{j}$-th country in the system, with $\boldsymbol{j = 1, 2, \ldots, N}$ and $\boldsymbol{N}$ is the number of countries selected for the study (which is 20). Following Diebold and Yilmaz (2009), the trade linkage measures for this study are based on the normalized generalized forecast error variance decompositions (NGFEVDs) of an underlying $\boldsymbol{p}$-th

[1] Other techniques have also been used in the literature for the study of macroeconomic linkages. Ogbuabor et al (2018) provides an overview of such alternative methodologies such as the dynamic latent factor models of Kose et al. (2008) and Canova et al. (2007), the CoVaR approach of Adrian and Brunnermeier (2011), and the marginal expected shortfall (MES) approach of Acharya et al. (2017) and Brownlees and Engle (2012).

order VAR model for the $\boldsymbol{N \; x \; 1}$ vector of endogenous variables $\boldsymbol{Z_t}$. The VAR($\boldsymbol{p}$) model is specified as follows:

$$\boldsymbol{Z_t = \alpha_z + \sum_{j=1}^{p} \Phi_j Z_{t-j} \; + \; \varepsilon_t}, \tag{1}$$

where $\boldsymbol{\alpha}$ is $\boldsymbol{Nx1}$ vector of intercepts; $\boldsymbol{\Phi_j}$ is $\boldsymbol{N \; x \; N}$ coefficient matrix; $\boldsymbol{p}$ is the lag order; and the residuals $\boldsymbol{\varepsilon_{it}} \sim \boldsymbol{iid}\left(\boldsymbol{0}, \sum_{\boldsymbol{\varepsilon,ii}}\right)$ so that $\boldsymbol{\varepsilon_t} \sim (\boldsymbol{0}, \sum_{\boldsymbol{\varepsilon}})$, where $\sum_{\boldsymbol{\varepsilon}}$ is positive definite covariance matrix. The optimal VAR lag order selected by Schwarz Information Criterion (SIC) for this study is one (see Appendix 5). Using the Wold's Representation Theorem, the model in equation (1) is expressed as an infinite order vector moving average representation given by:

$$\boldsymbol{Z_t = \varepsilon_t + \Theta_1 \varepsilon_{t-1} + \Theta_2 \varepsilon_{t-2} + \; \dots \; = \sum_{j=0}^{\infty} \Theta_j \varepsilon_{t-j}} \tag{2}$$

where $\boldsymbol{\Theta_0 = I_N}$, $\boldsymbol{\Theta_j = \Phi^j}$, $\boldsymbol{j = 1, 2}, \ldots$, and $\boldsymbol{I_N}$ stands for an $\boldsymbol{N \times N}$ identity matrix in which all the principal diagonal elements are ones and all other elements are zeros.

The network approach of Diebold and Yilmaz (2009) requires that after estimating the underlying VAR model, the forecast error variance decompositions (FEVDs) are then generated and used to build linkage measures. In this study, the interest is in the shocks to the disturbances, $\boldsymbol{\varepsilon_{jt}}$ in the country-specific equations. Hence, following Pesaran and Shin (1998), Diebold and Yilmaz (2016) and Greenwood-Nimmo et al (2015), this study adopts the order-invariant generalized forecast error variance decompositions (GFEVDs) defined as:

$$\boldsymbol{GFEVD\left(Z_{it};\; \varepsilon_{jt}, H\right) = d_{ij}^{gH} = \frac{\sigma_{\varepsilon,jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' \Theta_h \Sigma_\varepsilon e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' \Theta_h \Sigma_\varepsilon \Theta_h' e_i\right)}} \tag{3}$$

where $i, j = 1, \ldots, N$; $H = 1, 2, \ldots$ is the forecast horizon; $e_i\left(e_j\right)$ is $N \; x \; 1$ selection vector whose *i*-th element (*j*-th element) is unity with zeros elsewhere; Θ_h is the coefficient matrix multiplying the *h*-lagged shock vector in the infinite moving-average representation of the non-orthogonalized VAR; $\sum_{\boldsymbol{\varepsilon}}$ is the covariance matrix of the shock vector in the non-orthogonalized VAR; and $\boldsymbol{\sigma_{\varepsilon,jj}}$ is the *j*-th diagonal element of $\sum_{\boldsymbol{\varepsilon}}$ (i.e. the standard deviation of ε_j). We adopted a maximum forecast horizon of 16 quarters in order to ensure that the long-run results are better captured. It must be stressed that the choice of GFEVDs for this study rather than the orthogonalized forecast error variance decompositions (OFEVDs) of Diebold and Yilmaz (2009) is particularly based on the fact that the

OFEVDs depend on the reordering of the variables in the system such that once the order of variables in the VAR is reshuffled, a different outcome results.

Diebold and Yilmaz (2014) explain that shocks are rarely orthogonal in the GFEVD environment so that sums of forecast error variance contributions are not necessarily unity, that is, row sums of the generalized variance decomposition matrix, D^{gH} are not necessarily unity. This renders the interpretation of the GFEVDs complicated. Thus, to restore a percentage interpretation of the GFEVDs, this study follows Diebold and Yilmaz (2014) to define the normalized GFEVDs (NGFEVDs) given by[2]:

$$\widetilde{D}^g = [\tilde{d}_{ij}^g], \quad \textbf{where } \tilde{d}_{ij}^g = \frac{d_{ij}^g}{\sum_{j=1}^N d_{ij}^g}, \quad d_{ij}^g = \boldsymbol{GFEVD}(\boldsymbol{Z_{it}};\, \boldsymbol{\varepsilon_{jt}}, \boldsymbol{H}) \tag{4}$$

By construction, $\sum_{j=1}^N \tilde{d}_{ij}^g = 1$ and $\sum_{i,j=1}^N \tilde{d}_{ij}^g = N$, so that the total sum of the generalized forecast error variance share of each variable is normalized to 100%.

3.3 Construction of the Generalized Trade Linkage Measures (GTLMs)

The various trade linkage measures that are relevant for the ensuing analysis are defined in this sub-section. The intuition behind this framework is quite simple. Variance decomposition permits the splitting of the forecast error variances of each variable in the VAR system into parts attributable to the various system shocks. By so doing, it becomes easy to answer the question: What fraction of the h-step-ahead error variance in forecasting $\boldsymbol{Z_{1t}}$ is due to shocks to $\boldsymbol{Z_{1t}}$? Shocks to $\boldsymbol{Z_{2t}}$? Similarly, what fraction of the h-step-ahead error variance in forecasting $\boldsymbol{Z_{2t}}$ is due to shocks to $\boldsymbol{Z_{1t}}$? Shocks to $\boldsymbol{Z_{2t}}$? And in general, what fraction of the h-step-ahead error variance in forecasting $\boldsymbol{Z_{jt}}$ is due to shocks to $\boldsymbol{Z_{it}}$, $\boldsymbol{i = 1, 2, \ldots, N}$. Thus, the approach marries VAR variance decomposition theory and network topology theory by recognizing that variance decompositions of VARs form networks and also characterizing linkages in those variance decomposition networks. This in turn characterizes trade linkages of the variables in our VAR system. This is the intuition behind this framework, which we now exploit in the ensuing analysis. Diebold and Yilmaz (2015) authoritatively document this framework and its relation to network theory.

[2] In what follows and without loss of generality, the superscript H is dropped whenever it is not needed for clarity so that D^{gH} and d_{ij}^{gH} are simply written as D^g and d_{ij}^g respectively.

Table 1: Trade Linkage Schematic

Variables	Z_1	Z_2	$\cdots$	Z_N	From Others
Z_1	d_{11}	d_{12}	$\cdots$	d_{1N}	$\sum_{j=1}^{N} d_{1j}, \quad j \neq 1$
Z_2	d_{21}	d_{22}	$\cdots$	d_{2N}	$\sum_{j=1}^{N} d_{2j}, \quad j \neq 2$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
Z_N	d_{N1}	d_{N2}	$\cdots$	d_{NN}	$\sum_{j=1}^{N} d_{Nj}, \quad j \neq N$
To Others	$\sum_{i=1}^{N} d_{i1}$ $i \neq 1$	$\sum_{i=1}^{N} d_{i2}$ $i \neq 2$	$\cdots$	$\sum_{i=1}^{N} d_{iN}$ $i \neq N$	$\frac{1}{N}\sum_{i,j=1}^{N} d_{ij}, \quad i \neq j$

Source: Adapted from Diebold and Yilmaz (2014) and Ogbuabor et al (2016). **Note**: For simplicity, each time series variable in this table $\boldsymbol{Z_{jt}}$ is written as $\boldsymbol{Z_j}$, $\boldsymbol{j = 1, 2, \dots, N}$.

To construct the GTLMs for this study, let us denote the H-step ahead NGFEVDs for the $\boldsymbol{N \, x \, 1}$ vector of endogenous variables $\boldsymbol{Z_t}$ obtained from equation (4) by $\boldsymbol{d_{ij}}$. By cross-tabulating $\boldsymbol{d_{ij}}$, the trade linkage table shown in Table 1 is formed. The sum of each row in Table 1 is normalized to 100% in line with equation (4). This table is now used to define the various GTLMs and their relationships. The diagonal entries in Table 1 measure own variance shares (or *own-effect*), while the off-diagonal entries measure variance shares arising from shocks to other variables in the system and are therefore referred to as pairwise directional linkage. Accordingly, the *own-effect* ($\boldsymbol{H_j}$), also known as the heatwave, is defined as:

$$\boldsymbol{H_j = d_{jj}} \tag{5}$$

The total cross-variable variance share ($\boldsymbol{F_j}$) captures the spillovers from all other variables to $\boldsymbol{Z_{jt}}$ as fractions of the H-step-ahead error variance in the forecasts of $\boldsymbol{Z_{jt}}$ resulting from $\boldsymbol{Z_{it}}$, where $\boldsymbol{i = 1, 2, \dots, N}$ and $\boldsymbol{i \neq j}$. This measures the total directional linkage from other variables (countries) in the system (i.e. the *from-effect*) to $\mathrm{Z}_{\mathrm{j}t}$. This means that the *from-effect* can be used to capture the role each individual economy in the system plays in a given African economy, and it is computed in this study by aggregating the spillovers from all the economies in the system to a given African economy across all horizons. Hence, the economy contributing the highest of such aggregate spillover is deemed to play a dominant role in the particular African economy. This study therefore defines $\boldsymbol{F_j}$ as:

$$\boldsymbol{F_j} = \sum_{i=1, i \neq j}^{N} \boldsymbol{d_{ji}} \quad (6)$$

By construction, $\boldsymbol{H_j} + \boldsymbol{F_j} = \mathbf{1}\ \forall\ \boldsymbol{j}$.

This study also defines the total spillover or total contributions of $\boldsymbol{Z_{jt}}$ to all other variables (denoted by $\boldsymbol{T_j}$) as:

$$\boldsymbol{T_j} = \sum_{i=1, i \neq j}^{N} \boldsymbol{d_{ij}} \quad (7)$$

By construction, $\boldsymbol{T_j}$ measures the total directional linkage from $\boldsymbol{Z_{jt}}$ to other variables in the system (i.e. the *to-effect*). In other words, the *to-effect* measures the directional linkage from a given economy (for instance, a given African economy) to other economies in the system, thereby showing the impact or influence of that particular African economy on other economies in the VAR system. The net directional linkage (or simply *net-effect*) of $\boldsymbol{Z_{jt}}$ is therefore defined as:

$$\boldsymbol{N_j} = \boldsymbol{T_j} - \boldsymbol{F_j} \quad (8)$$

Since there are N economies in the VAR system, it also follows that there are 2N total directional trade linkages, N capturing the total shocks transmitted to others (i.e. spillover to) and N capturing the total shocks received from others (i.e. spillover from). These measures are aptly reflect the bilateral trade patterns between the African economies and other economies in the system since they mirror the total exports and total imports for each of the N economies in the system, and will therefore facilitate deeper understanding of the inter-linkages among the African economies. We shall utilize the *net-effects* to establish the net transmitters/receivers of shocks in the system over time. By construction, $\sum_{j=1}^{N} \boldsymbol{N_j} = \mathbf{0}$.

The most aggregative (non-directional) trade linkage measure in this study which will be used to evaluate the degree of trade linkage Africa, the BRICS and the rest of the global economy is known as the *total trade linkage index* ($\boldsymbol{TTLI}$) or *total-effects*, and it is defined as:

$$\boldsymbol{TTLI} = \frac{\mathbf{1}}{\boldsymbol{N}} \sum_{j=1}^{N} \boldsymbol{F_j} = \frac{\mathbf{1}}{\boldsymbol{N}} \sum_{j=1}^{N} \boldsymbol{T_j} \quad (9)$$

This measure captures the grand total of the off-diagonal elements in Table 1, that is, the sum of the "From Others" column or "To Others" row. There is only one total trade linkage measure, which is analogous to total global imports or total global exports, since the two are identical.

An important objective of this study is to determine which of the countries among the BRICS and in the rest of the global economy exert the most dominant trade influence on African economies and therefore have the potential to spread trade shocks to Africa. To achieve this objective, this study defines two indices, *dependence* and *influence indices*. These indices are necessary to determine the dependence of the **j**-th variable (or **j**-th economy) on external shocks and the influence of the **j**-th variable (or **j**-th economy) on the system as a whole. The *dependence index* is defined as:

$$\boldsymbol{O_j^H = \frac{F_j}{H_j + F_j}}, \qquad \forall\, \boldsymbol{j = 1, 2, \dots, N} \tag{10}$$

where $\boldsymbol{0 \le O_j^H \le 1}$. This index expresses the relative importance of external shocks for the **j**-th economy in the VAR system such that if $\boldsymbol{O_j^H \to 1}$, then conditions in the **j**-th economy is open, deeply interlinked and sensitive to external conditions, but if $\boldsymbol{O_j^H \to 0}$, then the **j**-th economy is less sensitive to external shocks.

Similarly, the *influence index* is expressed as:

$$\boldsymbol{I_j^H = \frac{N_j}{T_j + F_j}}, \qquad \forall\, \boldsymbol{j = 1, 2, \dots, N} \tag{11}$$

where $\boldsymbol{-1 \le I_j^H \le 1}$. For a given horizon H, the **j**-th economy is a net receiver of trade shocks if $\boldsymbol{-1 \le I_j^H} < 0$, that is, if the index has a negative value; a net transmitter of trade shocks if $\boldsymbol{0 < I_j^H \le 1}$, that is, if the index takes a positive value; and neither a net receiver or transmitter of trade shocks if $\mathrm{I_j^H} = 0$. Thus, the *influence index* measures the extent to which the j-th economy in the system influences or is influenced by external shocks. Overall, the coordinate pair $(\boldsymbol{O_j^H, I_j^H})$ in the *dependence*-*influence* space provides a good representation of the **j**-th economy's role in global real activities. A priori expectation is that African economies, which are relatively small open economies would be located close to the point (1,-1), while overwhelmingly open but highly influential and dominant economies like the USA, China and Japan would be located close to the point (1,1).

4. Results and Discussions

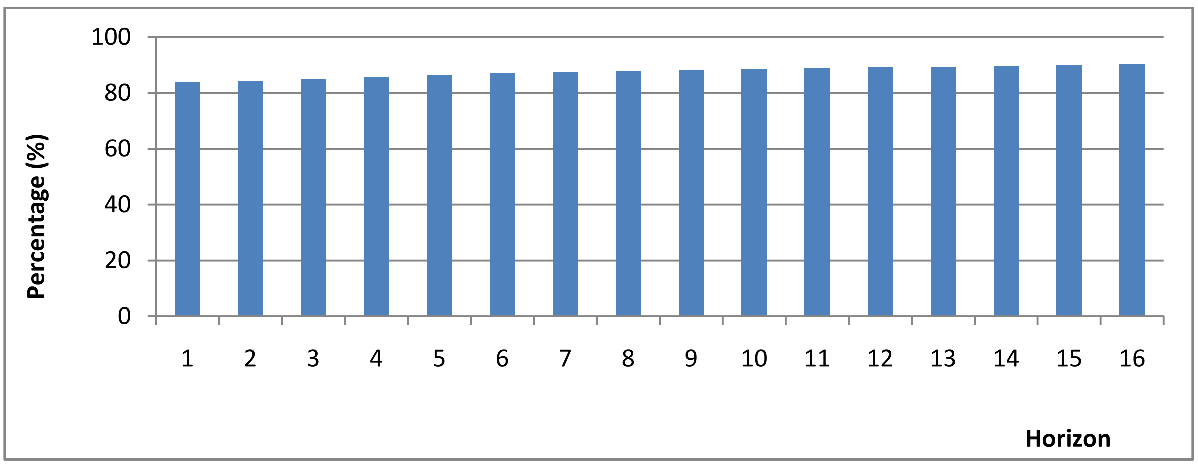
We started this empirical analysis by examining the time series properties of the data. The Phillips-Perron unit root tests showed that all the series are I(1) for all the countries (Please see Appendix 3, which reports for total trade of all the countries. To conserve space, we do not report separately for exports and imports since the patterns are similar, that is, all the series are I(1)). However, the test for long-run or equilibrium relationship using the Johansen System Cointegration test showed that both the Trace and Maximum Eigenvalue statistics returned full rank, indicating that the data are not cointegrated (Please see Appendix 4 which reports the Trace test in Panel 1 and the Max-Eigenvalue test in Panel 2). Therefore, a VAR in first differences was estimated rather than a vector error correction model (VECM). Thereafter, the GTLMs were computed for all forecasting horizons, $H = 1,2, \ldots ,16$. The average values of the GTLMs over all the horizons are reported, since Diebold and Yilmaz (2016) had shown that the measures follow similar patterns regardless of the choice of window lengths and forecast horizons. As earlier stated, we set the maximum forecast horizon at 16 quarters in order to capture the long-run results better. As a robustness check, we also estimated the underlying model and computed the GTLMs separately for exports and imports. As shall soon see, the results follow the same qualitative pattern.

4.1 Measuring the degree of trade linkage between Africa, the BRICS and the rest of the global economy

The first specific objective of this study is to measure the degree of trade linkage between African economies, the BRICS and the rest of the global economy. In addition, we examine here how this index changed from the short-run (i.e. from horizon 1) through the long-run (i.e. until horizon 16). To achieve this objective, we estimated the underlying VAR model of equation (1) and used the NGFEVDs distilled from this estimation based on equation (4) to compute the *Total Trade Linkage Index* (TTLI) based on equation (9). We report the plots of this index in Figure 1 based on the total trade data, while the plots based on the exports and imports data are reported in Appendix 5. This figure shows how the most aggregated generalized trade linkage measure in this study evolved from the short-run through the long-run. We find that the index rose smoothly from 84% at horizons 1 and 2 to 90% at horizons 15 and 16. In other words, the total trade linkage index is higher in the long-run than in the short-run, indicating African economies become more interlinked in the long-run as the business cycles become more synchronized. This finding is consistent with the trend of global macroeconomic interlinkage reported by Greenwood-Nimmo et al (2015), Diebold and Yilmaz (2016) and Ogbuabor et al (2018) that the ongoing globalization process is engendering more significant comovement in industrial production fluctuations. Furthermore, we find that the TTLI recorded an average value of 87%, which shows that the trade linkage between Africa, the BRICS and the rest of the global economy is quite substantial.

As shown in Appendix 5, the patterns in this index remained qualitatively unchanged when the underlying model is estimated using the exports and imports data respectively. However, a closer look at panels 1 and 2 of this Appendix reveals that the index recorded higher values across all the horizons for exports than for imports. This aptly captures the pattern of trade between Africa and the rest of the world, which shows that Africa's export trade in dollar terms, at least in the last decade, is higher than its import trade (see table 1 in appendix 1 of African Trade Statistics Yearbook 2017). This finding clearly indicates that Africa may be vulnerable to trade shocks, which underlines the motivation behind this study.

Figure 1: Total Trade Linkage Index



Source: Authors. **Notes**: The *Total trade linkage Index* reported here is the most aggregated non-directional trade linkage index computed for all horizons following equation (9). Notice that the index rises smoothly from the short-run (i.e. horizon 1) towards the long-run (i.e. horizon 16), indicating that African economies become more interlinked in the long-run.

4.2 Determining the BRICS countries and other countries in the rest of the world that are dominating Africa's trade and therefore have the potential to spread trade shocks to Africa:

An important objective of this study is to determine the BRICS member countries and other countries in the rest of the world that are dominating Africa's trade and therefore have the potential to spread trade shocks to Africa. To achieve this objective, we report the from-effect trade linkage from all the economies in the system to each African economy following equation (6). We include the heatwave (or *own-effect*) of equation (5) in this table so that it sums up to 100%. We aggregate the contributions from key regional trading blocs in order to reveal their influence on each African economy. The regional trading blocs accounted for here includes: the BRICS (Brazil, Russia, India, China, South Africa); the Asian Bloc (India, China, Indonesia, Japan, Malaysia, Russia); Europe (UK, EU); and the Americas (Canada, Brazil, USA).

Table 2: The *From-effect* Linkage of African Economies based on Total Trade Data

Country	South Africa	DR Congo	Egypt	Ghana	Morocco	Nigeria	Tanzania	Tunisia
USA	7.1778	2.9440	6.1788	4.2154	7.4728	4.3927	1.8340	6.0843
Brazil	5.8032	1.9932	5.5790	4.4390	3.3250	4.2150	1.4919	6.7961
Russia	6.6697	3.1216	6.4970	4.9067	3.5979	3.2582	2.5549	7.2983
India	5.5713	6.0962	7.2008	6.4639	4.6561	3.2564	0.8157	4.6453
China	6.8649	5.7823	7.3921	9.0160	5.5913	5.4103	1.6375	7.5379
South Africa	8.0744	4.4883	8.0196	6.5987	5.4168	4.2197	0.6952	7.5993
Australia	2.7148	3.1751	2.5479	3.8758	2.5946	4.4026	2.6291	3.4948
Canada	6.5383	4.1541	5.7408	3.7902	7.3538	4.7009	1.4725	5.5939
EU	6.8368	1.5015	5.7468	3.8353	7.5445	4.2242	1.2341	6.3107
Indonesia	2.3779	1.6606	1.6213	1.5499	0.9009	2.6810	0.6512	2.3182
Japan	6.8181	3.1048	5.5894	4.0754	7.7014	5.5484	2.4794	6.1861
Malaysia	4.5584	4.2499	3.3993	1.6137	4.2698	3.0786	5.5850	2.9298
UK	8.0756	1.5008	7.6576	7.6385	9.6626	7.8466	6.9155	6.2834
DR Congo	1.8171	28.7238	1.6923	2.9821	0.7776	1.5582	10.3410	2.0364
Egypt	6.0237	3.0150	8.9778	7.5198	4.6710	2.7362	3.5750	6.4429
Ghana	3.3558	4.1383	5.2468	12.1599	4.2637	4.6661	2.7242	3.7347
Morocco	4.3059	1.0130	4.0407	3.3048	9.3997	6.8184	5.2822	4.5226
Nigeria	1.3664	9.5792	1.1543	6.7823	2.8771	18.6518	0.5394	1.6720
Tanzania	0.5952	8.0171	0.3841	1.5953	2.9832	6.5904	45.1662	0.8304
Tunisia	4.4544	1.7412	5.3335	3.6375	4.9400	1.7444	2.3759	7.6830
Total From-effect	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total from Regional Trading Blocs								
Total from BRICS	24.9093	21.4816	34.6886	31.4243	22.5871	20.3596	7.1952	33.8770
Total from Asia	32.8605	24.0154	31.7000	27.6255	26.7174	23.2328	13.7238	30.9157
Total from Europe	14.9124	3.0023	13.4044	11.4738	17.2072	12.0708	8.1496	12.5940
Total from the Americas	19.5193	9.0913	17.4986	12.4446	18.1516	13.3086	4.7984	18.4742

Source: Authors. **Notes:** This table is a transpose of Table 1. It reports the from-effect of equation (6) for all the African economies and includes the heatwave of equation (5) so that the total for each economy sums up to 100%. The table also aggregates the contributions from key regional trading blocs in the system to each African economy. In the case of South Africa, the contribution from BRICS excludes South Africa's heatwave. Here, BRICS includes Brazil, Russia, India, China, and South Africa; Asia includes India, China, Indonesia, Japan, Malaysia, and Russia; Europe includes UK and EU; while the Americas include Canada, Brazil, and USA.

We find that among the BRICS, China is the highest contributor to the NGFEVDs of the African economies. It contributed at least 5% to each African economy, except for Tanzania. India and South Africa also made remarkable contributions. India contributed 3% to Nigeria and at least 5% to all other African economies, except for Tanzania; while South Africa contributed at least 4% to majority of the other African economies. The roles of Brazil and Russia are only notable in South Africa, Egypt and Tunisia. At this point, we have established that among the BRICS, China plays a dominant role in Africa's trade. As a trading bloc, we find that the BRICS contribute at least 20% to each African economy, except for Tanzania that showed 7%. This shows that the BRICS play dominant role in Africa's trade and therefore have the potential to spread trade shocks to it. In the rest of the global economy, we find that UK, USA, Japan, EU, and Canada play important roles in Africa's trade. UK contributed at least 6% to all the African economies, except for DR Congo; while each of USA, Japan, EU, and Canada contributed at least 4% to majority of the African economies. Overall, we find that China, UK, USA, Japan, EU, and Canada dominate Africa's trade and that the BRICS as a trading bloc also exert a dominant influence on Africa. These findings are consistent with the bulk of the established literature, such as Greenwood-Nimmo et al (2015), Diebold and Yilmaz (2016), Ogbuabor et al (2016), and Ogbuabor et al (2018), which shows that China, USA, Japan, EU and UK are important real activity shock transmitters and therefore dominate global economic activities. We stress that even though the results in Table 2 are based on the total trade data, they are nonetheless consistent with the results obtained by using the exports and imports data in separate regressions (please see Appendix 6 for the details of these results).

4.3 Determining other trade blocs outside the BRICS that exert dominant influence on Africa and therefore have the prospects of spreading trade shocks to it:

Another specific objective of this study seeks to determine other trading blocs outside the BRICS that exert dominant influence on Africa and therefore have the potential to spread trade shocks to it. To achieve this objective, we consider the contributions from the regional trading blocs to the respective African economies as shown in Table 2. We find that outside the BRICS, the Asian trading bloc exert the most dominant influence on Africa, with China, Japan and India accounting for the bulk of the influence coming from this region to Africa. The contribution of this region ranged from 14% in Tanzania to 33% in South Africa. The Asian bloc is followed by the Americas whose influence ranged from 5% in Tanzania to 20% in South Africa, with USA and Canada accounting for the bulk of the influence emanating from this region. We also find that the role of the European trading bloc cannot be called negligible. The European trading bloc comprises UK and EU, whose joint contribution to majority of the African economies is at least 12%. Overall, we find that even though the Asian trading bloc is playing a dominant role in Africa, the roles of the Americas and Europe cannot be called unimportant. The findings here are consistent with the ones obtained by using the exports and imports data in separate regressions (please see Appendix 6).

4.4 Determining the African economies that are most susceptible to trade shocks originating from the BRICS member countries and the rest of the global economy

Another important specific objective of this study seeks to determine the African economies that are most vulnerable to trade shocks originating from the BRICS and the rest of the global economy. To achieve this objective, we report the estimates of the *dependence* and *influence indices* following equations (10) and (11), respectively. To provide a robustness check on these estimates, we will also consider the results of the *net-effect* linkage of each African economy following equation (8).

To begin, consider the results of the *dependence* and *influence indices* as shown in Table 3 based on the total trade data. We find that except for South Africa and Egypt, all the other African economies in the system reported a negative *influence index*, indicating that rather than being influential, they are all vulnerable or susceptible to trade shocks emanating from the influential economies. The notable influential economies in the system include China, UK, USA, Japan, Canada, EU and South Africa. These economies have positive *influence index* of at least 5%, and thus dominate the system. Among the BRICS, China has the highest *influence index* of 16%, and in the rest of the global economy, UK and USA recorded the highest *influence index* of 18% and 11% respectively. We find that the African economies have *dependence index* ranging from 71% to 92%, except for Tanzania which recorded 55%. This indicates that the African economies are considerably open to external influences, particularly the trade shocks originating from the dominant economies in the system. The BRICS have *dependence index* ranging between 91% and 92%, while the other countries in the rest of the global economy have *dependence index* ranging between 87% and 92%, showing that these economies are highly open economies. These findings are consistent with our a priori expectations. They are also consistent with studies like Ogbuabor et al (2016) which have established that African economies are predominantly small open economies, deeply interlinked with the rest of the world but systemically unimportant and vulnerable to headwinds emanating from the dominant economies in the overall global economy. Note that even though the results in Table 3 are based on the total trade data, they are quite consistent with the results obtained by using the exports and imports data in separate regressions (please see Appendix 7).

Table 3: *Dependence* and *Influence Indices* Results based on Total Trade Data

Country	Dependence Index	Influence Index
USA	0.9225	0.1146
Brazil	0.9120	-0.0219
Russia	0.9112	0.0455
India	0.9078	-0.0084
China	0.9089	0.1571
South Africa	0.9193	0.1043
Australia	0.9204	-0.1804
Canada	0.9162	0.0942
EU	0.9242	0.0508
Indonesia	0.8702	-0.4052
Japan	0.9058	0.0983
Malaysia	0.8912	-0.0356
UK	0.8952	0.1750
DR Congo	0.7128	-0.1741
Egypt	0.9102	0.0250
Ghana	0.8784	-0.0938
Morocco	0.9060	-0.0343
Nigeria	0.8135	-0.1450
Tanzania	0.5483	-0.2800
Tunisia	0.9232	-0.1425

Source: Authors. **Notes:** The dependence and influence indices were computed using equations (10) and (11) respectively. Please see Appendix 7 for the details of the results obtained by using the exports and imports data in separate regressions, which are consistent with the results reported in this Table 3.

To see if the above findings are robust to the *net-effect* linkage of African economies, let us consider the *net-effect* results presented in Table 4 following equation (8). We find that while the dominant economies have huge positive *net-effects*, including USA, China, UK, Japan, Canada, and

EU, all the African economies have negative *net-effects*, except for South Africa (which is also a member of the BRICS) and Egypt (whose positive *net-effect* is quite marginal). Hence, while the aforementioned dominant economies are net transmitters of trade shocks, majority of the African economies are net receivers of trade shocks. This is consistent with our earlier findings that African economies are predominantly small open economies, deeply interlinked with the rest of the world but systemically unimportant and vulnerable to headwinds emanating from the dominant economies. These results still hold even when are subjected to robustness check by running separate regressions using the exports and imports data (please see Appendix 8).

Table 4: *Net-effect* Linkage Results based on Total Trade Data

Country	From-effect	To-effect	Net-effect
USA	92.2486	116.7212	24.4726
Brazil	91.1992	87.4640	-3.7352
Russia	91.1225	100.0613	8.9388
India	90.7825	89.8242	-0.9583
China	90.8903	124.8026	33.9122
South Africa	91.9256	113.6053	21.6797
Australia	92.0363	64.8580	-27.1782
Canada	91.6215	111.2171	19.5956
EU	92.4230	102.9565	10.5335
Indonesia	87.0173	36.9507	-50.0665
Japan	90.5765	110.9993	20.4227
Malaysia	89.1174	83.3400	-5.7774
UK	89.5223	127.9940	38.4716
DR Congo	71.2762	50.1596	-21.1166
Egypt	91.0222	96.0466	5.0244
Ghana	87.8401	77.4361	-10.4040
Morocco	90.6003	84.6578	-5.9425
Nigeria	81.3482	68.2922	-13.0560
Tanzania	54.8338	32.9206	-21.9132
Tunisia	92.3170	69.4139	-22.9031

Source: Authors. **Notes:** The *From-effects*, *To-effects* and *Net-effects* were computed following equations (6), (7) and (8), respectively. Please see Appendix 8 for the details of the results obtained by using the exports and imports data in separate regressions, which are consistent with the results reported in this Table 4.

5. Conclusion and Policy Implications

This study examined the dynamics of trade shock propagation between Africa, the BRICS and the rest of the global economy using the network approach of Diebold and Yilmaz (2009). The paper extended the empirical method by constructing generalized trade linkage measures at various levels of aggregation. The main findings are summarized as follows. First, we find that African economies become more interlinked in the long-run as the business cycles become more synchronized and that the trade linkage between Africa and the rest of the global economy is quite substantial, with the total trade linkage index having an average value of 87%. Second, we find that China, USA, UK, Japan, EU, and Canada dominate Africa's trade and therefore have the potential to spread output shocks to it. The results further indicate that apart from the BRICS, other regional trade blocs (Asia, the Americas, and Europe) play influential roles in Africa's trade. Third, we find that African economies are predominantly open but vulnerable to global trade shocks, especially those originating from the aforementioned dominant sources. These findings particularly provide support for some earlier research findings which indicate that intra-Africa's trade has been relatively low as a result of low level of structural complementarities among these economies. Overall, our findings suggest that the roles of African economies in global economic activities can be systemically called unimportant since these economies are predominantly net receivers of trade shocks rather than net transmitters.

The findings of this study have several policy implications because, according to Greenwood-Nimmo et al. (2015), "…globalization makes it impossible for dominant economies to collapse in isolation". First, policymakers in Africa are able to see that the stability of the continent depends somewhat on the actions of the rest of the global economy, which are generally outside the control of the continent. In other words, the results of this study constitute an essential wake-up call to policymakers in Africa to be mindful of the chances of adverse trade shocks emanating from the aforementioned dominant sources, particularly the Asian trade partners. Policymakers and leaders in Africa should therefore coordinate policies towards safeguarding the continent from future crisis. For example, deliberate and well-coordinated policy efforts should target the diversification of African economies as a form of insurance against future trade shocks. To drive economic diversification, entrepreneurs and other investors should be encouraged through the provision of basic infrastructure and adequate security for lives and property. Second, the results of this study provide evidence to assist policymakers in Africa and the rest of the global economy in identifying the likely sources of future trade shocks so that appropriate policy responses to such shocks can be designed. Such policies and strategies will in turn ensure that the Africa's common goal of shared prosperity and enhanced living standards for all its citizens are achieved on a sustainable basis. Third, the findings provide evidence that can assist policymakers across the globe in understanding how measurement and evaluation of macroeconomic linkages can be used to improve risk measurement and management, public policy, regulatory oversight and overall economic integration. This underlines the need for policymakers in Africa to view the results of this study as part of the much needed early warning signals towards the evolution of well-coordinated policy actions that can safeguard the continent from potential global trade shocks.

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Appendix 1: Descriptive statistics

Panel 1: Total trade

	AUS	BRA	CAN	CHN	CON	EGY	EU	GHA	IND	INDO
Mean	8.4011	8.1358	8.8127	6.7001	7.7455	8.0301	8.5688	7.4184	7.2914	8.4264
Median	8.4236	7.9800	9.0033	6.7500	8.3329	7.5169	8.6593	6.8642	7.1163	8.3149
Maximum	9.7207	9.4582	9.5355	10.1668	9.8959	9.6559	9.6925	10.2321	9.7017	9.6790
Minimum	6.8070	5.9661	7.4991	2.1419	5.2033	6.6311	7.1997	4.5609	4.1361	6.5780
Std. Dev.	0.9103	0.9923	0.6307	2.5939	1.5215	1.0771	0.7832	1.8510	1.8889	0.8659
Skewness	-0.2557	-0.3265	-0.8339	-0.1564	-0.2113	0.1983	-0.3892	0.2254	-0.1552	-0.0788
Kurtosis	1.8436	2.0982	2.4076	1.6568	1.6486	1.3023	1.7853	1.6793	1.6301	1.8843
Jarque-Bera	7.1942	5.5790	14.0960	8.5592	9.0220	13.6781	9.3660	8.7637	8.8786	5.7136
Probability	0.0274	0.0615	0.0009	0.0138	0.0110	0.0011	0.0093	0.0125	0.0118	0.0575
Sum	907.3191	878.6664	951.7664	723.6112	836.5173	867.2560	925.4352	801.1865	787.4676	910.0564
Sum Sq. Dev.	88.6614	105.3555	42.5632	719.9027	247.7109	124.1421	65.6302	366.6218	381.7577	80.2300
Observations	108	108	108	108	108	108	108	108	108	108

	JPN	MAL	MOR	NIG	RUS	SAF	TAN	TUN	UK	USA
Mean	8.7236	8.3778	8.3738	7.6289	8.2244	8.6661	7.8667	7.9968	8.6786	8.5707
Median	8.7044	8.4389	8.2930	7.3778	8.3385	8.6057	7.9551	7.7917	8.8201	8.6262
Maximum	9.5578	9.4754	9.8656	9.3881	9.5886	9.6149	10.1364	9.4617	9.5788	9.5813
Minimum	7.7730	5.9370	7.1394	5.9040	6.6530	7.3517	5.5142	6.3446	7.4210	7.0590
Std. Dev.	0.5861	0.9711	0.8697	1.1261	1.0013	0.7122	1.4826	1.0113	0.6881	0.7874
Skewness	-0.1509	-0.7693	0.0520	0.0961	-0.0788	-0.3648	0.0245	0.0168	-0.5261	-0.5221
Kurtosis	1.6540	2.5582	1.5010	1.4196	1.4106	1.9515	1.6529	1.5297	1.8919	2.0504
Jarque-Bera	8.5624	11.5304	10.1596	11.4054	11.4789	7.3429	8.1769	9.7338	10.5077	8.9641
Probability	0.0138	0.0031	0.0062	0.0033	0.0032	0.0254	0.0168	0.0077	0.0052	0.0113
Sum	942.1434	904.8058	904.3667	823.9173	888.2388	935.9360	849.5988	863.6512	937.2902	925.6322
Sum Sq. Dev.	36.7539	100.9027	80.9327	135.6855	107.2816	54.2746	235.1912	109.4302	50.6657	66.3408
Observations	108	108	108	108	108	108	108	108	108	108

Panel 2: Exports

	AUS	BRA	CAN	CHN	CON	EGY	EU	GHA	IND	INDO
Mean	4.3295	4.1726	4.4997	3.3564	3.9203	3.9204	4.2884	3.7423	3.6712	4.1902
Median	4.3989	4.2513	4.6369	3.3563	4.0228	3.7215	4.3260	3.4893	3.6168	4.1063
Maximum	4.9267	4.7480	4.8047	5.0647	5.1078	4.8075	4.8591	5.2280	4.9347	4.8121
Minimum	3.5181	3.2658	3.8487	1.0999	2.8248	3.1282	3.5764	2.2685	2.0866	3.2299
Std. Dev.	0.3567	0.4627	0.2889	1.2951	0.7307	0.5704	0.3974	0.9473	0.9485	0.4404
Skewness	-0.5126	-0.3390	-1.1139	-0.1593	0.1003	0.1444	-0.3788	0.2615	-0.1339	-0.0785
Kurtosis	2.4040	1.6695	2.8948	1.6237	1.7569	1.3333	1.8292	1.7687	1.5771	1.9101
Jarque-Bera	6.3277	10.0352	22.3840	8.9813	7.1350	12.8756	8.7513	8.0535	9.4336	5.4568
Probability	0.0423	0.0066	0.0000	0.0112	0.0282	0.0016	0.0126	0.0178	0.0089	0.0653
Sum	467.5847	450.6379	485.9645	362.4899	423.3933	423.4076	463.1435	404.1731	396.4876	452.5383
Sum Sq. Dev.	13.6178	22.9032	8.9333	179.4823	57.1317	34.8181	16.8996	96.0184	96.2699	20.7557
Observations	108	108	108	108	108	108	108	108	108	108

	JPN	MAL	MOR	NIG	RUS	SAF	TAN	TUN	UK	USA
Mean	4.2639	4.1893	4.2189	4.0448	4.2248	4.4177	3.9647	3.9949	4.3572	4.2808
Median	4.2484	4.2653	4.2154	3.8822	4.3018	4.4454	4.1144	3.9034	4.3987	4.2616
Maximum	4.7407	4.7004	4.8937	4.8585	4.7489	4.7584	5.2432	4.7544	4.7638	4.7884
Minimum	3.6895	3.0077	3.6326	3.3208	3.4602	3.8788	2.5067	3.1643	3.7575	3.5685
Std. Dev.	0.3435	0.4889	0.4158	0.5011	0.3967	0.2711	0.7820	0.4997	0.3222	0.3643
Skewness	-0.0975	-0.8534	-0.0141	0.3327	-0.3128	-0.5993	-0.2009	-0.0408	-0.5455	-0.2672
Kurtosis	1.5123	2.5749	1.5233	1.5819	1.6434	2.1907	1.9619	1.5902	1.9928	1.9945
Jarque-Bera	10.1311	13.9237	9.8169	11.0416	10.0430	9.4126	5.5756	8.9743	9.9206	5.8349
Probability	0.0063	0.0009	0.0074	0.0040	0.0066	0.0090	0.0616	0.0113	0.0070	0.0541
Sum	460.5043	452.4443	455.6463	436.8366	456.2831	477.1111	428.1869	431.4453	470.5765	462.3307
Sum Sq. Dev.	12.6277	25.5735	18.4992	26.8627	16.8392	7.8665	65.4348	26.7198	11.1068	14.1975
Observations	108	108	108	108	108	108	108	108	108	108

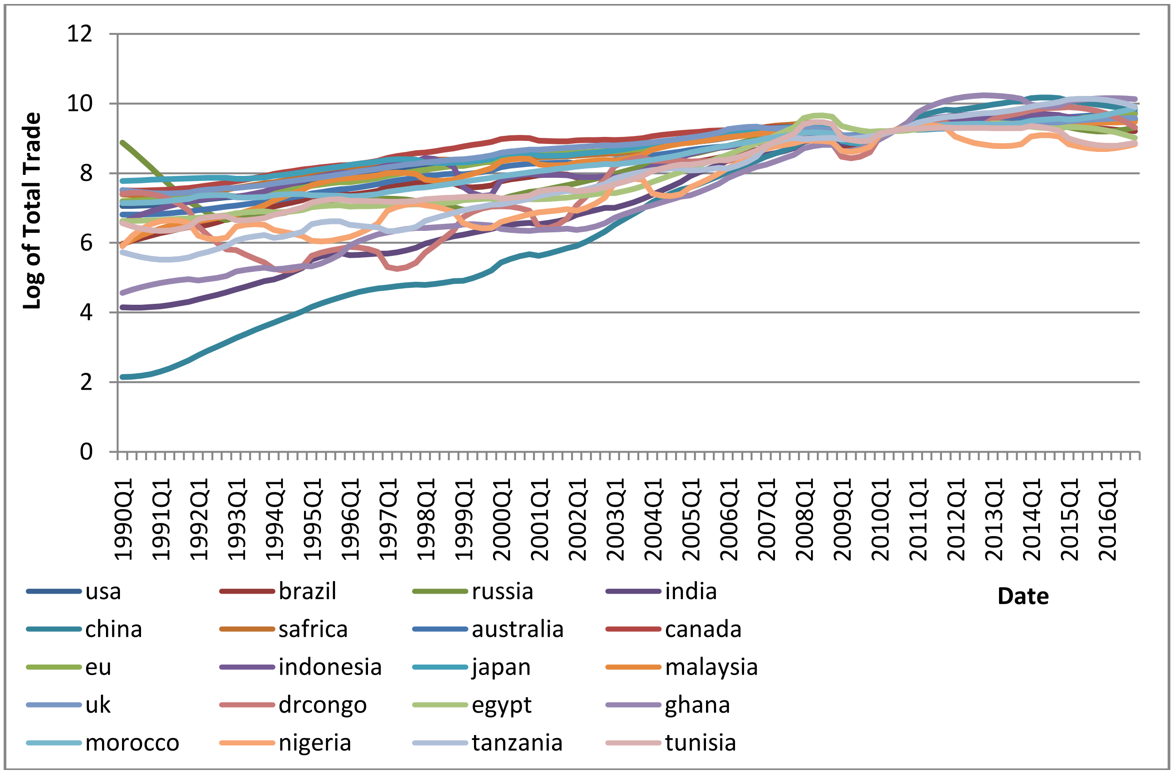
Panel 3: Imports

	AUS	BRA	CAN	CHN	CON	EGY	EU	GHA	IND	INDO
Mean	4.0716	3.9632	4.3130	3.3437	3.8252	4.1097	4.2805	3.6761	3.6202	4.2363
Median	4.0293	3.8797	4.3425	3.3938	4.2632	3.8025	4.3333	3.3749	3.4995	4.2524
Maximum	4.8275	4.7789	4.7365	5.1059	4.7958	4.8484	4.8334	5.0553	4.8606	4.8670
Minimum	3.1854	2.7002	3.6458	1.0124	2.3431	3.4572	3.6232	2.2924	1.9763	3.3482
Std. Dev.	0.5623	0.5535	0.3511	1.3000	0.8121	0.5130	0.3861	0.9070	0.9426	0.4291
Skewness	-0.1054	-0.2950	-0.5179	-0.1564	-0.4266	0.2822	-0.3998	0.1867	-0.1796	-0.0986
Kurtosis	1.6142	2.3579	1.9916	1.6996	1.7030	1.3341	1.7464	1.5966	1.6997	1.8396
Jarque-Bera	8.8414	3.4218	9.4030	8.0500	10.8455	13.9220	9.9495	9.4901	8.1891	6.2349
Probability	0.0120	0.1807	0.0091	0.0179	0.0044	0.0009	0.0069	0.0087	0.0167	0.0443
Sum	439.7345	428.0285	465.8019	361.1214	413.1240	443.8484	462.2917	397.0134	390.9800	457.5180
Sum Sq. Dev.	33.8298	32.7825	13.1914	180.8338	70.5702	28.1581	15.9501	88.0160	95.0711	19.7015
Observations	108	108	108	108	108	108	108	108	108	108

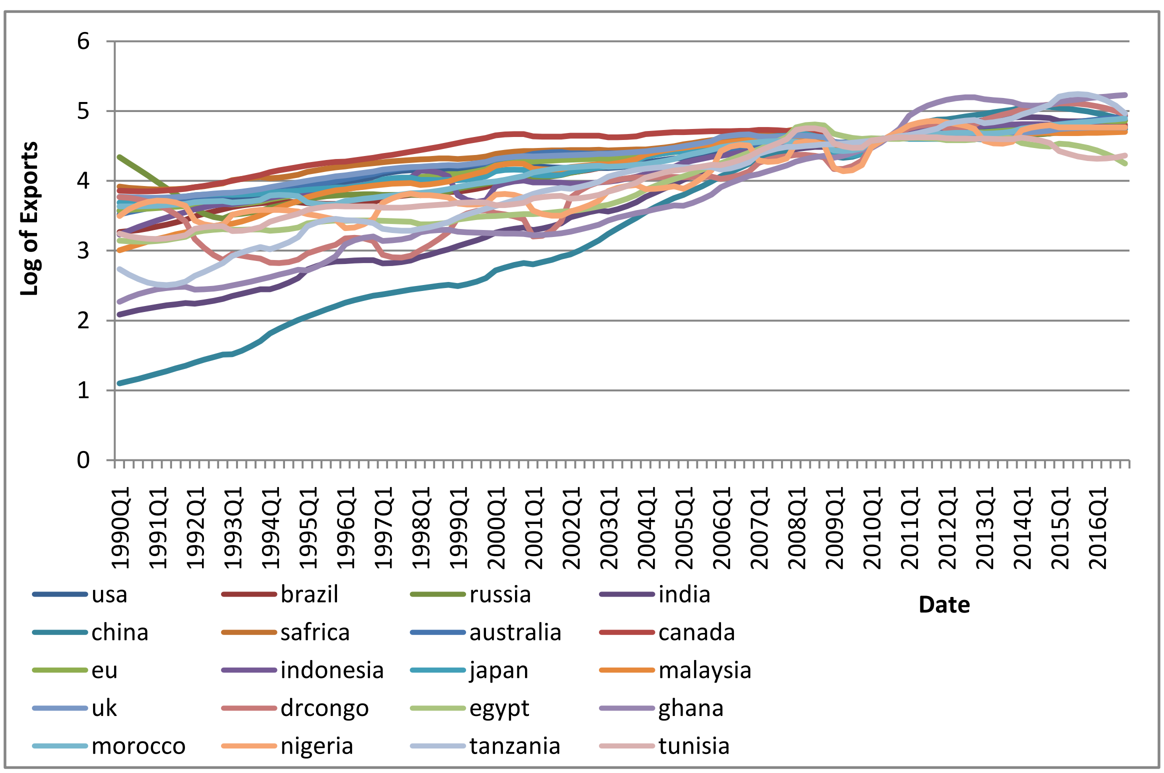
	JPN	MAL	MOR	NIG	RUS	SAF	TAN	TUN	UK	USA
Mean	4.4596	4.1885	4.1548	3.5841	3.9996	4.2484	3.9020	4.0019	4.3214	4.2898
Median	4.4561	4.1759	4.0821	3.5106	4.0211	4.1620	3.8407	3.8883	4.4214	4.4011
Maximum	4.8381	4.7750	4.9720	4.6132	4.9229	4.8587	4.9650	4.7288	4.8210	4.7980
Minimum	4.0342	2.9293	3.5068	2.4090	3.0390	3.4645	2.9905	3.1802	3.6600	3.4622
Std. Dev.	0.2461	0.4854	0.4568	0.6666	0.6219	0.4457	0.7157	0.5136	0.3670	0.4301
Skewness	-0.2384	-0.6748	0.1142	0.0167	0.0316	-0.2192	0.2042	0.0811	-0.5114	-0.6862
Kurtosis	1.9290	2.5254	1.4961	1.5951	1.4596	1.8055	1.4998	1.4947	1.8138	2.0792
Jarque-Bera	6.1848	9.2090	10.4121	8.8865	10.6955	7.2860	10.8786	10.3152	11.0391	12.2905
Probability	0.0454	0.0100	0.0055	0.0118	0.0048	0.0262	0.0043	0.0058	0.0040	0.0021
Sum	481.6391	452.3614	448.7204	387.0807	431.9557	458.8249	421.4119	432.2059	466.7138	463.3015
Sum Sq. Dev.	6.4784	25.2086	22.3300	47.5453	41.3775	21.2507	54.8102	28.2235	14.4087	19.7896
Observations	108	108	108	108	108	108	108	108	108	108

Appendix 2: Time series plots of the data

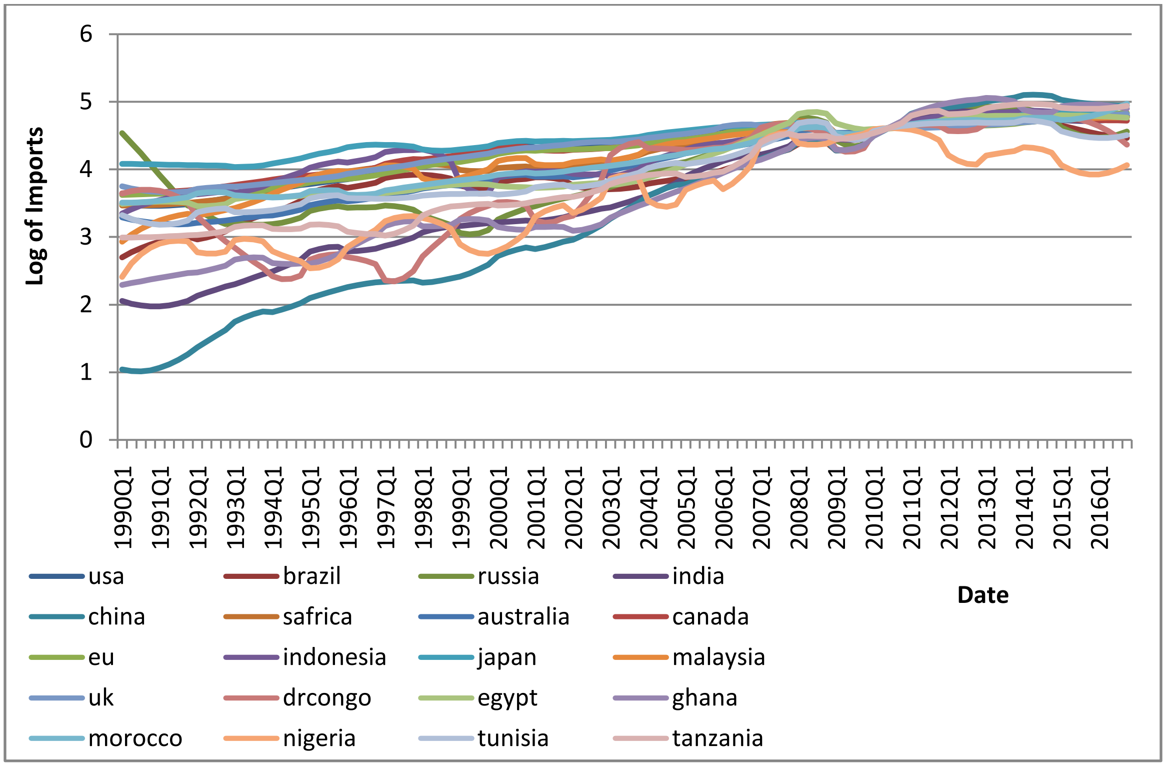
Panel 1: Total Trade



Panel 2: Exports



Panel 3: Imports



Source: Authors. **Notes**: These graphs plot the data over the full sample.

Appendix 3: Phillips-Perron Unit Root Test Results for Total Trade

Variables	**PP Test stat at level**	**Critical value at 5%**	**PP Test stat at 1^{st} Diff**	**Critical value at 5%**	**Order of Integration**
Australia	-2.087649	-3.452358	-5.511474	-3.452764	I(1)
Brazil	-1.51073	-3.452358	-4.815699	-3.452764	I(1)
Canada	-1.688886	-3.452358	-4.919794	-3.452764	I(1)
China	-0.761713	-3.452358	-4.666041	-3.452764	I(1)
DRCongo	-2.701397	-3.452358	-4.969701	-3.452764	I(1)
Egypt	-1.110372	-3.452358	-4.587926	-3.452764	I(1)
EU	-2.479035	-3.452358	-4.796753	-3.452764	I(1)
Ghana	-1.789434	-3.452358	-4.749838	-3.452764	I(1)
India	-0.176913	-3.452358	-5.580811	-3.452764	I(1)
Indonesia	-1.940294	-3.452358	-7.723706	-3.452764	I(1)
Japan	-2.7304	-3.452358	-4.666113	-3.452764	I(1)
Malaysia	-1.798537	-3.452358	-5.140808	-3.452764	I(1)
Morocco	-3.427262	-3.452358	-5.251978	-3.452764	I(1)
Nigeria	-1.885798	-3.452358	-6.573952	-3.452764	I(1)
Russia	-2.427019	-3.452358	-4.584745	-3.452764	I(1)
Safrica	-2.459347	-3.452358	-5.061753	-3.452764	I(1)
Tanzania	-2.080362	-3.452358	-4.639207	-3.452764	I(1)
Tunisia	-2.521464	-3.452358	-4.922059	-3.452764	I(1)
UK	-2.92419	-3.452358	-4.914527	-3.452764	I(1)
USA	-1.015221	-3.452358	-5.002348	-3.452764	I(1)

Source: Authors. **Notes:** This table reports for total trade data. To conserve space, we do not report for exports and imports since the patterns are similar, that is, all the variables are I(1).

Appendix 4: Johansen system cointegration test results

Panel 1: Trace test

Hypothesized No. of CE(s)	Eigenvalue	Trace Stat	0.05 Critical Value	Prob.**
None*	0.8119	2037.2650	760.5409	0.0000
At most 1*	0.7484	1861.8330	695.0496	0.0000
At most 2*	0.6943	1716.9350	640.9570	0.0000
At most 3*	0.6896	1592.5080	594.5066	0.0000
At most 4*	0.6813	1469.6730	548.6505	0.0000
At most 5*	0.6751	1349.6030	503.8266	0.0000
At most 6*	0.6619	1231.5570	459.7583	0.0000
At most 7*	0.6605	1117.6950	417.2519	0.0000
At most 8 *	0.6570	1004.2670	374.9076	0.0000
At most 9 *	0.6534	891.9101	322.0692	0.0000
At most 10 *	0.6439	780.6611	273.1889	0.0000
At most 11 *	0.6424	672.2533	228.2979	0.0001
At most 12 *	0.6365	564.2802	187.4701	0.0000
At most 13 *	0.6312	458.0251	150.5585	0.0000
At most 14 *	0.6183	353.2980	117.7082	0.0000
At most 15 *	0.5059	252.1643	88.8038	0.0000
At most 16 *	0.4229	178.1345	63.8761	0.0000
At most 17 *	0.3477	120.4084	42.9153	0.0000
At most 18 *	0.3308	75.5525	25.8721	0.0000
At most 19 *	0.2723	33.3740	12.5180	0.0000

Panel 2: Max-Eigenvalue test

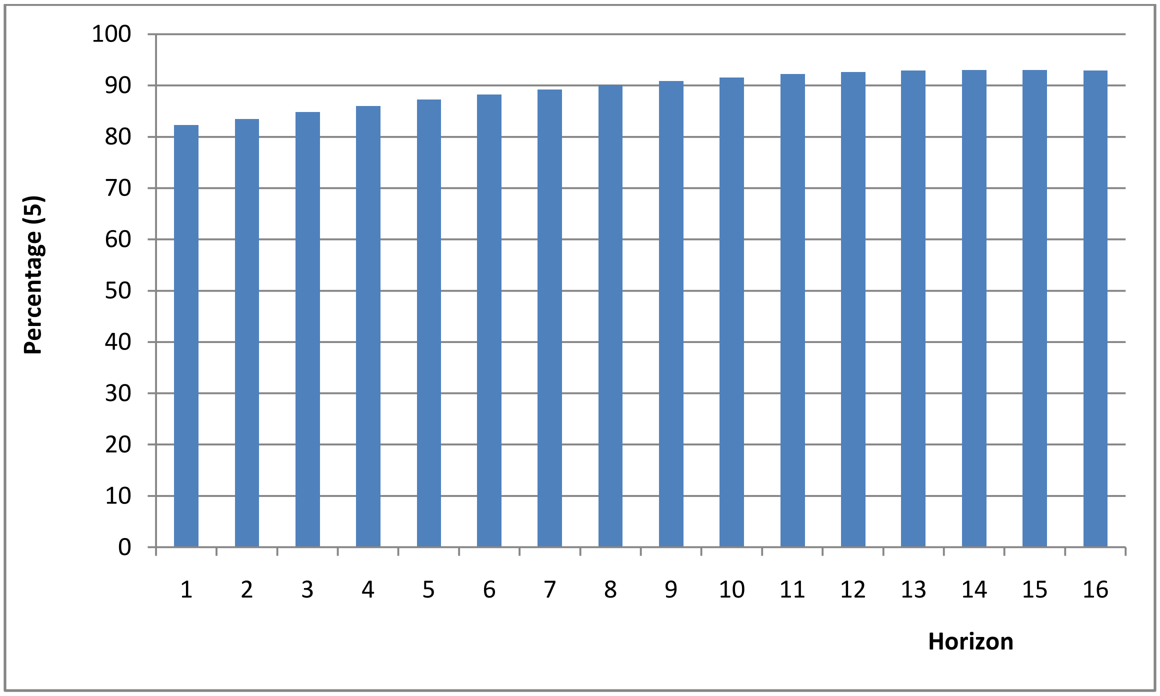
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Stat	0.05 Critical Value	Prob.**
None*	0.8119	175.4311	126.2691	0.0000
At most 1*	0.7484	144.8984	104.2928	0.0000
At most 2*	0.6943	124.4273	89.5584	0.0000
At most 3*	0.6896	122.8346	88.4120	0.0000
At most 4*	0.6813	120.0704	86.4224	0.0000
At most 5*	0.6751	118.0455	84.9650	0.0000
At most 6*	0.6619	113.8626	81.9543	0.0000
At most 7*	0.6605	113.4280	81.6415	0.0000
At most 8 *	0.6570	112.3565	80.8703	0.0000
At most 9 *	0.6534	111.2489	74.8375	0.0000
At most 10 *	0.6439	108.4078	68.8121	0.0000
At most 11 *	0.6424	107.9731	62.7522	0.0000

At most 12 *	0.6365	106.2552	56.7052	0.0000
At most 13 *	0.6312	104.7271	50.5999	0.0000
At most 14 *	0.6183	101.1337	44.4972	0.0000
At most 15 *	0.5059	74.0298	38.3310	0.0000
At most 16 *	0.4229	57.7261	32.1183	0.0000
At most 17 *	0.3477	44.8558	25.8232	0.0001
At most 18 *	0.3308	42.1785	19.3870	0.0000
At most 19 *	0.2723	33.3740	12.5180	0.0000

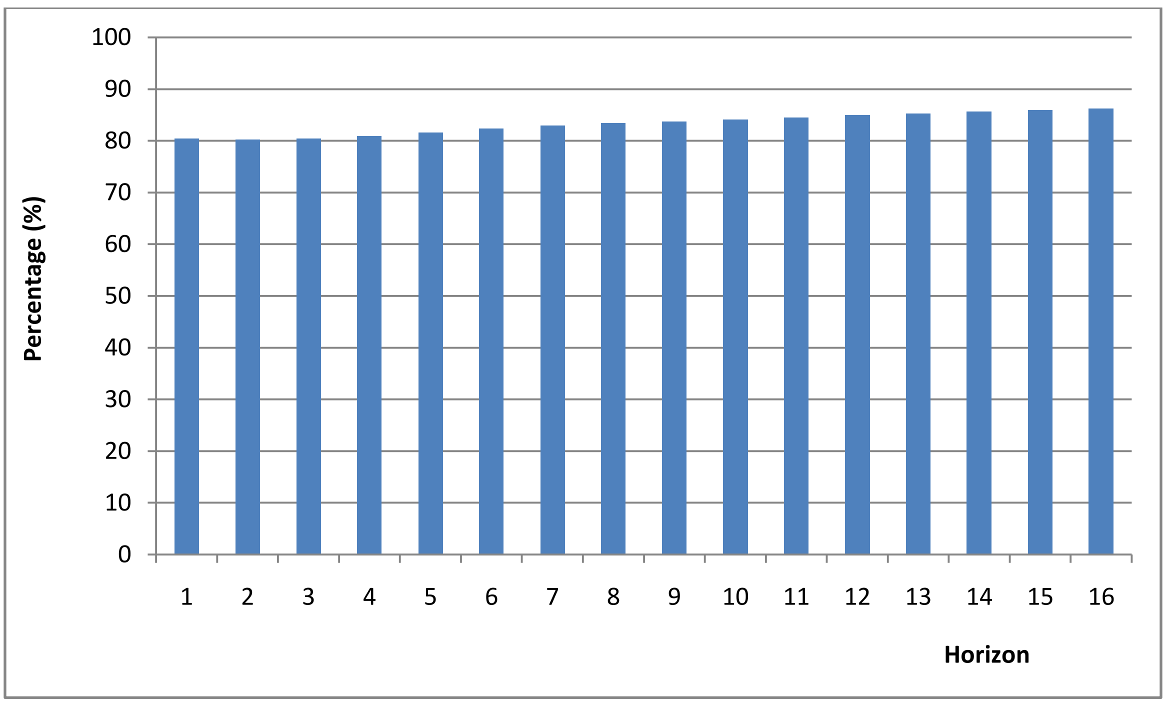
Source: Authors.

Appendix 5: Plots of *Total Trade Linkage Index* (TTLI)

Panel 1: For Exports Data



Panel 2: For Imports Data



Source: Authors. **Notes:** The graphs plot the *Total Trade Linkage Index* of equation (9) based on the data for exports and imports.

Appendix 6: The *From-effect* Linkage of African Economies

Panel 1: Based on Exports Data

Country	South Africa	DR Congo	Egypt	Ghana	Morocco	Nigeria	Tanzania	Tunisia
USA	7.5340	3.1220	5.2535	2.4920	3.2451	8.0425	1.6142	5.8582
Brazil	7.0609	0.8813	8.9311	0.4341	11.8017	3.1421	3.4896	7.0440
Russia	7.7612	12.5327	11.0425	3.4878	3.7666	3.2531	2.0684	9.5616
India	3.7554	8.8615	2.8643	6.8745	1.4462	4.5156	2.7108	2.0011
China	7.2605	5.5905	6.5828	9.8491	4.4992	7.4646	1.9369	7.9720
South Africa	9.7203	3.6750	7.2784	3.5206	3.1078	5.9433	2.5869	6.8574
Australia	1.1614	4.4655	0.2851	0.8205	10.9096	0.2585	3.2873	1.5055
Canada	7.3007	7.3293	5.0845	1.7185	5.7174	5.4735	0.8255	6.0655
EU	8.4055	2.5762	6.6141	2.6268	4.8995	6.8512	1.2978	6.8320
Indonesia	1.9769	2.4314	0.1169	8.0320	1.8449	1.6285	1.4550	0.5139
Japan	8.5308	4.0028	5.5534	2.2141	6.2552	8.5835	1.6891	7.0244
Malaysia	5.6649	7.0935	3.7736	3.1557	2.6228	6.7378	1.9406	3.7956
UK	5.3469	1.6542	6.4573	11.0048	1.9054	10.7249	5.5380	4.5530
DR Congo	2.9744	21.5520	3.9112	7.1369	0.9432	2.6191	0.7574	3.2377
Egypt	4.3495	3.7493	14.0244	1.7884	3.1158	2.7479	8.0075	6.0913
Ghana	0.3332	3.9604	2.1476	26.1490	1.0461	0.4486	1.2166	2.4795
Morocco	2.6742	1.2945	2.8298	0.4647	23.2156	2.7901	4.7621	4.8632
Nigeria	3.0411	0.5806	2.2706	6.4205	1.4887	13.0388	4.2022	2.5243
Tanzania	0.3455	1.0693	0.3545	1.1170	2.4621	3.1812	50.1363	0.6036
Tunisia	4.8028	3.5778	4.6245	0.6928	5.7070	2.5551	0.4778	10.6163
Total From-effect	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total from Regional Trading Blocs								
Total from BRICS	25.8380	31.5410	36.6990	24.1662	24.6216	24.3188	12.7926	33.4361
Total from Asia	34.9497	40.5125	29.9335	33.6134	20.4349	32.1832	11.8008	30.8685
Total from Europe	13.7525	4.2304	13.0714	13.6316	6.8050	17.5761	6.8358	11.3850
Total from the Americas	21.8956	11.3326	19.2691	4.6445	20.7642	16.6581	5.9294	18.9677

Panel 2: Based on Imports Data

Country	South Africa	DR Congo	Egypt	Ghana	Morocco	Nigeria	Tunisia	Tanzania
USA	8.4417	2.7346	6.4937	0.8671	5.8633	4.5316	5.0364	0.8786
Brazil	6.2986	1.7990	5.2082	6.7154	4.2216	2.3105	7.9339	5.3891
Russia	8.0149	2.2871	8.5737	5.9520	4.4582	0.3436	7.2180	0.8594
India	2.4108	8.8781	3.2734	4.1954	8.0329	5.9152	3.5292	3.1134
China	5.7369	6.7788	5.1214	9.7239	3.6961	0.3302	4.8212	1.5927
South Africa	9.6491	2.3300	7.0515	2.2174	3.7526	1.6513	5.8827	1.5241
Australia	2.9237	6.7747	2.9516	6.2979	6.9457	0.3181	4.3946	2.4635
Canada	6.8897	3.1125	5.5227	4.7717	8.2931	0.7959	6.1205	0.5466
EU	7.1382	4.1920	4.0932	0.9740	8.2114	4.4444	7.1835	1.6233
Indonesia	4.5443	0.3361	3.7592	0.3145	2.4308	0.4855	2.0374	0.5870
Japan	6.7811	2.7701	6.1483	4.2867	4.6307	3.7472	6.4150	5.3856
Malaysia	5.7080	0.8193	5.6191	2.7331	6.1632	4.2365	2.6281	2.5684
UK	7.9705	0.8899	5.7763	0.9308	1.8636	7.5911	3.9259	3.0355
DR Congo	0.9940	31.4128	0.4962	5.1581	2.9301	0.7936	3.2248	9.4814
Egypt	3.3338	1.5688	11.3752	5.7598	3.4201	1.8514	4.0609	1.6733
Ghana	1.4299	2.5910	4.5405	24.3033	1.4637	6.0390	3.6649	1.0144
Morocco	2.9828	9.1510	3.2439	5.0298	13.6523	2.8312	6.4231	3.4121
Nigeria	1.6423	0.6604	3.1183	1.7516	0.7315	39.0801	0.9295	6.8504
Tunisia	4.0701	3.4480	5.0979	6.3742	6.7218	3.5759	11.7458	3.8775
Tanzania	3.0396	7.4657	2.5357	1.6435	2.5175	9.1275	2.8247	44.1238
Total From-effect	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total from Regional Trading Blocs								
Total from BRICS	22.4613	22.0729	29.2282	28.8040	24.1613	10.5508	29.3849	12.4787
Total from Asia	33.1961	21.8695	32.4952	27.2055	29.4119	15.0583	26.6489	14.1065
Total from Europe	15.1087	5.0819	9.8695	1.9048	10.0749	12.0355	11.1094	4.6588
Total from the Americas	21.6300	7.6461	17.2245	12.3541	18.3780	7.6381	19.0908	6.8143

Source: Authors. **Notes:** The notes in Table 2 apply.

Appendix 7: *Dependence* and *Influence Indices* Results

	Panel 1: Based on Exports Data		Panel 2: Based on Imports Data	
Country	**Dependence Index**	**Influence Index**	**Dependence Index**	**Influence Index**
USA	0.9188	0.0959	0.9065	0.0856
Brazil	0.8344	0.1108	0.8742	0.0260
Russia	0.8388	0.2094	0.8924	0.0929
India	0.9000	-0.1139	0.8413	-0.0254
China	0.9102	0.1438	0.8912	0.0402
South Africa	0.9028	0.0416	0.9035	0.0097
Australia	0.7105	-0.2842	0.8673	-0.0439
Canada	0.8991	0.0946	0.8986	0.1122
EU	0.9121	0.1077	0.8971	0.0713
Indonesia	0.7591	-0.3108	0.8369	-0.2587
Japan	0.8998	0.1361	0.8803	0.0883
Malaysia	0.9000	0.0528	0.8364	0.0472
UK	0.8870	0.0649	0.8808	-0.0493
DR Congo	0.7845	-0.0328	0.6859	-0.0974
Egypt	0.8598	-0.0230	0.8862	-0.1441
Ghana	0.7385	-0.3746	0.7570	-0.1304
Morocco	0.7678	-0.0723	0.8635	0.1011
Nigeria	0.8696	-0.1538	0.6092	-0.2776
Tanzania	0.4986	-0.3598	0.5588	-0.0770
Tunisia	0.8938	-0.1993	0.8825	-0.0518

Source: Authors. **Notes:** The notes in Table 3 apply.

Appendix 8: *Net-effect* Linkage Results

	Panel 1: Based on Exports Data			Panel 2: Based on Imports Data		
Country	**From-effect**	**To-effect**	**Net-effect**	**From-effect**	**To-effect**	**Net-effect**
USA	91.8838	111.6203	19.7365	90.6516	108.0837	17.4321
Brazil	83.4405	104.8823	21.4418	87.4223	92.2305	4.8081
Russia	83.8838	130.1518	46.2681	89.2421	107.6102	18.3681
India	90.0031	71.5701	-18.4330	84.1338	84.2608	0.1270
China	91.0213	121.6863	30.6650	89.1159	96.6746	7.5587
South Africa	90.2797	98.2282	7.9485	90.3509	92.3706	2.0197
Australia	71.0525	39.5694	-31.4831	86.7260	79.8447	-6.8813
Canada	89.9143	108.9583	19.0440	89.8639	113.1561	23.2923
EU	91.2144	113.4632	22.2487	89.7115	103.6992	13.9877
Indonesia	75.9059	40.5570	-35.3488	83.6906	49.2962	-34.3944
Japan	89.9771	118.4811	28.5039	88.0287	105.4533	17.4246
Malaysia	89.9995	100.1143	10.1148	83.6384	92.2360	8.5975
UK	88.7018	101.1048	12.4029	88.0782	79.9256	-8.1526
DR Congo	78.4480	73.8784	-4.5696	68.5872	57.6096	-10.9776
Egypt	85.9756	83.8059	-2.1696	88.6248	66.5117	-22.1131
Ghana	73.8510	36.4252	-37.4258	75.6967	60.7614	-14.9354
Morocco	76.7844	66.6083	-10.1761	86.3477	106.6309	20.2831
Nigeria	86.9612	63.8121	-23.1491	60.9199	35.1031	-25.8168
Tanzania	49.8637	23.9716	-25.8921	55.8762	53.5112	-2.3650
Tunisia	89.3837	59.6566	-29.7271	88.2542	79.9916	-8.2626

Source: Authors. **Notes:** The notes in Table 4 apply.