

# Trade linkages and business cycle co-movement: an empirical analysis of Africa and its main trading partners using Global VAR

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## Abstract

This paper assesses the extent of trade linkages and shock transmission between African economies and its main trading partners, namely China, Europe and the United States (US). Using the global vector autoregressive (GVAR) model, the paper investigates how shock transmission between Africa and its main trading partners evolves over the periods before and after the 1990s. Moreover, the paper assesses the extent of business cycle synchronization between Africa and the three trading partners during the same periods. The results suggest that before 1990s, Europe had significant trade linkages with Africa in that shocks to imports and exports in Europe impacted positively on exports and imports in Africa, respectively. However, after the 1990s, Europe's influence has reduced in favour of China. The results also suggested that the period of significant and strong trade linkages between Africa and China corresponds to the synchronization of their business cycles. This is not the case with Africa and the Euro area as well as Africa and the US, where trade linkage did not translate into business cycle synchronization. Moreover, the results indicate that the US remains the source of contagion for African economies.

**Keywords:** Trade linkages GVAR model, business cycle synchronization, Africa

**JEL classification:** C32, C51, F44

## 1 Introduction

The rise of globalization has led a growing body of literature to investigate the impact of trade linkages on business cycle co-movement between countries and regions (Rosmy and Simons, 2014; Kandil, 2011; Lee, 2010; Kose et al., 2003).

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According to conventional wisdom countries that trade with each other have a correlated business cycle and the magnitude of the transmission of shock increases with bilateral trade between these countries (Kose and Yi, 2005) Following the literature, African countries' business cycle should be highly correlated with those of Europe, the US and China, as close to 50%<sup>1</sup> of Africa's total export and imports are with them.

The relationships between Africa and Europe and Africa and the United States can be traced back to the era of colonization. Most African countries have had trade ties with European countries due to their colonial history and with the United States because it was, and still is, the largest economy in the world. However, the recent global changes in the world's geopolitics, as shown by the resurgence of Asian economies, especially China, and the creation of BRICS<sup>2</sup> have dramatically altered both international relationships and world trade. China's quest for a closer relationship with the rest of the world has led the former to have an influential position in the world economy, which needs to be seriously considered by the former major players namely European Union and United States. This is especially evident in the case of Africa, where the emergence of China has significantly altered Africa's direction of trade, which had been dominated by Europe and the United States (Obuah, 2012).

It is important to note that African countries, as an economic bloc, occupy a very low position in the global market. The continent's share of world trade is insignificant. According to the African Union Commission (2013), the Africa's total imports account for only 1.8% of world imports, while its total exports represent 3.6 % of world exports. Nonetheless, the three major African trading partners continue to influence the economy of the continent to a varying extent. Thus, the aim of this paper is to assess the extent at which the entry of China within African market has somewhat changed the patterns of trade linkages between the continent and its former major player (US and Euro). Moreover, the paper investigates the degree of shock transmission and business cycle synchronization between Africa and each of its main trading partners. The empirical analysis is conducted in two different sample periods: the period 1980–1996 and the period 1997–2012. The year 1996 as a cutting point of our empirical analysis, corresponds to the economic and financial liberalization of a number of African economies and the rising prosperity and global influence of the Chinese economy in the 1990s (Bonga-Bonga, 2012; Compendium, 2005) In addition the cutting point also coincides with the creation of the World Trade organisation (WTO)<sup>3</sup> in 1995. The establishment of WTO has permitted more trade linkages among its members, mainly dominated by developing economies (Rena, 2012).

Trade linkages are an important aspect of shock transmission (Frankel and Rose, 1998); however there is no universal view on whether strong trade linkages lead to more or less business cycle synchronization. According to Kose and Yi (2001), the relationship between trade linkages and business cycle synchronization depends on the type of trade (intra-industry trade and inter-industry trade)

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<sup>1</sup>World Bank indicator (online databases from Quantec)

<sup>2</sup>Brazil, Russia, India, China and South Africa

<sup>3</sup>Replacing the General Agreement on Tariffs and Trade (GATT)

and the nature of shocks (demand or supply shock). When intra-industry trade dominates bilateral exchange between two countries, any shock contributes to the rise in the level of business of business cycle correlation among the countries (Calderon et al. 2007; Kose and Yi, 2001; Frankel and Rose, 1997). However, Krugman (1991, 1993), Kenen (1969), Baxter and Kouparitsas (2005) point out that strong trade linkage actually reduce the synchronization of business cycles between two countries. In fact, according to the authors inter-industry trade always dominates bilateral exchange especially among developing countries. Thus, any industry-specific shock on one country will not affect the other economy.

Empirical studies that have investigated the impact of trade linkages on business cycle synchronization or business cycle co-movement generally have concluded that strong bilateral trade between two countries leads to the synchronization of their business cycles. These studies include those of Marcus (2011), Dees and Zorell (2011), Rosmy and Simons (2014), Antonakakis (2014), Chi Gong and Soyoungh (2013), Pía Olivero and Madak (2011), Di Giovanni and Levchenko (2010), Kandil (2011), Gouveia and Correia (2013). These authors have for the most part used regression analyses in order to examine the relationship between trade linkages and business cycle synchronization. For example, using cross-section augmented VAR in the Euro area, Marcus (2011) found that although countries with strong trade linkages tend to have more similar business cycles in the long term, the trade channel does not help to explain the synchronization in the short term. In addition, Dees and Zorell (2011) used a system of equations proposed by Imbs (2004, 2006) on developed countries and concluded that the GDPs of economies with more intensive bilateral trade move more closely together. Using simultaneous equations among European countries, Antonakakis (2014) found that trade and foreign direct investment have a significant positive effect on business cycle synchronization.

Most of the studies that assess the relationship between trade linkage and business cycle have been focused on developed or emerging countries. The few studies that were conducted on Africa mainly focused on individual countries such as South Africa (see Nyembwe and Kholodilin, 2005; Boshoff 2011). However, this study is the first to deal with the issue of trade linkage and business cycle between Africa and its three main trading partners during two different sample periods. Assessing whether there is more or less output synchronization between Africa and its main trading partners is important for African economies. Firstly, more synchronized business cycles would presumably mean a stronger and faster transmission of shocks across countries, which could provide an important motivation for international policy coordination. Secondly, if business cycles in a country are mostly driven by external factors, domestic policy aimed at economic stabilization will probably have a smaller impact (Garcia-Herrero and Ruiz (2008). Policymakers in Africa should be aware of these realities when proposing economic policies.

Our approach in investigating the issue of trade linkages between Africa and its main trading partners is different to previous studies in that we make use of GVAR methodology to group 33 African countries in a region, referred to as Africa. In addition, the paper makes use of data from eight European countries

grouped as Euro area as well as data from 20 other countries in the world in addition to data from China and the U.S. Instead of using regression framework to identify the relationship between trade linkage and business cycle, we makes use of the GVAR model proposed by Persaran *et al.* (2004) and further developed by Dees *et al.* (2007) to investigate the dynamics of shocks transmission between Africa and the three trading partners in the context of trade linkages and real output spillovers during a specific sample period. Moreover, the study assesses the nature of business cycle synchronization between Africa and the three trading partners during the corresponding sample period. Thus, the quasi correlation technique is used in order to assess the extent of business cycle synchronization. In doing so, the study endeavours to assess whether periods of strong trade linkages between Africa and its trading partners correspond to their business synchronization.

The rest of the paper is organized as follows. Section 2 outlines the relationship between Africa's trade and its main partners. In this section, the study intends to show the significance of trade between Africa and its main partners. Section 3 describes the methodology used as well as the data sources and sample period. Section 4 presents the results and their interpretation, and the last section concludes the study and provides some recommendations.

## 2 Africa's relationship with its main trading partners

The shares of trade, in terms of exports and imports, are widely used in the literature to measure trade linkages and some authors have found them to be positive and significantly correlated with economic growth (see Saldariaga and Winkelried, 2014). The implication of increased shares of trade means that when African countries are becoming increasingly integrated into the global economy, Africa's macroeconomic performance is also becoming increasingly linked to the developments in the economies of trading partners. The trade linkages between two countries can be defined as the sum of country  $i$ 's imports from country  $j$  and exports to country  $j$  divided by the sum of country  $i$ 's total imports and exports (Blanchi *et al.*, 2011).

In this section, we briefly provide an insight on the trend and intensity of trade between Africa and the three trading partners Figure 1 and 2 present the trade share and total trade between Africa and each of the three trading partners, respectively. By definition the total trade is simply the sum of the values of export and import. Figure 1 shows that of the total trade between Africa and the three main trade partners, the trade share between Africa and the Euro area decreased from 93% in 1970 to 33% in 2013, while the trade share between Africa and China increased from 1% in 1970 to 46% in 2013 making China Africa's number one trade partner since 2009 (Global times, 2013).

Figure 2 shows the trend of total trade between Africa and the three main trading partners from 1970 to 2013. The increasing trend in trade between the

Euro area and Africa in the 1970s experienced a remarkable decline in early 1980s, due mainly to the negative effects of the 1980 global crisis. Nevertheless, Figure 2 shows an increasing trend of trade between Africa and each of the three main trading partners in early 2000s. This occurrence can be dubbed as a race for Africa's trade share from the three main trade partners as it is during that period that a number of trade agreements were signed between Africa and each of the three partners. For example, the commitment made by United States in 2000 in order to support the development of trade in Africa through the African Growth and opportunity Act (AGOA) has resulted to an increase in African exports towards US. The AGOA act provides duty-free market access to US for some qualifying African countries. Since its approval in May 2000, total African exports to the US have more than quadrupled<sup>4</sup> as shown in Figure 2.

Through the forum on China-Africa cooperation (FOCAC) established in October 2000, China signed bilateral trade and investment treaties and created joint economic commission mechanisms to support African countries

It is important to note that China's trade with Africa was insignificant between 1970 and early 1990s, due to the limited relationship between the African continent and China. However, the emergence of China in the global economy has changed the direction of trade in a significant number of countries, including African economies. Many countries in Africa have shifted their direction of trade from the US and EU towards China (Obuah, 2012). As illustrated in Figure 1, China's trade share with Africa started to rise from 1997 onwards to become the largest Africa's trade partner in 2009. Figure 2 indicates that the global financial crisis of 2007 did not affect China's trade share with Africa to a greater extent as it did with the US and the Euro area. China dominates the market as Africa's biggest destination for oil and mineral exports (Lin and Farrell, 2013).

However, trade between Africa and China is not without controversy. For example, Moyo (2012) questioned the nature of the China-Africa trade relationship. The author points out that Chinese firms are desperately in search of natural resources, which might have some negative repercussions for the world in general and Africa in particular in the near future. Nonetheless, trade linkages between China and Africa have helped African countries to establish an upstream-downstream-integrated industry chain transforming resource advantages into economic growth opportunities. For example, in the Democratic Republic of Congo and other energy and mineral resources endowed African economies, Chinese enterprises have built up infrastructure in response to the extraction and exploitation of mineral resources (Global Times, 2013). While trade deal between Africa and China is assumed to have contributed to sustained economic growth for African countries in dire need of infrastructural development, trade deals between Africa and Western economies have been dubbed by a number of authors as sheer exploitation as Western countries buy raw material from Africa at a very low prices and resell finished products to Africa at higher prices, causing African countries to experience balance of payments

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<sup>4</sup>SA info, 2014

deficits (Acemoglu, Johnson and Robinson, 2001; 2002 and Boopen, 2006)

### 3 The GVAR methodology

Since the pioneering work of Sims (1980), the vector autoregressive (VAR) model has attained a prominent role among the tools used for macroeconomic analysis. Nevertheless the methodology has been criticized for its inability to handle largescale data. Moreover, as pointed out by Pesaran *et al.* (2004) the VAR model is often estimated using cross-sectional data, ignoring possible international linkages. The authors went on to explain that, in the presence of international linkages in a VAR model, one might have to include either higher-order time lags or half a dozen domestic variables, in order to capture complicated international linkages. Given the failure of the VAR model to handle largescale variables, and in addition to the increased globalization and interdependency of the world economy, economists and econometricians have attempted to develop largescale macro-econometric models to forecast and quantify the global interdependencies that exist between countries.

Thus, the global VAR (GVAR) proposed by Pesaran *et al.* (2004), and further developed by Dees *et al.* (2007) is most suitable for examining international shocks and their spillover effect among countries (Dees *et al.*, 2007; Chen *et al.*, 2010; Bussiere *et al.*, 2012; Galesi and Lombardi, 2009; Vasishtha and Maier, 2013). The GVAR is also suitable for the research question set by this paper for many reasons. Firstly, the analysis is suitable for the large data sample used in this paper. Secondly, the general impulse response functions (GIRFs) obtained from the GVAR model are invariant to the order of the variables used Thirdly, The GVAR model has the ability to combine individual country-specific models into a global framework, and allows for the analysis of interactions between them, while avoiding any dimensionality problems. The country-specific model is linked with the rest of the countries through country-specific foreign variables, in such a way that a shock in one country could be propagated to the rest of the world.

This study uses the GVAR model in order to investigate the transmission of shocks between Africa, China, the US and the EU. It is important to note that the GVAR modelling strategy consists of three main steps as proposed by Pesaran *et al.* (2004) and Dees *et al.* (2007). Firstly, each country is modelled individually as a small open economy by estimating a country-specific vector error-correction model in which domestic macroeconomic variables are related to country-specific foreign variables. Global variables which are common among all countries (such as the oil price) are also included in each of the country-specific models and assumed to be weakly exogenous. Secondly, a restricted reduced-form global model is built stacking the estimated country-specific models and connecting them through a matrix of trade linkages. Thirdly and finally, taking into account the possibility that the error terms of this restricted/reduced form model are correlated contemporaneously, impulse response functions and forecast error variance decompositions may be computed to analyse the transmission

of shocks and their historical importance. In between these steps, a number of tests should be performed; these include the unit root test, the cointegration test and the weak exogeneity test.

### 3.1 Country specific models

The modelling of country-specific VECM is done as follows:

For a set of  $(N + 1)$  countries indexed by  $i = 0, 1, 2, \dots, N$ , with country 0 taken as the reference country, which is the United States in this study.

Each country  $i$  is modelled as a  $VARX^*$  specification of the form:

$$x_{it} = a_{i0} + a_{i1}t + \phi_i x_{i,t-1} + \Lambda_{i0} x_{it}^* + \Lambda_{i1} x_{i,t-1}^* + \Gamma_{i0} d_t + \Gamma_{i1} d_{t-1} + \varepsilon_{it} \quad (1)$$

with  $t = 0, 1, 2, \dots, T$

$x_{it}$  is a  $(k_i \times 1)$  vector of domestic variables for each country  $i$  at time  $t$ .  $x_{it}^*$  is a  $(k_i^* \times 1)$  vector of foreign variables specific to each country  $i$  at time  $t$ .  $a_{i0}$  is a  $(k_i \times 1)$  vector of fixed intercept coefficient.  $a_{i1}$  is a  $(k_i \times 1)$  vector of coefficients of the deterministic time trend,  $\phi_i$  is a  $(k_i \times k_i)$  matrix of coefficient associated with lagged domestic variables.  $\Lambda_{i0}$  and  $\Lambda_{i1}$  are  $(k_i \times k_i^*)$  matrices of coefficients related to foreign and lagged foreign variables respectively.  $d_t$  is a set of common global variables assumed to be weakly exogenous to the global economy but should be endogenous to only one country, the reference country. As the United States is taken as the reference country, the study therefore considers  $d_t$  as the endogenous variable for this specific country.  $\Gamma_{i0}$  and  $\Gamma_{i1}$  are matrices of fixed coefficients. The error term  $\varepsilon_{it}$  is a  $(k_i \times 1)$  vector of shocks specific to each country, which is assumed to be serially uncorrelated with average equal zero and with a nonsingular covariance matrix that is  $\varepsilon_{it} \rightarrow i.i.d. (0, \sum_{ii})$ .

Country-specific foreign variables play a crucial role in the GVAR methodology as they measure the magnitude of the influence that other countries have on the domestic economy. The country-specific foreign variables are calculated as weighted averages of the corresponding variables in other countries. These variables are generated using fixed or varying trade weight. With reference to Pesaran *et al* (2004) and Dees *et al* (2007), this study uses the fixed trade weight. Dees *et al.* (2007) in their study used the time-varying trade weights and concluded that these have a small impact on the results of the GVAR. Besides this, time-varying trade weights can only be used when the time span of the trade flows cover the time period of the estimation sample. In this study there are some missing values in the trade flows data for some African countries in certain years, which make it impossible for the study to use time-varying trade weights. The weight  $w_{ij}$  is computed as the share of country  $j$  in the total trade of country  $i$ .

$$w_{ij} = \text{average}(\text{export}_{ij} + \text{import}_{ij})$$

Therefore,  $w_{ii} = 0 \forall i = 0, 1, 2, \dots, N$  and  $\sum_{j=0}^N w_{ij} = 1 \forall i, j = 0, 1, 2, \dots, N$

Thus, the foreign specific variable is constructed as:

$$x_{it}^* = \sum_{j=0}^N w_{ij} x_{jt} \text{ with } w_{ij} > 0 \quad (2)$$

In addition to foreign variables, the study includes one global variable which is the oil price (*poil*), thus  $d_t = (poil)$  in equation (1) Both the foreign and global variables should be considered as weakly exogenous according to Pesaran *et al* (2004) in order to allow the estimation of a country/regionspecific model to be consistent This assumption implies that with the exception of the United States, the rest of the countries should be considered small and open economies. The weak exogeneity in the context of cointegrating models implies no long feedback from  $x_{it}$  to  $x_{it}^*$  without necessarily ruling out lagged shortrun feedback between the two sets of variables (Dees *et al*, 2007). The weak exogeneity implies that the macroeconomic variables of the reference country which is the United States in this study might affect the macroeconomic variables of the rest of the countries considered in our sample, but the reverse is not possible. Thus the GVAR model allows for interaction among economies through three separate and interrelated channels as defined by Pesaran *et al* (2004) which are the following: firstly the direct dependence of domestic variables  $x_{it}$  on foreign variables  $x_{it}^*$ , secondly the dependence of the country-specific domestic variables  $x_{it}$  on common global exogenous variables  $d_t$ , and lastly the vector of countryspecific shock country  $\varepsilon_{it}$ .

### 3.2 Specifications of the global VAR model

Having specified the countryspecific *VARX* models, the next step is to combine them into one global model. The estimated parameters from the country-specific models are then stacked together to build a global VAR. Let us consider the *VARX* without the global variable, because this variable is considered endogenous for the US model, as it is the dominant economy in the model, while weakly exogenous for the remaining country-specific models. Thus, equation (1) is written as follows:

$$x_{it} = a_{i0} + a_{i1}t + \phi_i x_{i,t-1} + \Lambda_{i0} x_{it}^* + \Lambda_{i1} x_{i,t-1}^* + \varepsilon_{it} \quad (3)$$

The global variables are included as foreign variables for all countries except the US model where the variable is considered to be a country-specific variable. Thus to construct the global VAR model from the individual country-specific models, we assume a matrix  $Z$  that combines domestic and foreign variables for each country within a single vector such as:

$$Z_{it} = (x_{it}, x_{it}^*)$$

Therefore equation (3) becomes:

$$A_i Z_{it} = a_{i0} + a_{i1}t + B_i Z_{i,t-1} + \varepsilon_{it} \quad (4)$$

Where  $A_i = (I_{k_i}, -\Lambda_{i0})$  and  $B_i = (\phi_i, \Lambda_{i1})$

The dimensions of  $A_i$  and  $B_i$  are  $k_i \times (k_{it} + k_{it}^*)$  and  $A_i$  has a full row rank which means  $rank(A_i) = k_i$ .

In order to create the global vector  $x_t$ , we collect all the country/regionspecific domestic data with dimension  $(k \times 1)$  where  $k = \sum_{i=0}^N k_i$  denotes the total number of endogenous variables in the system:  $x_{it} = (x_{0t}, x_{1t}, x_{2t}, \dots, x_{Nt})$ .



We assume that all country-specific variables in the global economy are endogenously determined. We can now write country-specific variables in terms of the global variable vector  $x_t$ , to obtain the following identity:

$$Z_{it} = M_i x_t \quad \forall i = 0, 1, 2, 3, \dots, N \quad (5)$$

Where  $M_i$  is a  $(k_{it} + k_i^*) \times k_i$  matrix collecting the trade weights  $w_{ij} \forall i, j = 0, 1, 2, \dots, N$ . With reference to Pesaran, Schuermann and Weiner (2004),  $M_i$  is defined as the link matrix which allows the country-specific models to be written in terms of the global variable vector  $x_t$ . Thus, by expression in Equation (5) in each country-specific model in Equation (4), we then have the following formulation:

$$A_i M_i x_t = a_{i0} + a_{i1} t + B_i M_i x_{i,t-1} + \varepsilon_{it} \quad (6)$$

Where  $A_i M_i$  and  $B_i M_i$  are both  $(k \times k)$  dimensional matrices. Finally by stacking each country-specific model in equation (6), we then obtain the global VAR for all the endogenous variables in the system  $x_t$ ,

$$K x_t = a_0 + a_1 t + P x_{t-1} + \varepsilon_{it} \quad (7)$$

With  $K = A_i M_i$  and  $P = B_i M_i$

$$\begin{aligned} \text{Where } K &= \begin{pmatrix} A_0 M_0 \\ A_1 M_1 \\ \dots \\ \dots \\ A_N M_N \end{pmatrix} \quad P = \begin{pmatrix} B_0 M_0 \\ B_1 M_1 \\ \dots \\ \dots \\ B_N M_N \end{pmatrix} \quad a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \dots \\ \dots \\ a_{N0} \end{pmatrix} \quad a_1 \\ &= \begin{pmatrix} a_{01} \\ a_{11} \\ \dots \\ \dots \\ a_{N1} \end{pmatrix} \quad \varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ a_{1t} \\ \dots \\ \dots \\ \varepsilon_{Nt} \end{pmatrix} \end{aligned}$$

The  $K$  matrix has dimensions  $(k \times k)$  and if it is non-singular, then it can be inverted. By inverting the  $K$  matrix we get the global VAR model in its reduced form:

$$x_t = K^{-1} a_0 + K^{-1} a_1 t + K^{-1} P x_{t-1} + K^{-1} \varepsilon_{it} \quad (8)$$

Thus equation (8) can also be written as follows:

$$x_t = b_0 + b_1 t + T x_{t-1} + \mu_t \quad (9)$$

With  $b_0 = K^{-1} a_0$ ,  $b_1 = K^{-1} a_1$ ,  $T = K^{-1} P$  and  $\mu_t = K^{-1} \varepsilon_{it}$

Where  $x_t$  is the global vector with dimension  $(k \times 1)$  and  $k = \sum_{i=0}^N k_i$  is the total number of the endogenous variables in the global model containing the macroeconomic variables for all the countries,  $x_t$  is a function of time, and  $x_{t-1}$

is the lagged value of all macro-economic variables, the exogenous variables common to all countries and their lags.  $b_0$  and  $b_1$  are vector ( $k \times 1$ ) of coefficients,  $T$  is a matrix of ( $k \times k$ ) dimension and  $\mu_t$  is a ( $k \times 1$ ) vector of reduced form shocks, which are a linear function of the country-specific shocks. Thus, equation (9), which is the GVAR model, can be solved recursively and the dynamic properties of the model are analysed using generalized impulse response functions (GIRFs).

### 3.3 Estimation of the model, data and data sources

In this study, the global VAR contains a total of 63 countries 33 African countries and 30 countries from other region in the world. Table 2 shows the list of countries included in the sample The sample period is divided into two sub-periods: the first sub-period 1980Q1-1996Q4, which corresponds with an increasing international trade relationship between Africa and of the US and Europe. The period also reveals a period of financial repression for most African economies. On the other hand, the second sub-period 1997Q1-2012Q4, illustrates the financial liberalization of many African countries (Bonga-Bonga, 2012) and also the emergence of China in the global economy. Given the objectives of the study the variables included in the estimation are the following: real GDP, real export, real import, inflation rate and the oil price (see Table 3 for the names and codes of these variables)

The first stage in the construction of the model is to define the domestic and foreign variables. For country  $i = 1, 2, 3, \dots, N$ , the following country-specific domestic  $x_{it}$  and foreign variables  $x_{it}^*$  are considered:

$$x_{it} = (y_{it}, x_{it}, m_{it}, Dp_{it}, ep_{it}) \text{ and } x_{it}^* = (y_{it}^*, Dp_{it}^*, poil_t)$$

Where  $y$  is the real Gross Domestic Product,  $Dp$  is the inflation rate,  $ep$  is the real exchange rate  $x$  is the real export and  $poil$  is the oil price. The oil price is treated as an exogenous variable for all the countries included in the sample except the US following the specification of the GVAR. Since the US is the reference country, its equation is different from the other countries within the sample. The following domestic and foreign variables for US model:

$$x_{0t} = (y_{0t}, x_{0t}, m_{0t}, Dp_{0t}, poil_t) \text{ and } x_{0t}^* = (y_{0t}^*, Dp_{0t}^*, ep_{0t}^*)$$

Given the importance of the US economy for the global economy the study includes the oil price as an endogenous variable for the US model and treats the set of real exchange rates as weakly exogenous for the US model. The real exchange rate is included in the US model as weakly exogenous, because in practice the real value of the US dollar is determined outside the US model (Cesa-Bianchi *et al.*, 2011). The country-specific foreign variables are built using fixed trade weights The countryspecific foreign variables are defined as follows:

$$y_{it}^* = \sum_{j=0}^N w_{ij} y_{jt} Dp_{it}^* = \sum_{j=0}^N w_{ij} Dp_{jt} \text{ and } ep_{it}^* = \sum_{j=0}^N w_{ij} ep_{jt}$$

The motivation behind choosing the trade weights is to accommodate the spillover effects of output shocks that might be propagated via the trade channel as pointed out by Pesaran *et al* (2004). The trade shares for the Africa economies with its main partners and the rest of the world are presented in Table 4. The study later aggregate countries as follows: Firstly, eight Europeans countries are modelled as in a single regional model and secondly all African countries in a single regional VARX\* model. Thus, the regional variable such as  $y_{it}$ ,  $x_{it}$ ,  $m_{it}$ ,  $ep_{it}$ ,  $Dp_{it}$  and  $poil_t$  are built from the countryspecific variables using the following weighted averages:

$$y_{it} = \sum_{p=1}^{N_i} w_{ip}^0 y_{ipt}$$

Where  $y_{ipt}$  indicates output of country  $p$  in region  $i$  and  $w_{ip}^0$  are the Purchasing Power Parity-GDP weights (PPP-GDP). Since the study estimates the region in two periods, 1980Q1-1996Q4 and 1997Q1-2012Q4, the regional weight is constructed for each of these periods. The weights are constructed by averaging the PPP-GDP for each country over a period of three years, depending on the sample period covered by the study. For example, in the first sub-period, 1980–1996, the PPP-GDP weight used applied to the period 1990–1992, while for the second sub-sample the PPP-GDP used is computed for the period 2006–2008. It is important to note that these weights (PPP-GDP) used to group countries into one region is different to the weight (trade weight) used to generate foreign-specific variables.

Before proceeding with the estimations, a number of tests should be conducted. The unit root test is conducted to ascertain the level of integration of variables. The study conduct the unit root test using both the Augmented Dickey-Fuller (AD) and the Weighted Symmetric Augmented Dickey-Fuller (WS-ADF) test, which uses the time reversibility of stationary autoregressiveness. The lag order for both tests (ADF and WS-ADF) was determined by the minimization of the Akaike Information Criterion (AIC), for which the maximum lag allowed is set to 4. The study report results from the WS-ADF test (see Table 5)<sup>5</sup> The results from the unit root test show that most of the variables are stationary in difference

Having verified the stationarity of the variables, the next step is to determine whether there is cointegration of long-term relationships between variables. The study then uses the Johansen (1992, 1995) reduced-rank procedure. The cointegration rank is derived by employing the trace test statistic at the 95% critical values and the maximum eigenvalue statistics. Table 6 presents the number of cointegrating ranks obtained for each of our focus economy VARX\* model as well as the lag orders for each their domestic and foreign variables. The study also conducts the weak exogeneity test for foreign and global variables. This test is the key assumption of the global VAR approach. The weak exogeneity assumption in the context of cointegrating models implies no long-term feedback from  $x_{it}$  to  $x_{it}^*$ , without necessarily ruling out lagged short-run feedback

<sup>5</sup>Other unit roots results can be obtained on request.

between the two sets of variables. With reference to Dees *et al.* (2007), we employed the weak exogeneity tests proposed by Johansen (1992) and Harbo, Johansen, Nielsen and Rahbek (1998). The results of F-statistics for testing the weak exogeneity of Africa and its main partner's country-specific foreign variables and the oil price are reported in Table 7. It shows that most of the weak exogeneity assumptions are accepted

It is important to note that the variables used in this study are collected from the International Financial Statistics (IMF) database, the Direction of Trade Statistics (DoT) of the IMF, the World Bank database and the GVAR toolbox 1.1. We also used interpolation in some cases, with the cubic spline method, in order to convert real GDP annual data into quarterly data. This was done only on some African countries, where real GDP quarterly data was not available. The study gives more detailed information about the variables and countries included in the analysis in Tables 2 and 3 in the appendix

## 4 Results and interpretation

This section presents the empirical results of the degree of trade linkage and the effects of shock transmissions between Africa and its main trading partners based on the generalized impulse response functions (GIRFs). The GIRFs are used to assess the effect of the different shocks on variables of interest used in this paper over a time horizon of 40 quarters. Nonetheless, the paper focuses on the results over eight quarters, which is a reasonable period for making inferences about short-term macro-economic dynamics (Dees *et al.*, 2007 and Gurura and Ncube, 2013). The results of the GIRFs reported from Figures 3 to 8 include the confidence intervals at the 95 % significance level, calculated using the bootstrap technique with 100 replications. Moreover, this section presents the empirical findings of the business cycle co-movement between Africa and its trading partners.

### 4.1 Generalized impulse response function of shocks in the context of trade linkages

In order to consider the extent of trade linkage between Africa and its three main trading partners, we consider two positive shocks, namely shocks to exports and imports from the three main trading partners, and their dynamic effects on imports and exports of Africa, respectively. It is important to note that when two countries are linked through trade, an increase in exports or imports in one country is translated into increase in imports or exports in the other country. Figures 3, 4 and 5 present the dynamic responses of exports and imports of Africa to shocks to trade variables from the Euro area, the US and China, respectively during the sub-sample periods 1980–1996 and 1997–2012.

Figure 3 displays positive real export and import shocks from the Euro area. It shows that the export shock from the Euro area has a positive impact on African imports during the sub-sample period 1980–1996. The effect is signifi-

cant from the second to the fourth quarter. Nonetheless the positive response of African's import to shock from Euro area is short-lasting and statistically insignificant for most of the time horizon. Likewise, positive import shock from the Euro area translates into a rise in Africa's real exports, with the effect being statistically significant on impact and for more than 15 quarters during the sub-sample period 1980–1996, while the positive response of Africa's real export to 1% import shocks to the Euro area is short-lasting during the sub-sample period 1997–2012. This reveals a significant trade linkage between Africa and the Euro area during the sub-sample period 1980–1996 compared to the sub-sample period 1997–2012.

Figure 4 presents the GIFS of positive real export and import shocks from the US. The results show that African imports react positively on impact to shocks to real exports from the US during the sub-sample 1980–1996, while the response of African imports to shocks to US exports is not statistically different from zero during the sub-period 1997–2012. Moreover, the results reported in Figure 4 show that African real exports react positively to import shocks from the US. The response of African real exports to import shocks from the US is long-lasting in the sub-period 1997–2012 compared to the period 1980–1996. The increased response of Africa real exports to import shocks from the US should be attributed to the benefit of the African Growth and Opportunity Act (AGOA) which resulted to a significant increase of the total African exports since its establishment in 2000 (see Figure 2)

Figure 5 displays real export and import shocks from China. A positive real export shock from China has no effect on African imports in both the sub-period 1980–1996 and 1997–2012, as the confidence interval shows that the results are statistically not different from zero. Nonetheless, the results presented in Figure 5 show that African real exports responded positively to import shocks from China only in the sub-period 1997–2012. This positive response is statistically significant from the 8<sup>th</sup> to the 20<sup>th</sup> quarter. However, during the sub-period 1980–1996, African real exports remained neutral to import shocks from China. This is not surprising, as during this period the relationship between China and Africa was insignificant, as shown in Figure 1. However, with the emergence of China in the global economy, the period 1997–2012 shows positive trade linkages between Africa and China. The positive response of African exports to import shocks from China in the sub-period confirms the increasing trade linkage between Africa and China during the sub-period 1997–2012, with China becoming the largest Africa trading partner from 2009. The percentage of Chinese imports from Africa increased from 2.47% in 2000 to 6.23% in 2012 (Global Times, 2013).

It is worth noting that, contrary to the US and Euro area, the trade linkages between Africa and China were insignificant during the period 1980–1996, as indicated by the results reported in Figure 5. However, trade linkages between China and Africa rose during the sub-period 1997–2012, as evidenced by an increasing proportion of Chinese imports from Africa with China becoming the largest of Africa's trading partners from 2009. These findings indicate the increasing trade linkages between China and Africa.

## 4.2 Generalized impulse response function of a shock to real GDP

This section examines the dynamic responses of Africa's real GDP to shocks to real GDP from the Euro area, the US and China in order to assess the extent of spillover of economic activities from the three trading partners to Africa. A number of studies make use of impulse response functions in the context of shock transmission among countries to make inferences about business cycle synchronization among countries (Darvas and Szapáry, 2008; Fidrmuc and Korhonen, 2006). Thus, the findings of this section will serve as a prelude to business cycle comovement between Africa and each of its three partners discussed in section 4.3. The rationale of using shock transmission of GDP between countries to make inferences about business cycle synchronization is that, if an increase in GDP in one country spills over to another country, there is the possibility of business cycle synchronization between the two countries

Figure 6 displays the dynamic response of Africa's real GDP to shocks to real GDP from the Euro area. The results of the GIRFs show a positive response of Africa's real GDP to positive shocks to GDP from the Euro area during the sub-period 1980–1996. The effects are statistically significant and longlasting. However, the effects of these shocks on African real GDP are shortlived and insignificant for most of the time horizon during the sub-period 1997–2012. The findings denote the decreasing spillover of economic activities from the Euro area to Africa.

Figure 7 displays the results of the GIRFs of a 1% increase in the US real GDP, during 1980–1996 and 1997–2012. The results show that the positive responses of Africa's GDP to shocks to US GDP are not statistically significant either in the sub-period 1980–1996 or 1997–2012. This finding indicates that positive growth in the US does not necessarily spill over to African economies.

GDP in China. The results show that shocks to real GDP in China did not have any impact on African real GDP during the sub-period 1980–1997. However, during the sub-period 1997–2012, a positive shock from China's real GDP has a positive and significant effect on African real GDP. Lastly, Figure 8 presents the results of shocks to real GDP in that 1% changes in China's GDP is translated into 0.05% changes in Africa's GDP.

## 4.3 Business cycle synchronization between Africa and its main trading partners

As stated earlier, section 4.2 provided a basis from which business cycle synchronization between Africa and the three main trading partners could be assessed. For example the finding that positive shocks to GDP from China has a positive effect on GDP in Africa during the sub-period 1997–2012 might indicate the possibility of business synchronization between China and Africa during that period. However, such an extrapolation needs to be validated by an appropriate method for business cycle synchronization. There are number of different methods for measuring synchronization of the business cycle between individual

and groups of countries. This paper makes use of the Instantaneous Quasi Correlation (IQC) method employed by Duval et al. (2014) in order to measure the degree of business cycle synchronization between Africa and each of its three main trading partners. According to Duval et al. (2014) the quasi correlation is defined as follows:

$$QCORR_{ijt} = \frac{(g_{it} - g_i^*) \times (g_{jt} - g_j^*)}{\sigma_i^g \times \sigma_j^g}$$

Where  $QCORR_{ijt}$  is the quasi-correlation of real GDP growth rates of country  $i$  and  $j$  in year  $t$ .  $g_{it}$  denotes the output growth rate of country  $i$  in year  $t$ .  $g_i^*$  and  $\sigma_i^g$  represent the mean and standard deviation of output growth rate of country  $i$  respectively, during the sample period. Duval et al. (2014) shows that this measure is a better proxy of business cycle synchronization than the others for the following reasons Firstly, it provides a dynamic correlation measure as it enables the calculation of co-movement at every point in time rather than over an interval of time. Secondly, the quasi correlation is not bounded between -1 and 1. A number of authors show that when the business cycle synchronization measure lies between -1 and 1, the error terms in the regression explaining it are unlikely to be normally distributed (Otto et al., 2001 and Inklaar et al., 2008).

The bilateral business cycle synchronization between Africa and each of its main partners is presented in Figure 9 below. Figure 9 shows a lack of steady business synchronization between Africa and its main trading partners during the sub-period 1980–1996. The correlation between Africa’s GDP and the GDP of its three main trading partners swerves between positive and negative values, thus signalling the lack of persistent business cycle synchronization. Nonetheless, in the sub-period 1997–2012, there is regular business cycle synchronization between Africa and China, especially from the year 2000 onward. High business synchronization between Africa and the US and Africa and the Euro area occurs during periods of economic and financial crises, during which the US and Euro experience the decline of their economic activities. For example, Figure 9 shows that in the early 1980s the global financial crisis that led to a severe recession in the US also affected African economies. It is also clear from Figure 9 that the high correlation or business synchronization between Africa and the US and Africa and the Euro area is attributed to the effects of the 2007 global financial crisis, which stemmed from the US. This indicates that business cycles between Africa and the US and Africa and the Euro area mostly synchronize due to the direct effect of contagion. This reality is not observed in the synchronization of the business cycle between Africa and China, which GDPs move in tandem since the year 2000.

This finding raises a question about whether trade linkage necessarily links to business cycle synchronization. While periods of high trade linkage between Africa and China coincide with their business cycle synchronization, this is not true in the case of Africa–US and Africa–Euro. One of the reasons why Africa–China trade linkage has led to their business cycle synchronization is that through trade cooperation between the Africa and China, Chinese enterprises have helped African countries establish an up-stream-downstream-integrated

industry chain, transforming resource advantages into economic growth opportunities. Moreover, as part of trade agreements China has helped a number of Africa economies to build the infrastructure that is needed for their economic growth (Global Times, 2013).

## 5 Conclusion

This paper endeavoured to investigate the extent of trade linkages and business cycle synchronization between Africa and its three main trading partners, namely China, the Euro area and the US, during two different periods, the periods 1980 to 1996 and 1997 to 2012. The paper makes use of GVAR methodology in order to assess the extent of shocks transmission between Africa and each of the three main trading partners. Particularly, the paper assessed how import and export shocks from each of the three main trading partners affect the dynamics of exports and imports, respectively, in Africa. The results of the GVAR methodology made possible inferences as to the extent of trade linkages between Africa and its three trading partners during the two periods. Moreover, the paper makes use of the Instantaneous Quasi Correlation method in order to measure the degree of business cycle synchronization between Africa and each of the three trading partners during the same periods. The results based on the generalized impulse response functions indicate an increasing trade linkage between Africa and the Euro area in the period 1980–1996 compared to the period 1997–2012. However, trade linkages between Africa and China become more significant during the period 1997–2012 than during the period 1980–1996.

The results based on Instantaneous Quasi Correlation show the synchronization of business cycles between Africa and China during the period 1997–2012. However, the results show that there is no consistent business cycle synchronization between Africa and the US and Africa and the Euro area in the two periods and that the observed infrequent business cycle co-movements between Africa and the US and Africa and the Euro area can mostly be attributed to the direct effect of contagion. While this paper contributes to showing the dynamic changes in the trade linkages and spillover of economic activities between Africa and its three main trading partners, it also contributes to the literature of trade linkages and business cycle synchronization by showing that periods of increasing trade linkages between countries coincide with their business cycle synchronization only if the nature of the trade agreement between the partners contributes to bolstering their mutual economic activities, as is mostly the case in the Africa–China trade relationship.

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