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ABSTRACT

This paper examines the relative importance of the global and regional markets for financial markets in developing countries, particularly during the US financial crisis and the European sovereign debt crisis. We examine the way in which the degree of regional (seven African markets combined), global (China, France, Germany, Japan, the UK and the US), commodity (gold and petroleum), and nominal effective exchange rate (Euro and US dollar) spillovers to individual African countries evolve during the two crises through the econometric method introduced by Diebold and Yilmaz (2012). We find that African markets are most severely affected by spillovers from global markets and modestly from commodity and currency markets. Conversely, the regional spillovers within Africa are smaller than the global ones and are insulated from the global crises. We also find that the aggregated spillover effects of European countries to the African markets exceeded that of the US even at the wake of the US financial crisis.

Keywords: African financial market; financial crisis; financial integration; spillover; variance decomposition.

JEL Classification Numbers: F36; G15; O55.

1. Introduction

The international financial linkage during crisis periods is known to be higher when spillovers across national borders are least needed. The recent financial turmoil that began in the housing market in the US and expanded as sovereign debt problems in Europe made stock prices plummet in their own markets and similarly in developing countries. The transmission mechanism may consist of the following two routes: a direct route from the crisis-originating countries and an indirect route from neighboring countries that are subsequently affected by the crisis-originating countries. This paper examines the relative importance of the global and regional effects for financial markets in developing countries, particularly during the recent turmoil in the global financial markets.

Amongst other developing countries in Asia, Latin America, and Eastern Europe, African stock markets deserve particular attention in light of the recent strengthening of economic links to developed countries. The historical and geographical link to Europe is obvious; for example, in 2011, 47% of inward foreign direct investments (FDI) to South Africa came from the UK, and 74% of inward FDI to Morocco came from France. The US, which has the largest economy in the world, also plays an important role in African stock markets. For example, 59% (52%) of foreign investing in South African (Tunisian) stock markets comes from the US.

We investigate the return transmissions in seven African stock markets (Egypt, Mauritius, Morocco, Namibia, South Africa, Tunisia, and Zambia) for the period between September 1, 2004 and March 29, 2013 which covers both the US financial crisis and the European sovereign bond crisis. The return transmission is measured by using the spillover indices based on the forecast error variance decompositions from a generalized impulse response function introduced by Diebold and Yilmaz (2012). The estimations of time-varying spillovers within African stock markets show how the degree of intra-regional financial interdependence is affected by the recent financial crises.

In addition to spillovers within the region, spillovers from different asset classes are also evident in other studies (Coudert, Couharde, and Mignon, 2011; and Ehrmann, Fratzscher, and Rigobon, 2011). Coudert et al. (2011) examine the degree to which the volatilities of exchange rates in emerging countries are affected by global

stock markets, emerging stock markets, and commodity markets. Ehrmann et al. (2011) also find evidence of spillovers across different asset classes both domestically and internationally. To capture the spillovers from the different regions as well as different financial markets, we include global (China, France, Germany, Japan, the UK and the US), commodity (gold and petroleum), and nominal effective exchange rate (Euro and US dollar). We examine the way in which their transmissions to individual African countries evolve during the US sub-prime and European sovereign debt crises[1].

We find that regional spillovers within African countries are insulated from the global crises but that African markets are severely affected by spillovers from global markets and modestly from commodity and currency markets. Conversely, the regional spillovers within Africa are smaller than the global ones. We also find that the aggregated spillover effects of European countries to the African markets exceeded that of the US even at the wake of the US financial crisis.

The remainder of this paper is structured in the following manner. Section 2 provides a brief survey of the recent developments in African stock markets and discusses the financial linkages between African stock markets and other financial markets. Section 3 describes the econometric approach used to examine return spillovers among a large number of financial markets. Section 4 discusses the selection of sample countries and the determination of VAR specifications using pre-tests. Section 5 provides empirical evidence and section 6 provides robustness checks and discussions. Section 7 concludes.

2. An overview of African stock markets

In this section, we review the recent developments in seven African stock markets and examine the external dependence (exports, FDI, and portfolio investments) of African markets.

The establishment of stock markets in the region extends back in history as far as the 19th century. The Egyptian Exchange is one of the oldest stock markets in Africa and the Middle East; the Alexandria Stock Exchange began in 1883, and the Cairo

[1] Our strategy is to include possible external factors in a VAR model. Alternatively, one can examine the causes of spillovers by including possible explanatory variables in conditional correlation equations as done by Nagayasu (2013).

Stock Exchange began in 1903. The Johannesburg Stock Exchange in South Africa was also established in the same era, dating back to 1887. In 1929, the Casablanca Stock Exchange was launched in Morocco, and in 1969, the Tunis Stock Exchange was created. Newcomers include the Stock Exchange of Mauritius in 1989, the Lusaka Stock Exchange of Zambia in 1994, and the Namibian Stock Exchange in 1992.

Numerous other African stock markets have been established during the past two decades because of financial sector reforms and developments in the capital markets. Notably, more than 20 stock exchanges are already members of the African Securities Exchanges Association (ASEA), compared with only 4 stock exchanges admitted as ASEA members 20 years ago. Moreover, one of the interesting characteristics of African markets is that these markets tend to form regional stock markets to resolve the problem of small market size and considerable illiquidity. Presently, there are two regional markets , namely, the Bourse Régional des Valeurs Mobilièrs (BVRM) in West Africa and the Bourse des Valeurs Mobilièrs de l'Afrique Centrale (BVMAC) in Central Africa for CFA member countries.

Except for South Africa, African stock markets remain the smallest among the global markets in terms of capitalization, traded value, and turnover ratio because of a lack of size, market transparency, settlement arrangements and access to information. Market capitalization differs widely among the seven examined African stock markets, as shown in Table 1. The ratio of the market capitalization of listed companies to gross domestic product is by far the greatest for South Africa (210%). The ratios of Morocco and Mauritius are 60% and 58%, respectively. The market capitalizations of other stock markets are less than a quarter of the GDP. Thus, the transaction costs and liquidity risks of their markets remain high (see Todd, Vijaya, and Scott, 2007; Senbet and Otchere, 2010; and Allen, Otchere, and Senbet, 2011). However, at the beginning of the 21st century, the continuous rise in commodity prices, particularly resource prices, contributed to African economic growth and attracted the attention of international investors with regard to African stock markets.

The recent financial turmoil affected individual African stock markets differently. During the crisis period, African stock markets that were relatively more integrated into the global financial economy, particularly South Africa and Nigeria,

were hit hard. Conversely, stock markets that were less integrated were relatively immune to any reduction in portfolio flows. Surprisingly, markets such as Namibia and Malawi generated positive returns in the face of the crises. However, the less integrated markets were also affected by the shocks in the real sector (e.g., sharp declines in trade and foreign direct investment inflows).

This difference in the responses to global crises occurs because some African economies are greatly dependent on European countries. The shares of European areas plus the UK in exports of African countries in 2011 were 24.9% (South Africa), 56.0% (Morocco), 32.3% (Egypt), 72.2% (Tunisia), 52.0% (Mauritius), and 7.9% (Zambia), as shown in Table 2. Africa also relies on Europe for inward foreign direct investments (Table 3) and inward portfolio investments (Table 4). The presence of US investors is prominent in foreign portfolio investments in South Africa, Morocco, and Tunisia.

After the crisis, the majority of the returning flows were concentrated on South Africa and other more developed markets. Thus, South Africa recovered to pre-crisis levels, whereas Ghana, Nigeria and Kenya remained significantly below their pre-crisis boom levels (see Senbet and Otchere, 2010; Allen, Otchere, and Senbet, 2011; and Fuchs, Losse-Mueller, Strobbe et al., 2012) In sum, the extent to which African stock markets showed resilience in the wake of global stock market selloffs amid the financial crisis depends on the degree of market integration and the shocks in the real sector.

3. Econometric approach

In the following sub-section, we provide a brief review of econometric approaches for investigating inter-market transmissions and discuss the advantages of choosing Diebold and Yilmaz's (2012) methodology. In 3.2, after a brief description of Diebold and Yilmaz's spillover index, we introduce a generalized spillover index among different groups of financial markets.

3.1. The measurement of interdependence across financial markets

Numerous existing papers that focus on the relationship among the financial markets in different countries are divided roughly into two types, i.e., long-run and short-run relationship analyses. Taylor and Tonks (1989) examine the long-run

relationship among the financial markets by using cointegration tests, whereas Longin and Solinik (1995) consider the short-run dynamics by estimating a multivariate generalized autoregressive conditional heteroskedasticity (GARCH) model.

Onour (2010), Anoruo and Gil-Alana (2011) and Alagidede, Panagiotidis and Zhang (2011) use the cointegration method to characterize the interdependence of African stock markets. Alagidede, Panagiotidis and Zhang (2011) suggest that the global markets had little impact on African stock markets. Conversely, Léon (2007) and Anoruo and Braha (2011) use the GARCH method to examine the African stock market spillovers. Additionally, Agyei-Ampomah (2011) follow a different methodology, the Barari (2004) method, by examining the monthly returns of ten African stock markets before the global financial crisis. These researchers demonstrate that African stock markets with country-specific volatilities were still segmented from global markets.

These two methods, however, have some disadvantages. Cointegration method examines long-term relationship and is not an adequate approach to describe dynamic characteristics of spillovers when spillover relationships are constantly changing[2]. GARCH, on the other hand, can estimate a complicated dynamics of spillovers; however, two or three variables is the maximum number with which GARCH can practically achieve a numerical conversion in calculations. Accordingly, this paper focuses on the methodology of Diebold and Yilmaz (2009), who first introduced the spillover measures based on forecast error variance decompositions from the traditional orthogonalized impulse response function and calculated the degree of volatility spillovers across the stock markets of 19 countries. This method can investigate a large number of variables simultaneously as well as characterize a rich dynamics of spillovers.

In Diebold and Yilmaz (2009)'s methodology, however, the forecast error variance decompositions are dependent to variable ordering. In other words, the respective values of the spillover matrix are sensitive to the order of the data. To remove this shortcoming, Diebold and Yilmaz (2012) examine the volatility spillovers by inventing a revised version of spillover measure based on the generalized impulse

[2] Cointegration relationship with multiple break points can only detect a few break points, certainly not possible daily shifts in spillovers.

response approach by Koop, Pesaran and Porter (1996) and Pesaran and Shin (1998). The forecast error variance decompositions of this version are independent to variable ordering. Accordingly, this paper uses the new method created by Diebold and Yilmaz (2012).

Antonakakis (2012), Awartani and Maghyereh (2013) and Duncan and Kabundi (2013) adopt the Diebold and Yilmaz (2012) methodology. Anotnakakis (2012) compares the spillovers among the major four currencies before and after the adoption of the Euro. Awartani and Maghyereh (2013) examine the degree of interdependence between oil and stock markets in the Gulf Cooperation Council countries. Duncan and Kabundi (2013) focus on the interdependence of different capital markets in South Africa.

3.2. The Diebold-Yilmaz spillover index

The spillover index proposed by Diebold and Yilmaz (2009) is based on the standard approach of a variance decomposition associated with a vector autoregressive model.

Let us consider a following covariance stationary N-variable VAR (p) model,

$$\boldsymbol{x_t} = \sum_{i=1}^{p} \boldsymbol{\Phi_i x_{t-i}} + \boldsymbol{\varepsilon_t} \quad , \qquad t = 1,2,\cdots,T \tag{1}$$

where $\boldsymbol{x_t} = (x_{1t}, x_{2t}, \cdots, x_{nt})'$ is an $n \times 1$ vector and $\{\boldsymbol{\Phi_i}, i = 1,2,\cdots,p\}$ is an $n \times n$ coefficient matrix. ε_t is an $n \times 1$ *i.i.d.* error vector, where $\mathrm{E}(\boldsymbol{\varepsilon_t}) = \mathbf{0}$ and $\mathrm{E}(\boldsymbol{\varepsilon_t \varepsilon_t}') = \boldsymbol{\Sigma}$ for all t and $\boldsymbol{\Sigma}$ is a positive definite variance-covariance matrix. Equation (1) is assumed to meet the condition that all the eigenvalues (λ) satisfying the following equations are $|\lambda| < 1$.

$$\left|\boldsymbol{I_n}\lambda^p - \boldsymbol{\Phi_1}\lambda^{p-1} - \boldsymbol{\Phi_2}\lambda^{p-2} - \cdots - \boldsymbol{\Phi_{p-1}}\lambda \quad - \boldsymbol{\Phi_p}\right| = 0$$

If this condition is satisfied, equation (1) can be rewritten as an infinite order moving average representation.

$$\boldsymbol{x_t} = \sum_{i=1}^{\infty} \mathbf{A_i}\boldsymbol{\varepsilon_{t-i}} \quad , \qquad t = 1,2,\cdots,T$$

where $\mathbf{A_i}$ is an $n \times n$ coefficient matrix, which is expressed as follows:

$$\mathbf{A_i} = \boldsymbol{\Phi_1 A_{i-1}} + \boldsymbol{\Phi_2 A_{i-2}} + \cdots + \boldsymbol{\Phi_p A_{i-p}}, \qquad i = 1,2,\cdots$$

where $\mathbf{A_0}$ is an $n \times n$ identity matrix and $\mathbf{A_i} = \mathbf{0}$ for i < 0.

By denoting $a_{h,ij}$ for the i-j component of matrix A_h, H-step ahead own variance share and cross-variance share can be defined as the following:

$$\theta_{ij}(H) = \frac{\sum_{h=0}^{H-1} a_{h,ij}^2}{\sum_{h=0}^{H-1}\sum_{j=1}^{N} a_{h,ij}^2} = \frac{\sum_{h=0}^{H-1}\left(e_i' A_h e_j\right)^2}{\sum_{h=0}^{H-1}\left(e_i' A_h A_h' e_i\right)}$$, where i = j for H-step ahead own variance share and i $\neq$ j for cross-variance share and e_i is an $n \times 1$ selection vector that takes 1 for the ith element and 0 otherwise. Aggregating all the cross-variance terms and expressing it relative to the sum of all own variance and cross-variance shares, Diebold and Yilmaz (2009) define *total* spillover index for H-step ahead forecasts as

$$S(H) = \frac{\sum_{i=1}^{N}\sum_{j=1, j\neq i}^{N}\theta_{ij}(H)}{\sum_{i=1}^{N}\sum_{j=1}^{N}\theta_{ij}(H)} \times 100 = \frac{\sum_{i=1}^{N}\sum_{j=1, j\neq i}^{N}\theta_{ij}(H)}{N} \times 100 \qquad (2)$$

This index shows the total amount of impacts that each shock makes on the total sums of forecast error variances. In other words, this index is defined as the ratio of the amount of impacts from one market to another against the total amount of impacts between all possible pairs of markets, which include impacts from one to another and even from one to the same.

Diebold and Yilmaz's (2009) method adopted the Cholesky decomposition of the variance-covariance matrix of error terms ($\boldsymbol{\Sigma}$) to orthogonalize shocks. Therefore, this method depends on variable ordering in variance decomposition; that is, the elements of the decomposed matrix vary with the reordering of variables. In light of this issue, Diebold and Yilmaz (2012) took the generalized impulse response approach and devised a method that is invariant to the ordering of variables. As derived by Koop et al.

(1996) and Pesaran and Shin (1998), the H-step ahead forecast error variance decomposition based on the generalized impulse responses is as follows:

$$\theta_{ij}^{g}(H)=\frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}\left(e_i^{'}A_h\Sigma e_j\right)^2}{\sum_{h=0}^{H-1}e_i^{'}A_h\Sigma A_h^{'}e_i}$$

where σ_{ii} is a standard error term in the ith equation. In order to normalize the sum of the elements in each row equal to 1, own variance and cross-variance shares are adjusted as:

$$\tilde{\theta}_{ij}^{g}(H)=\frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N}\theta_{ij}^{g}(H)}$$

Using these variance shares, Diebold and Yilmaz (2012) have re-defined a total volatility spillover index, which is given below.

$$S^{g}(H)=\frac{\sum_{i=1}^{N}\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ij}(H)}{\sum_{i=1}^{N}\sum_{j=1}^{N}\tilde{\theta}_{ij}(H)}\times 100=\frac{\sum_{i=1}^{N}\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ij}(H)}{N}\times 100 \quad (3)$$

Now set free from the composition dependence problem (see, Koop et al., 1996), Diebold and Yilmaz (2012) introduced directional concept to the spillover index. Equation (4) measures the size of the impacts one market (i) receives from all other markets, and equation (5) measures the size of the impacts one market (j) makes on all other markets.

$$S_{i\cdot}^{g}(H)=\frac{\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ij}(H)}{N}\times 100 \quad (4)$$

$$S_{\cdot j}^{g}(H)=\frac{\sum_{i=1,j\neq i}^{N}\tilde{\theta}_{ij}(H)}{N}\times 100 \quad (5)$$

Building on the directional concept of spillovers in Diebold and Yilmaz (2012), we introduce a more generalized concept of spillovers from a set of variables to another set of variables. Conceptually, these sets need not be mutually exclusive. For any two sets of variables, $G_1\subset G$, $G_2\subset G$,where $G=\{x_1,..,x_N\}$ and $G_1\cap G_2$ may not be

empty. We define the spillover from G_2 to G_1 as following,

$$S^{g}_{G1 \cdot G2}(H) = \frac{\sum_{i \in G_1} \sum_{j \in G_2, j \neq i} \tilde{\theta}_{ij}(H)}{N} \times 100 \quad (6)$$

Note that this generalized spillover index degenerates to (3) if G_1 and G_2 are equal to G, (4) if G_1 is one variable and G2 is equal to G, and vice versa for (5).

The basic idea for a generalized spillover index is simple and defines spillovers from one set of markets to another set of markets. Consider 5-variable VAR with two groups of markets; G1=$\{x_1, x_2, x_3\}$ and G2=$\{x_4, x_5\}$. The spillover index from G2 to G1 is:

$$S^{g}_{G1 \cdot G2}(H) = \frac{\sum_{i \in \{1,2,3\}} \sum_{j \in \{4,5\}} \tilde{\theta}_{ij}(H)}{5} \times 100$$

Using this generalized spillover index, we can investigate, for example, how stock markets in developed countries in an aggregate sense affect all African stock markets altogether[3].

4. Sample markets and VAR specifications

In this section, we first describe the selection of the dataset and the procedures to handle outlier data points and then discuss the specifications of VAR regarding the number of lag terms, the length of rolling samples, and forecast horizons.

4.1. Data

The data frequency is daily, and the sample period is between September 1, 2004 and March 29, 2013. For African stock markets, we selected seven African countries (Egypt, Mauritius, Morocco, Namibia, South Africa, Tunisia, and Zambia). For global markets, we selected three European countries (France, Germany, and the UK) and the three largest economies (China, Japan, and the US). For non-stock international markets, two commodities (gold and petroleum) and two nominal effective

[3] Alternatively, one can estimate spillover relationship by directly applying global index such as DJ Global Index; however, this entirely ignores a complex interactions at the level of individual stock markets.

exchange rates (Euro and US dollar) are selected. All variables are in return form by log-differencing the original data. Stock price indices are primarily taken from TickHistory, Thomson Reuters and supplemented by Datastream, Thomson Reuters[4]. The first quote of a stock index is used when intra-day frequency data are available. Commodity prices and nominal effective exchange rates are taken from Datastream.

We checked for outliers in each of the African stock price indices and deleted any outlier data. In addition to the deleted outlier data, some data are missing because the national holidays are different among the sample countries. Missing data cause a problem of unequal frequency in the sample. Instead of introducing unequal frequency and discarding valuable information by deleting a day with only a small number of missing data points, we replace any missing data points with data from the previous day. This procedure may produce bias toward no spillover effect because we introduce zero return days. To check the robustness of the results, we use an alternative dataset that interpolates missing data with pre-data and post-data points.

4.2. VAR specification

To select the order of lags, we estimate a VAR model for the number of lags (common for all variables) between one and ten and use both AIC and BIC to determine the optimal number of lags. Through these two information criteria, two lags are selected[5]. This number of lags is the same used in Diebold and Yilmaz (2009), although their study examines weekly data. For the length of rolling windows, in weekly frequency data analysis, Diebold and Yilmaz (2009) use 200 weeks (approximately four

4 The average stock indices are CCSI for Egypt, MDEX for Mauritius, MASI for Morocco, OVRLNM for Namibia, JALSH for South Africa, TUNINDEX for Tunisia, ALSLZ for Zambia, BRVMCI for BRVM in West Africa, CAC40 for France, DAX for Germany, FTSE100 for the UK, SHCOMP for China, Nikkei 225 for Japan, and DJI for the US. We did not include the Nigerian average stock index because data is not available for the entire sample period, although Nigeria ranks third in the African continent on market capitalization and fourth on the total value of stocks traded.

5 The values corresponding to all numbers of lags for AIC and BIC are provided in the appendix table B1. The optimal number of lags by BIC is one, whereas the number by AIC is two. We selected the longer lags, i.e., two, to avoid introducing a possible bias in estimates because of the omitted variable problem. As a robustness check, we re-estimated the VAR regression with only one lag, but the qualitative results remained unchanged. These results are available upon request from the authors.

years). Diebold and Yilmaz (2012) use 200 days (excluding weekends, approximately 10 months) for rolling samples. We use 500 days (excluding weekends, approximately 25 months), which is approximately the middle of the length of rolling samples in two studies by Diebold and Yilmaz. As a robustness check, we also use 300 days (approximately 15 months) and 700 days (approximately 3 years). The qualitative results in terms of total spillovers remain the same. For the length of the forecast period, *H*, 10 days are used, following the 10-period-ahead forecast used in both Diebold and Yilmaz (2009 and 2012).

5. Empirical results

In analyzing the spillovers across markets, we must specifically define the grouping. In regard to groupings, we define *total* as all 17 markets combined, *regional* (*Africa*: Egypt, Mauritius, Morocco, Namibia, South Africa, Tunisia, and Zambia and *global*: France, Germany, the UK, China, Japan, and the US), *commodities* (gold and petroleum), and *FX* (Euro NEER and dollar NEER). When we use groupings, spillovers are defined as the sum of spillovers from all individual markets in the group.

Figure 1 indicates the return spillover of all 17 markets combined. This spillover is the sum of spillovers between all possible pairs (17 times 17) minus a country's own spillovers (17). The findings indicate that the total spillover effect increased substantially in response to the Lehman shocks on the 15th of September 2008. Moreover, during the European sovereign debt crisis period, whenever negative news regarding bond ratings was delivered, the spillover effect also increased. However, these results fall short of concluding that the stock market in each African country was influenced by two global shocks, the global financial crisis after the Lehman shock and the European sovereign debt crisis. This total, gross-sum spillover may be driven only by spillovers between European countries and the US.

The total spillover effects for individual countries are also estimated in the appendix Figures A1(a)-(c). For an individual country, cross-spillovers with all other 16 markets are summed for both directions. For the entire sample period, the spillover effects of the US, the UK, France and Germany remain substantially above the spillover effects of the other markets. After October 2008, however, the spillover effect of US

dollars increases to the level comparable to those of the four countries.

In contrast to the (sum of both directions of spillovers) figures in Figure 1, only one direction of spillovers is shown in Figures 2 and 3. Figure 2 shows the relative impact of spillovers from global, regional, commodity, and FX to aggregate African markets. Global spillovers are the most notable throughout the sample period, and the impact heightens in correspondence to the crises. Regional spillovers are smaller in magnitude and are relatively less volatile than global spillovers. Both commodity and FX spillovers are much smaller in magnitude, although not negligible.

We should note that because the numbers of markets in each group are different, the extent of spillovers is emphasized for a group with more markets. Figure 3 shows the average (per market) spillover for each group. Based on per-market spillovers from each group, spillovers from FX and commodity exceed those from regional markets, whereas global spillovers remain the greatest.

5.1. The spillovers from individual markets to the African region

To examine which individual countries (or markets) are most influential to aggregate African markets, we break down these aggregate spillovers from global, regional, commodity, and FX groups by individual markets at the source. Spillovers from individual global markets to the African region are shown in Figure 4. The dynamics of spillovers from both US and European countries follow a similar pattern: a jump in the fall of 2008 and another increase during the European sovereign debt crisis. The second largest economies in Asia (formerly Japan and later China) play a small role in affecting African markets. In comparison, Namibia and South Africa appear to exert more influence on the entire African market.

Similarly, spillovers from individual African markets to the African region are shown in Figure 5. South Africa and Namibia stand out as the most influential markets with regard to other African countries. However, examining the breakdown of spillovers between the individual pairs of countries in Table 6, spillovers primarily occur between South Africa and Namibia. Therefore, spillovers from these two countries to other African countries are no more than the average spillover between any pairs in the African region. Regarding the countries' responses to crises shock, Egypt and Tunisia

intensify the degree of spillovers to other African countries in September 2008 but to a smaller degree than the developed countries in Figure 4.

The transmissions from individual commodity markets to the aggregate African market are shown in Figure 6 (and those to individual African markets are shown in A4 (gold) and A5 (petroleum) in the Appendix). The spillovers from gold to African markets decreased in the wake of the US stock market crash in 2008. Conversely, the spillovers from petroleum to African markets increased after 2008. These features are most notable for South Africa and Namibia.

The spillovers from the two major currencies trading in foreign exchange markets to the aggregate African market are shown in Figure 7 (and those to individual African markets are shown in Figure A6 (Euro) and Figure A7 (US dollar) in the Appendix). Despite historical links and the geographical proximity of Africa to European countries, African economies are less prone to the fluctuations of the Euro than to fluctuations in the US dollar. Increases in the degree of spillovers from the US dollar to African markets are particularly marked for Egypt, Namibia, and South Africa. A link between the denomination currency role of US dollars and an increased degree of spillovers from petroleum is suspected.

5.2. The spillovers to individual African markets

To examine the possible heterogeneous effects of the financial crises on African markets, the spillovers from the global, regional, commodity, and exchange rate groups to individual African countries are shown in Figures 9(a) – (g). The effects of the global and regional groups on individual African countries are also shown in Figures A2 and A3 in the Appendix, respectively. Each Figure 9 (a) – (g) is produced for an individual country, whereas all African countries are depicted in one figure in Figures A2 and A3.

First, heterogeneity in responsiveness to other stock markets is observed among African countries. South Africa and Namibia are the most responsive countries with respect to both global and regional markets. In comparison with these two markets, other African countries show only one-third to one-fifth the responsiveness to global and regional stock markets. Consistent with Figures 2 and 3, spillovers from global markets to individual African markets (except Zambia) intensify after 2008, reflecting

global financial turmoil, whereas spillovers from the African region to individual African markets are insulated from the global crisis.

The patterns of the global spillovers to individual African countries in Figures 9(a) - (g) can be categorized into three groups. South Africa, Egypt and Namibia experience a trapezoid-shaped curve of global spillovers as follows: a gradual increase in global spillovers up to 2008, the maintenance of high spillovers over three to four years, and a gradual decline in spillovers to the pre-crisis level. Conversely, Morocco, Tunisia, and Mauritius experience a sharp impulse-type increase in global spillovers in September 2008. Zambia shows fewer swings in global spillovers.

Notably, regional spillovers exceeded global spillovers for some periods in 2010-2011 for Morocco and Tunisia. For Zambia, regional spillover surpasses global spillover several times and continues to be higher at the end of the sample.

5.3. Spillovers from aggregate African markets to global, commodity, and FX markets

After controlling for directional causality in a VAR structure, spillovers from African stock markets to other financial markets can be examined. Spillovers from aggregate African markets to individual global markets (Figure A8), to individual commodity markets and to currency markets (Figure A9) are provided in the Appendix. As expected, the degrees of feedback spillovers from aggregate African markets to other financial markets are limited.

5.4. Crisis effects on spillovers to Africa

The empirical findings can be summarized into the following six issues. First, the global transmission mechanism is relatively more important for an individual African country, providing a significantly more substantial impact during the crisis periods. Global transmission is always above 6 percent and increases to 12 percent in the midst of crisis just after the collapse of Lehman Brothers, whereas regional transmission is below 4 percent.

Second, two consecutive crises (the US sub-prime crisis and the European sovereign debt crisis) affect African countries in different manners. After the advent of the US sub-prime crisis in 2007-2008, global transmission experiences an increase,

doubling the degree of transmission. During this period, regional transmission in Africa is also intensified, although with some delays. Conversely, during the European sovereign debt crisis, global transmission actually declines after 2010. This decline may be partly explained by a reversal of capital inflow in the African region in the wake of the Jasmine revolution in Tunisia in December 2010 and democratic movements in Egypt in January 2011 and the subsequent social disorder that rippled throughout the African regions[6]. The link between African markets and developed markets may undergo a structural change because of a decreased share in the international portfolio investments of developed countries.

Third, noting the changes in global transmission discussed above, for African countries, there were in effect not two crises but only one crisis; it was the European crisis from the very beginning that affected African countries. The combined spillovers from France, Germany, and the UK to the African region increased more than the spillover from the US even just after the sub-prime crisis.

Fourth, commodity transmission is substantial for African stock markets combined. This finding is particularly valid for South Africa and Namibia because Namibia continued to peg its currency to the South African rand after the introduction of the Namibian dollar in 1993. Notably, the degree of spillovers from petroleum to African stock markets particularly increases after 2008.

Fifth, with regard to individual pairs among African countries, bilateral transmission between South Africa and Namibia stands out because the Namibian dollar is pegged to the South African rand. Except for this pair of countries, there exists no single African country that plays a significant role in influencing other markets in the region. Moreover, intra-regional spillovers among African markets appear not to be affected by financial turmoil that originates from either the US or Europe. This finding does not apply to Egypt. The spillovers from Egypt to other African countries resemble those of global markets, i.e., synchronizing with the crises, although the degree of transmission is much smaller.

Sixth, spillovers from the two major currencies to African markets increase in

[6] The dates of important international events are listed in Table 5 and the close-up picture of Figure 1 from June 2009 to December 2011 is shown in appendix table A.10.

resonance with the crises. The spillovers of US dollars dominate those of the Euro even in the pre-crisis period and increase relatively more sharply after 2008, resulting in a wider difference in spillovers to Africa. Even after the solvency of sovereign debts in European periphery countries is brought into question, the stronger influential role of US dollars is unchanged. This result may reflect the role of US dollars as the denomination currency in commodity markets, in which spillovers also rose during the crises period.

6. Robustness checks

In the previous section, we find evidence regarding how the global financial crises affected the linkages between African stock markets and external financial markets and the linkages within the Africa region. In this section, we check the robustness of the previous results by addressing the problem of non-overlapping opening hours of stock markets and the selection bias of African countries.

As the first robustness check, we examine the validity of using daily data. The superiority of using higher frequency data is obvious and depends on the fact that financial markets are information-driven and that important news flows into the markets much more frequently than weekly or monthly. However, the notions of current and past variables in stock market daily returns become unclear when some markets have different opening hours. The problem is less severe if the analysis is based on stock markets only restricted within the African continent (and more or less including European markets.). However, our analysis includes stock markets in Asia and the Americas and exchange rates and commodity prices observed at different times of the day. For the same date, the variables for Asia lead those for Africa and Europe, followed by the variables for the Americas. Problems arising from the non-overlapping business hours of financial markets are well-known in the empirical finance literature. One methodology to ameliorate the problem is to use weekly data. We have re-estimated the VAR with weekly data using several specifications for the length of lags (1 and 2 weeks) and rolling windows (100 and 200 weeks). Although the overall results remain robust, several features are noteworthy. First, the longer length of rolling windows (200 weeks) extends the most influential period of global spillovers on African markets, up to

the period of the European sovereign debt crisis. However, this scenario merely reflects the fact that the length of rolling windows exceeds the length between the two crises. In fact, this high spillover only seen during the European sovereign debt crisis validates the length of the rolling window (500 days or approximately 100 weeks) in the previous section. Second, by using 100 weeks for the rolling window, the aggregate spillover effects per market compared with Figure 3 show relatively higher effects for regional, commodity, and currency markets. There are a few occasions in which we can observe these spillovers exceeding that of global markets for a short period. Finally, the number of lags does not affect the results.

For the second robustness check, we examine whether our sample for African countries is representative of overall Africa. Our sample for African stock markets includes the northern border countries (Egypt, Morocco, and Tunisia) with geographical advantages because of access to the European continent, the southern African countries (Namibia, South Africa, and Zambia) with rich endowments of natural resources, and the tax-haven country (Mauritius) off the southeastern coast of the African continent. The selection of these countries is based on the availability of stock market returns, in other words, they are the top 7 countries with largest market capitalization; therefore, the bias toward relatively well-off or financially open countries cannot be entirely avoided. However, it is still interesting to determine whether the effect of a crisis on a more or less average country is similar to our sample countries. For this reason, we add one of the western African countries (Cote d'Ivoire) to the sample and re-estimate the regressions, although the sample period must end by January 31, 2012. Cote d'Ivoire means just the place where the regional market, BVRM, is located. Thus, this stock market serves the following eight member countries of the CFA franc zone; Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, and Togo. In terms of spillovers, Cote d'Ivoire is as isolated as Zambia from other financial markets. By comparing spillovers across the subsample period, the contribution from other financial markets increases during the crises period: 4.2% (from September 1, 2004 to September 12, 2008), 12.5% (from September 15, 2008 to December 31, 2009), 16.6% (from January 1, 2010 to July 22, 2011), and 26.5% (from July 25, 2011 to January 31, 2012). From our limited sample, we can infer that the effect of crises on the spillovers

examined in this study is representative of the occurrences in a typical African stock market.

7. Conclusion

This paper examines the relative importance of the global and regional markets for financial markets in developing countries, particularly during the recent turmoil in global financial markets. In particular, we investigate the return transmissions in seven African stock markets (Egypt, Mauritius, Morocco, Namibia, South Africa, Tunisia, and Zambia) from September 2004 to March 2013 using the spillover indices based on the forecast error variance decompositions from a generalized impulse response function introduced by Diebold and Yilmaz (2012). The return spillovers of African stock markets are estimated to assess the degree of intra-regional financial interdependence. In addition, we examine the way in which the degree of regional (seven African markets combined), global (Europe: France, Germany, and the UK; non-Europe: China, Japan, and the US), commodity (gold and petroleum), and foreign exchange rate (Euro NEER and USD NEER) transmissions to individual African countries evolves during the US sub-prime crisis and the European sovereign debt crisis.

The US sub-prime crisis was foreshadowed as early as the summer of 2006, when housing prices reached a peak. The crisis became obvious even to laymen in September 2008 with the collapse of Lehman Brothers. Consequently, countries all over the world suffered from the great recession, and European countries were hit particularly hard with sharp losses in sub-prime-related investments. Next, the European sovereign debt crisis began. The sustainability of the sovereign debts of Greece, Italy, Ireland and Spain were brought into question, and the sovereign bond yields of these countries increased sharply. However, for African countries, there were in effect not two crises but only one crisis; it was the European crisis from the very beginning that affected African countries. The combined spillovers from France, Germany, and the UK to the African region increased more than the spillover from the US after the sub-prime crisis.

Compared with existing studies using the same econometric methodology, African stock markets are quite different from other regions, for example, Asian stock markets. Our evidence shows that within-region spillovers are much smaller than spillovers from developed countries, whereas Zhou, Zhang, and Zhang (2012) find that

spillovers are greater among China, Hong Kong, and Taiwan than spillovers of these countries with the US, the UK, or Japan. Sugimoto and Matsuki (2013) show that the stock markets of the developed group –Hong Kong, Singapore, Malaysia and Korea– are influenced by the regional stock markets and the global stock markets to the same degree during the normal period, while the effects of global markets are larger than those of regional markets during the crisis periods.

Although we have used the term spillovers throughout this paper, our interests focus on a possible shift in spillovers between African markets and external markets that include crisis-originating countries. This shift in parameters is known as 'contagion' in the literature; see Edwards (2000) for the alternative definitions of contagion. The existing literature is subtle in interchangeably using two terms, 'interdependence' and 'contagion'. The term 'contagion' is reserved for a shift in a parameter that relates a change in one market to another market. Forbes and Rigobon (2002) suggest that the use of correlation change as a test for contagion may be flawed by demonstrating the case in which correlation changes when no change in parameters occurs[7]. Our methodology is based on changes in the parameters of vector autoregressions when we implement rolling regressions, although we do not formally test the null hypothesis of no shift in parameters.

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[7] Corsetti, Pericoli, and Sbracia (2005) suggest that tests based on Forbes and Rigobon (2002) are biased toward rejecting the null hypothesis of 'no contagion' and propose an alternative test based on a factor model. Focusing on Hong Kong in the 1997 crisis, these researchers find evidence of contagion for five countries out of 17, whereas tests based on Forbes and Rigobon (2002) find only one case of contagion.

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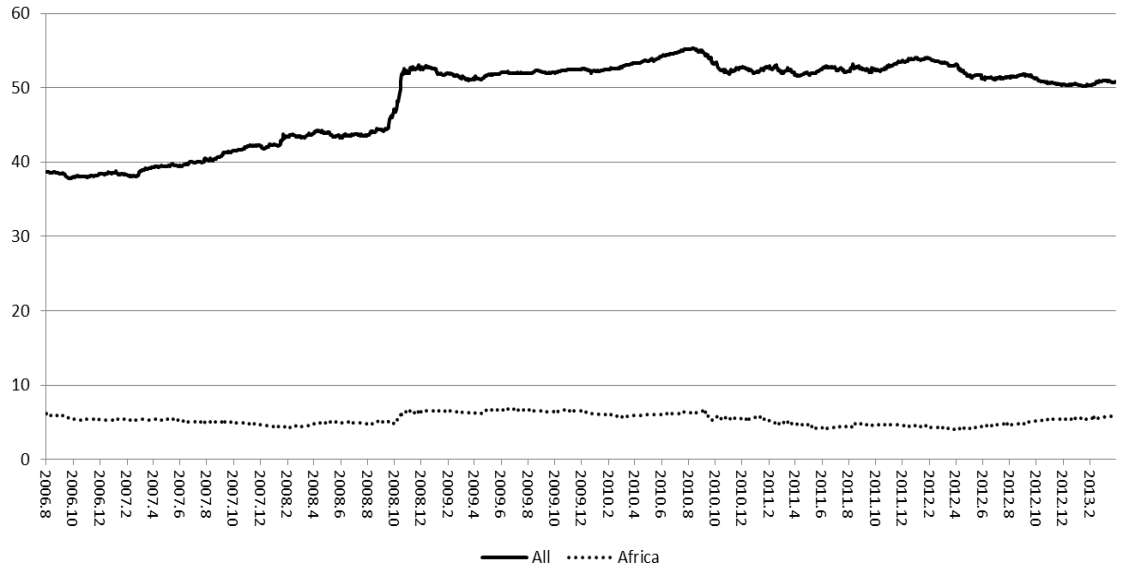
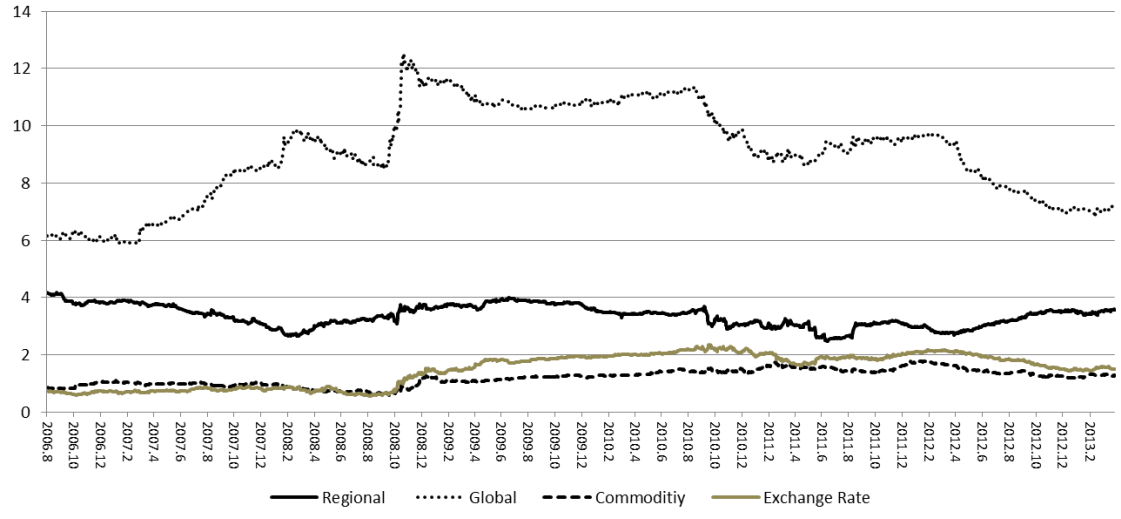
Figure 1. Total return spillovers



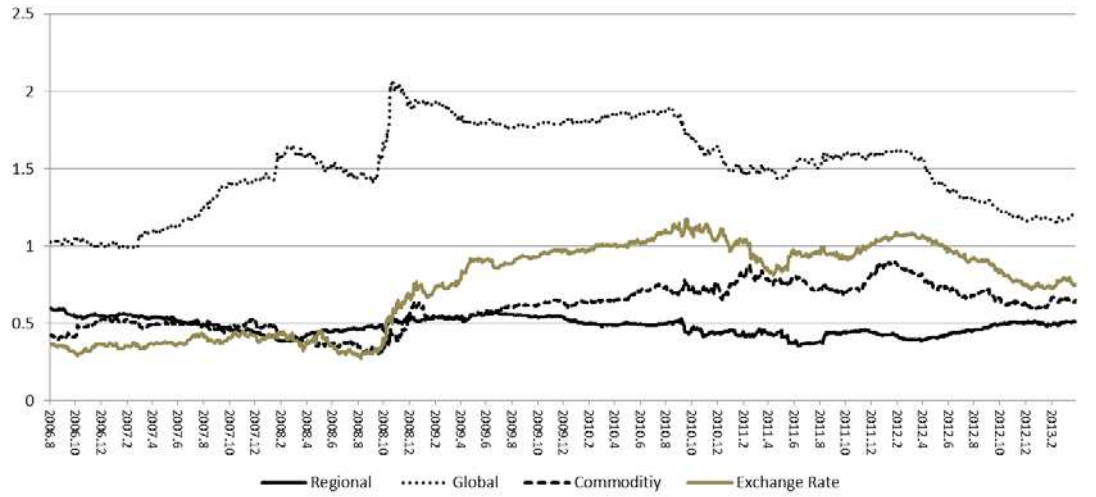
Note: All denotes the total spillover index calculated based on all 17 markets. Africa denotes the spillover index from seven African stock markets to seven African stock markets, based on 17-variable VAR model.

Figure 2. Aggregate spillovers (from 4 groups to African region)



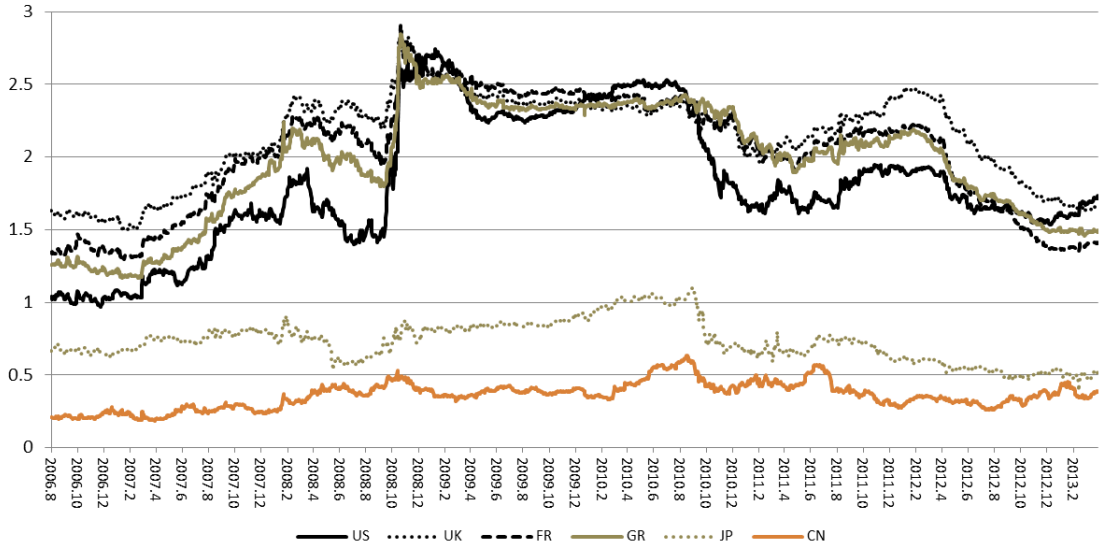
Note: The spillovers are from each of group (Region, Global, Commodity, and FX) to Regional group (seven African stock markets).

Figure 3. Aggregate Effects on African Region (Per Market)



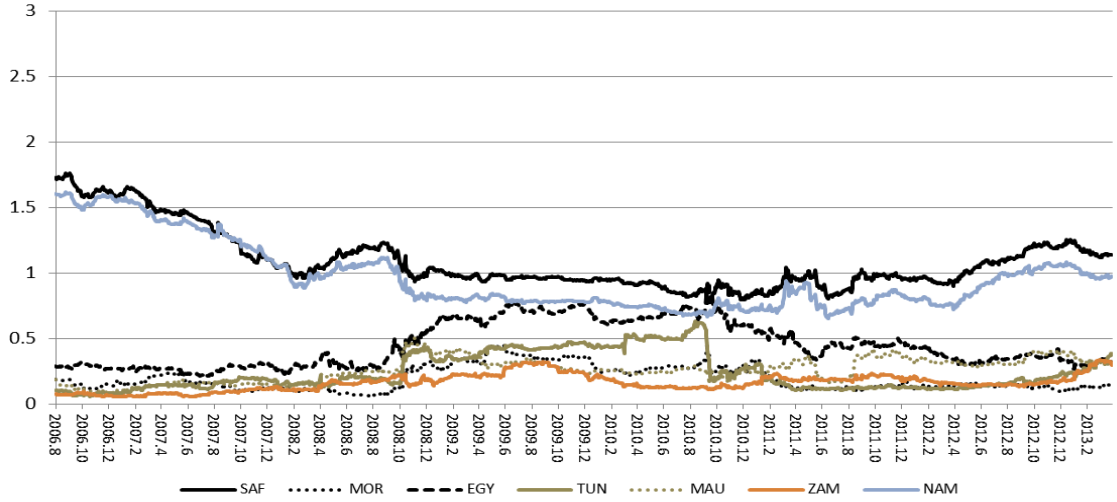
Note: The spillovers in Figure 3 are divided by the number of markets in the affecting group.

Figure 4. Global effects (from individual Global markets to African Region)



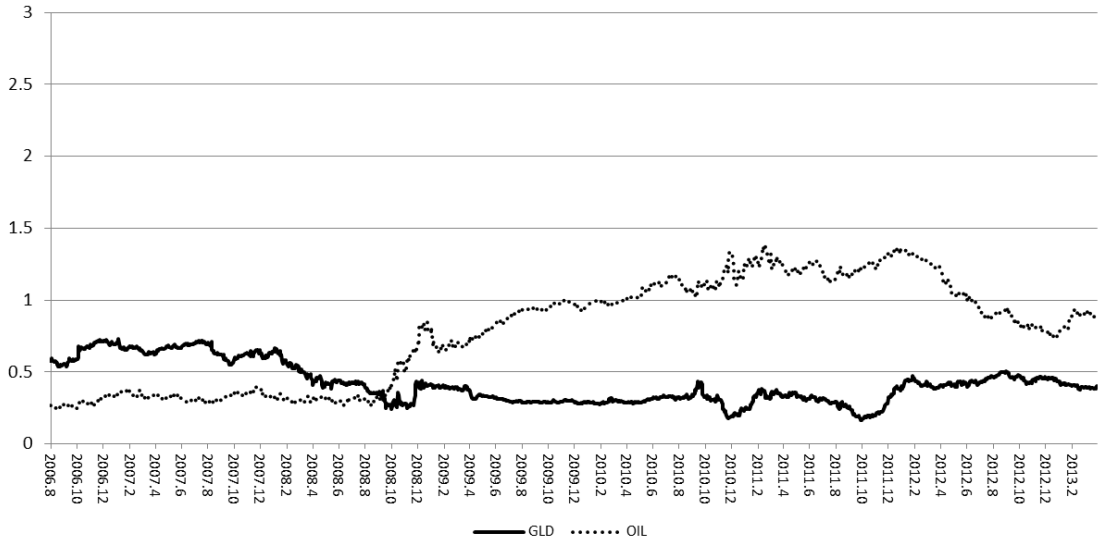
Note: The spillovers are from individual markets in Global group to African region.

Figure 5. Regional effects (from individual African markets to African Region)



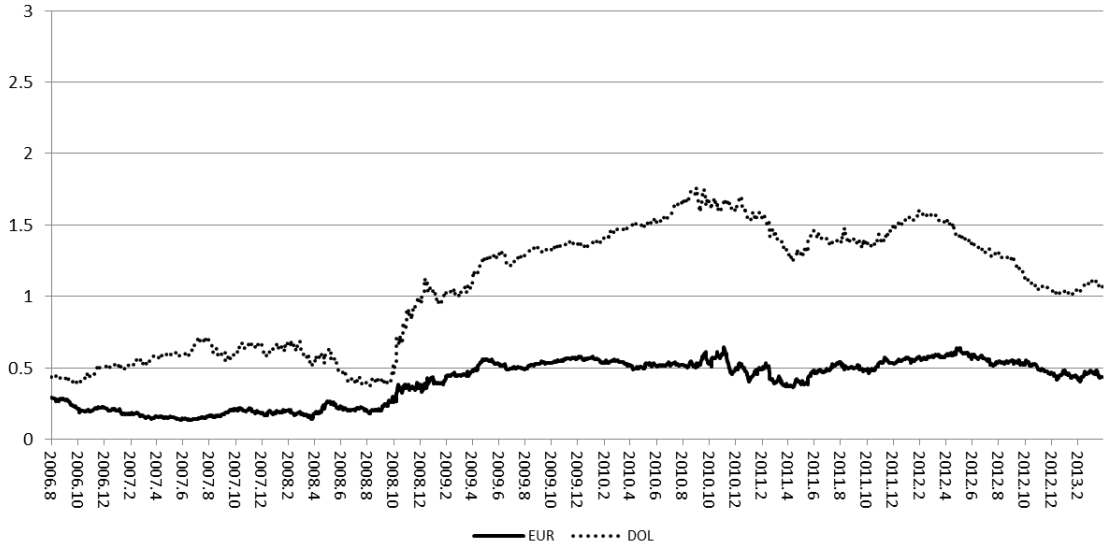
Note: The spillovers are from individual African markets to African region.

Figure 6. Commodity effects (from individual Commodity markets to African Region)



Note: The spillovers are from individual Commodity markets to African region.

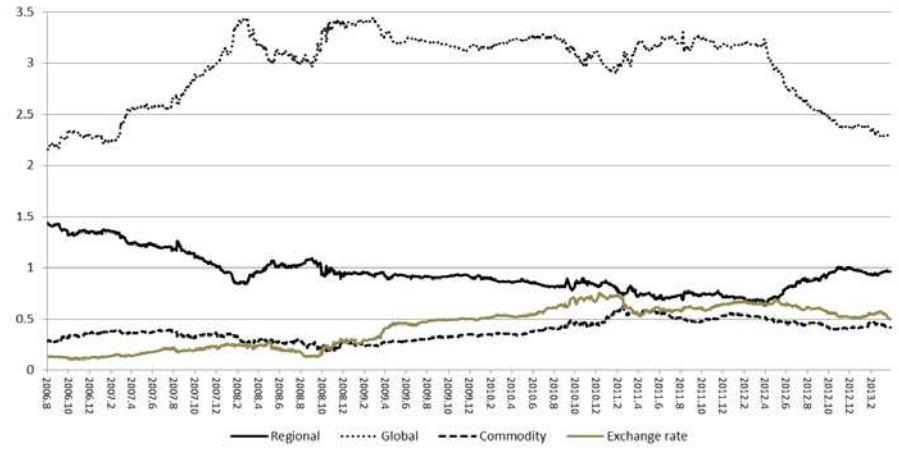
Figure 7. FX Effects (from Individual FX Markets to African Region)



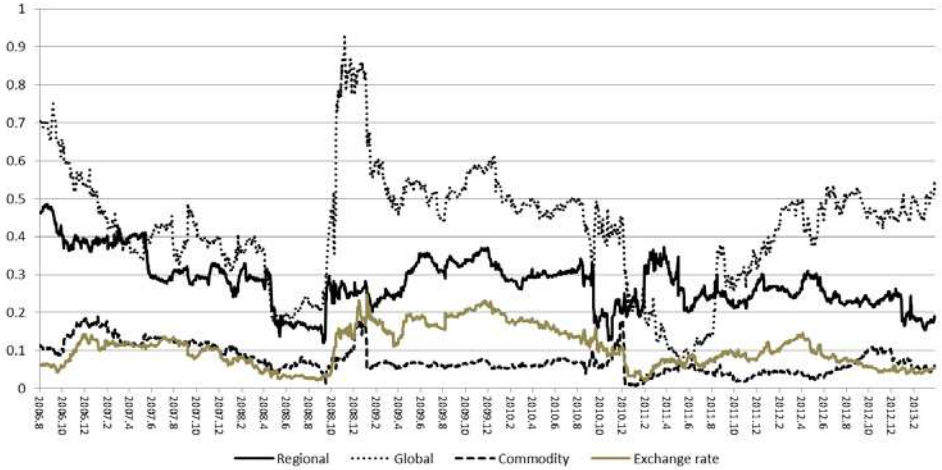
Note: The spillovers are from individual FX markets to African region.

Figure 8. Aggregate Effects on Individual African Markets

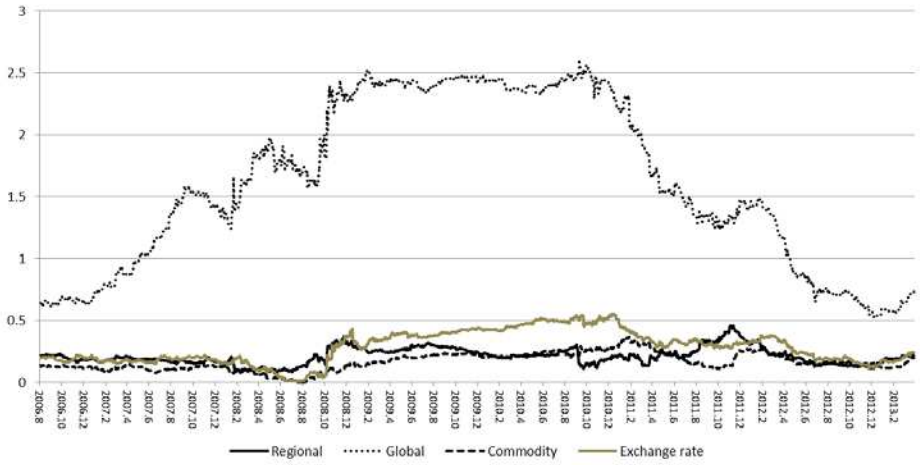
(a) South Africa



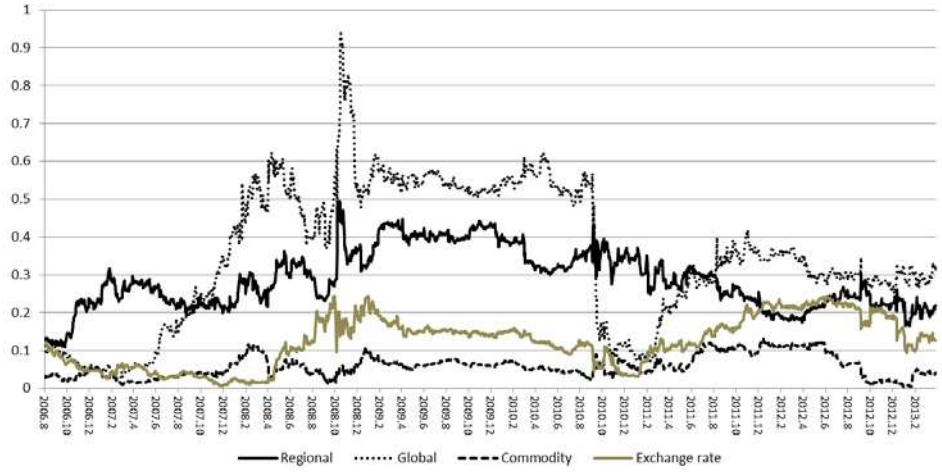
(b) Morocco



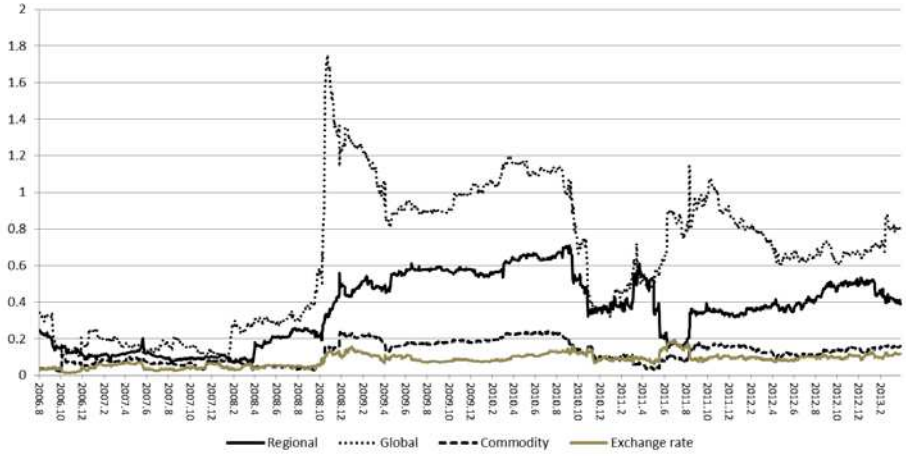
(c) Egypt



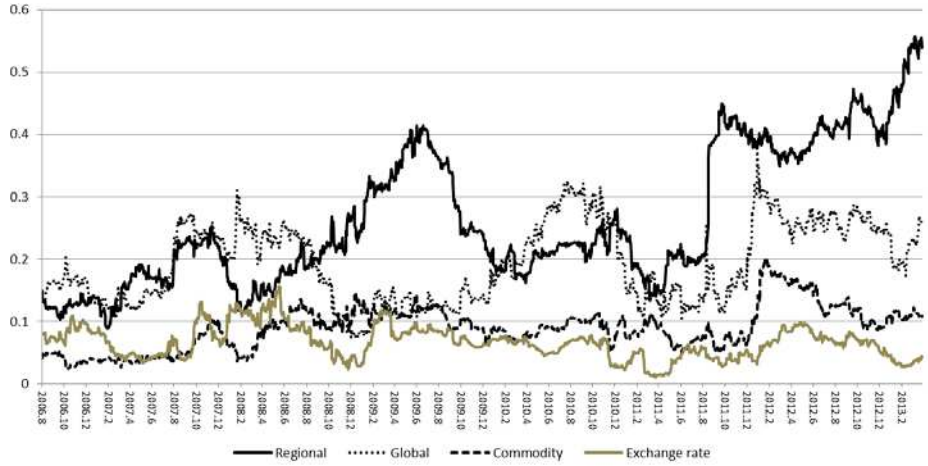
(d) Tunisia



(e) Mauritius



(f) Zambia



(g) Namibia

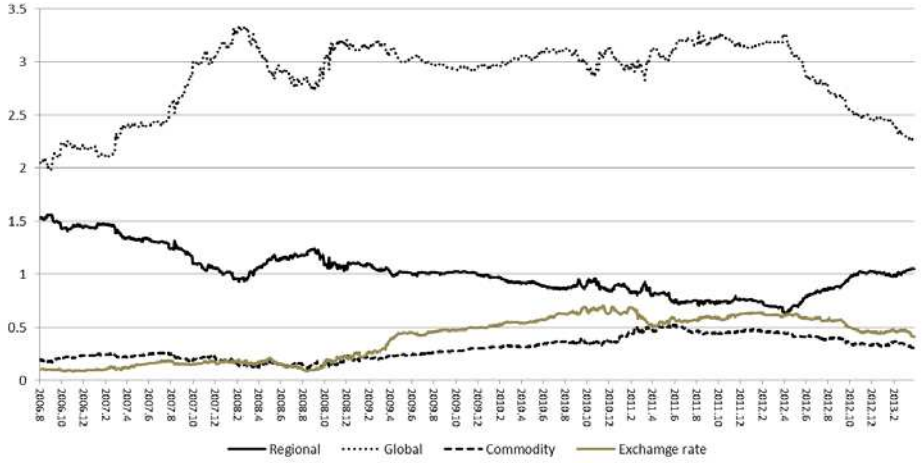


Table 1. African stock market

	Market cap[1)]	Stocks traded[2)]	Stocks traded[3)]
South Africa	210	91.2	39.8
Morocco	60	6.3	9.8
Egypt, Arab Rep.	21	9.6	33.5
Tunisia	21	2.4	11.0
Mauritius	58	4.6	8.0
Cote d'Ivoire	26	0.5	1.8
Zambia	21	0.5	2.9
Namibia	9	0.1	1.2

1) Market capitalization of listed companies (% of GDP) in 2011

2) Stocks traded, total value (% of GDP) in 2011

3) Stocks traded, turnover ratio (%) in 2011

Table 2. Export dependence in 2011 (%)

Export to	Euro area	UK	USA	Japan	China	MENA	SSA
South Africa	16.3%	8.6%	4.1%	7.9%	12.8%	2.5%	14.4%
Morocco	51.4%	4.6%	2.4%	0.7%	1.4%	4.1%	4.0%
Egypt, Arab Rep.	27.1%	5.2%	3.1%	1.2%	2.0%	28.6%	6.4%
Tunisia	70.2%	2.0%	1.9%	0.9%	1.2%	13.1%	2.2%
Mauritius	41.3%	10.7%	20.3%	0.6%	0.3%	0.7%	17.4%
Cote d'Ivoire	34.6%	11.9%	1.1%	0.0%	1.1%	0.8%	29.4%
Zambia	7.4%	0.5%	1.2%	0.8%	34.7%	6.9%	20.3%

MENA= Middle East and North Africa, SSA= Sub Saharan Africa.

Table 3. FDI dependence in 2011

	Total inward[1)]	1st country	2nd country	3rd country
South Africa	134391	UK 47%	Netherlands 21%	USA 7%
Morocco	21059	France 74%	Sweden 6%	Spain 5%
Zambia	7727	UK 20%	Australia 14%	Netherlands 12%

1) US Dollars, Millions. Source: Coordinated Direct Investment Survey by the IMF.

Table 4. Portfolio investment (equity securities) dependence in 2011

	Total inward[1)]	1st country	2nd country	3rd country
South Africa	98833	USA 59%	Luxembourg 10%	UK 8%
Morocco	2994	France 54%	Jersey 20%	USA 12%
Egypt, Arab Rep.	6156	Saudi Arabia 36%	Bahrain 7%	Italy 7%
Tunisia	630	USA 52%	Luxembourg 29%	Kuwait 7%
Mauritius	13782	France 34%	Kuwait 23%	Italy 13%
Zambia	195	UK 54%	USA 9%	South Africa 8%
Namibia	306	South Africa 98%		

1) US Dollars, Millions. Source: Coordinated Portfolio Investment Survey by the IMF.

Table 5. The dates of important international events

date	Events
October 2009	Change of the administration in Greece and exposure of its false report of the budget deficit
April 2010	Revision of the reported number of Greek budget deficit from 12.7% to 13.6%
December 2010	Occurrence of the Jasmine revolution in Tunisia
January 2011	Occurrence of the largest anti-government protests in Egypt

Table 6. Spillovers table (Sep. 1, 2004-Sep. 12, 2008)

	SAF	MOR	EGY	TUN	MAU	ZAM	NAM	US	UK	FR	GR	JP	CN	GLD	OIL	EUR	DOL	From Others
SAF	27.5	0.2	0.6	0.1	0.2	0.1	18.8	7.3	13.4	11.1	9.4	4.1	0.3	3.2	1.3	0.5	1.7	72
MOR	0.3	91.3	1.6	0.1	0.3	0.1	0.3	0.7	0.6	0.6	1	0.6	0.8	0.6	0.7	0.1	0.3	9
EGY	0.5	0.2	79	0.1	0.1	0.2	0.9	3.6	3.3	3.6	3	1.7	0.4	0.7	0.7	0.6	1.5	21
TUN	0.4	0	0.3	93.9	0.7	0.4	0.2	0.5	0.6	0.5	0.4	0.2	0.4	0.1	0	0.7	0.7	6
MAU	0.1	0.2	0.1	0.7	93.1	0.5	0.1	0.4	0.4	0.8	1.1	0.7	0.9	0.1	0.3	0.2	0.1	7
ZAM	0.3	0.4	0.2	0.1	0.6	95.5	0.5	0.1	0.4	0.3	0.1	0.5	0.2	0.3	0.4	0.1	0.2	4
NAM	21	0.2	0.7	0.1	0.2	0.1	30.9	6.5	13.1	10.2	9.2	3.2	0.4	1.8	0.7	0.4	1.3	69
US	0.1	0.2	0.1	0.1	0.3	0.1	0.1	51.9	13.9	15.5	14.1	1.5	0.1	0.4	0.8	0.7	0.1	48
UK	0	0.1	0.4	0.3	0.3	0.2	0.1	11.3	33.3	26.5	23	3.5	0.3	0.2	0.3	0.3	0	67
FR	0	0.1	0.4	0.3	0.2	0.1	0	11.7	24.8	31	26.6	3.5	0.3	0.2	0.2	0.6	0.1	69
GR	0	0.2	0.4	0.2	0.2	0.1	0	11.1	22.7	28.1	32.5	3.3	0.2	0.1	0.3	0.7	0	68
JP	0.1	0.3	1.3	0.3	0.4	0	0.1	14.1	11.2	13.5	12.1	43.2	1.5	0.6	0.3	0.7	0	57
CN	0.1	1.2	0.2	0.4	0.4	0.2	0.2	2.5	2.1	1.3	1.4	2.3	86.7	0.2	0.2	0.2	0.3	13
GLD	0.3	0.3	0.5	0.1	0.3	0.3	0.2	1.1	0.6	0.6	0.6	0.7	0.4	61.5	6.6	9.9	16.1	39
OIL	0.6	0.4	1.2	0.1	0.2	0.6	0.5	1.3	0.4	0.2	0.4	0.3	0	8.3	79.5	2.5	3.5	21
EUR	0	0.1	0.3	0.5	0.2	0	0.1	1.1	0.9	1.9	1.7	0.4	0.1	9.1	1.5	57.7	24.5	42
DOL	0	0	0.2	0.5	0.2	0.1	0.2	3.5	0.7	1	0.7	0	0	13.8	2.7	22.7	53.7	46
Contribution to others	24	4	9	4	5	3	22	77	109	116	105	26	6	40	17	41	50	658
Contribution including own	52	95	88	98	98	99	53	129	142	147	137	70	93	101	97	99	104	38.70%

Note: See abbreviations in appendix.

Table 7 (a). Changes in spillovers (Sep. 15, 2008–Dec. 31, 2009) (difference between the current values and figures in Table 6)

	SAF	MOR	EGY	TUN	MAU	ZAM	NAM	US	UK	FR	GR	JP	CN	GLD	OIL	EUR	DOL	From Others
SAF	▲ 14.3	0.5	1.3	1.0	0.8	0.0	▲ 9.6	3.2	▲ 0.4	2.4	3.4	0.5	1.1	▲ 2.0	3.9	1.8	6.6	15.0
MOR	0.1	▲ 13.8	1.2	1.5	0.6	0.7	0.1	1.6	1.0	0.7	▲ 0.1	0.5	2.4	0.6	▲ 0.3	2.1	1.1	13.0
EGY	0.0	▲ 0.1	▲ 41.8	2.8	0.7	0.3	▲ 0.6	8.8	5.6	5.8	7.7	1.3	0.6	▲ 0.2	2.6	1.2	5.0	42.0
TUN	0.6	1.6	1.9	▲ 20.4	0.2	0.7	0.4	3.5	1.4	2.2	2.0	3.0	0.6	0.3	0.6	▲ 0.1	1.5	21.0
MAU	1.0	1.1	2.8	4.4	▲ 32.9	0.2	0.8	4.1	4.0	3.8	2.2	1.7	0.6	2.8	1.8	0.3	1.6	33.0
ZAM	▲ 0.1	1.1	0.1	1.7	0.6	▲ 10.3	0.0	0.3	0.4	0.9	0.9	▲ 0.1	1.7	0.0	1.0	1.0	0.4	11.0
NAM	▲ 10.1	0.4	0.9	0.9	0.5	0.1	▲ 15.3	3.7	▲ 1.0	2.8	3.6	0.3	0.9	▲ 1.0	4.4	1.8	7.0	15.0
Global, Commodity, FX	3.4	4.0	12.9	6.1	6.2	3.3	4.6	2.4	8.8	0.6	8.6	▲ 9.5	▲ 13.9	▲ 16.4	▲ 11.5	▲ 13.9	4.1	158.0
Contribution to others	▲ 5.0	9.0	21.0	19.0	10.0	6.0	▲ 4.0	49.0	30.0	26.0	37.0	21.0	15.0	▲ 18.0	42.0	1.0	51.0	309.0
Contribution including own	▲ 20.0	▲ 5.0	▲ 21.0	▲ 2.0	▲ 23.0	▲ 5.0	▲ 19.0	27.0	20.0	19.0	28.0	▲ 3.0	▲ 6.0	▲ 16.0	2.0	▲ 6.0	27.0	18.2%

Note: The "Global, Commodity, FX" row shows the summation from the values of US to DOL. All figures indicate the changes in spillovers or own variance share. Therefore, total spillover at the right-most figure in the bottom row should be added to 38.70% to obtain the spillover at the end of December 2009.

Table 7 (b). Changes in spillovers (Jan. 1, 2010–July 22, 2011) (difference between the current values and figures in Table 6)

	SAF	MOR	EGY	TUN	MAU	ZAM	NAM	US	UK	FR	GR	JP	CN	GLD	OIL	EUR	DOL	From Others
SAF	▲ 13.4	▲ 0.1	1.2	0.2	0.2	▲ 0.1	▲ 8.3	2.0	0.5	1.8	3.2	▲ 0.9	2.2	▲ 1.7	5.9	1.2	6.3	14.0
MOR	0.1	▲ 1.3	0.3	0.2	1.0	0.0	0.2	0.0	0.0	0.1	▲ 0.6	▲ 0.2	▲ 0.4	▲ 0.2	▲ 0.5	1.1	0.4	1.0
EGY	2.5	0.0	▲ 19.8	0.2	1.4	0.0	1.2	1.2	2.3	1.9	1.2	0.0	0.4	0.5	2.3	1.7	3.0	20.0
TUN	0.5	0.4	0.2	▲ 10.1	0.6	2.1	0.6	0.7	0.3	0.4	0.4	0.6	▲ 0.1	0.5	1.8	0.0	1.1	10.0
MAU	1.3	0.3	0.5	▲ 0.3	▲ 12.3	0.1	0.6	1.3	1.7	1.8	1.1	0.8	0.2	0.6	0.9	0.4	1.2	12.0
ZAM	▲ 0.1	0.5	1.0	1.5	0.4	▲ 7.1	▲ 0.4	0.5	▲ 0.2	0.1	1.8	▲ 0.1	0.2	0.6	0.7	0.4	0.0	8.0
NAM	▲ 9.5	▲ 0.1	1.0	0.1	0.1	▲ 0.1	▲ 15.2	3.0	0.4	2.6	2.8	0.5	1.5	▲ 0.7	5.9	1.3	6.3	15.0
Global, Commodity, FX	4.9	▲ 0.7	9.3	0.5	0.4	0.6	2.4	0.6	11.7	1.5	5.3	▲ 6.6	▲ 14.1	▲ 15.2	2.5	▲ 17.3	14.4	177.0
Contribution to others	▲ 1.0	0.0	13.0	2.0	4.0	3.0	▲ 4.0	33.0	27.0	18.0	23.0	2.0	17.0	▲ 13.0	66.0	3.0	60.0	257.0
Contribution including own	▲ 15.0	▲ 1.0	▲ 7.0	▲ 8.0	▲ 8.0	▲ 5.0	▲ 19.0	9.0	17.0	10.0	15.0	▲ 6.0	▲ 10.0	▲ 15.0	19.0	▲ 11.0	33.0	15.10%

Note: See the notes in Table 7(a)

Table 7 (c). Changes in spillovers (July 25, 2011–Mar. 29, 2013) (difference between the current values and figures in Table 6)

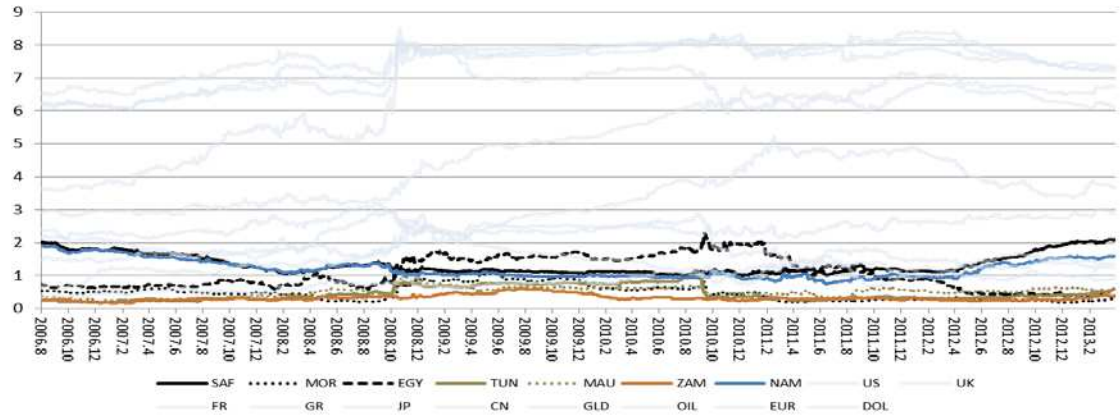
	SAF	MOR	EGY	TUN	MAU	ZAM	NAM	US	UK	FR	GR	JP	CN	GLD	OIL	EUR	DOL	From Others
SAF	2.5	0.1	▲ 0.3	0.0	0.7	0.3	▲ 3.9	2.2	▲ 3.5	▲ 2.8	▲ 0.4	▲ 2.8	0.7	▲ 0.8	2.9	0.8	4.6	▲ 2.0
MOR	1.0	▲ 10.3	▲ 1.0	0.6	0.9	0.3	0.5	3.7	1.4	0.9	0.8	0.4	▲ 0.3	0.2	0.3	0.1	0.7	10.0
EGY	▲ 0.3	0.4	▲ 3.6	0.6	0.3	1.7	▲ 0.8	▲ 0.3	▲ 1.1	▲ 1.0	▲ 0.8	▲ 0.4	0.8	0.0	2.2	1.0	1.1	4.0
TUN	0.2	0.6	0.1	▲ 7.5	▲ 0.4	1.3	0.3	0.6	0.5	0.1	0.2	1.7	0.4	0.1	0.3	1.3	0.2	8.0
MAU	1.6	0.2	1.2	2.2	▲ 20.8	0.2	0.2	2.9	2.1	1.7	1.5	2.4	0.7	0.3	1.7	0.9	1.2	21.0
ZAM	0.2	1.0	2.6	1.6	3.5	▲ 14.8	▲ 0.1	0.5	0.0	0.3	0.6	1.2	1.5	0.8	0.0	0.3	0.4	15.0
NAM	▲ 4.5	0.3	▲ 0.5	0.3	0.0	0.1	1.6	2.1	▲ 3.0	▲ 2.0	0.2	▲ 2.2	0.3	▲ 0.5	2.9	0.6	4.2	▲ 1.0
Global, Commodity, FX	16.7	0.9	▲ 4.0	2.0	1.7	▲ 0.4	10.0	3.4	7.7	3.0	10.5	▲ 17.6	▲ 12.8	▲ 13.2	▲ 8.5	▲ 12.9	14.1	162.0
Contribution to others	15.0	3.0	▲ 2.0	7.0	6.0	4.0	6.0	38.0	15.0	8.0	22.0	▲ 3.0	12.0	▲ 17.0	43.0	4.0	53.0	216.0
Contribution including own	17.0	▲ 7.0	▲ 6.0	0.0	▲ 14.0	▲ 11.0	8.0	15.0	5.0	0.0	13.0	▲ 18.0	▲ 9.0	▲ 13.0	1.0	▲ 8.0	27.0	12.70%

Note: See the notes in Table 7(a).

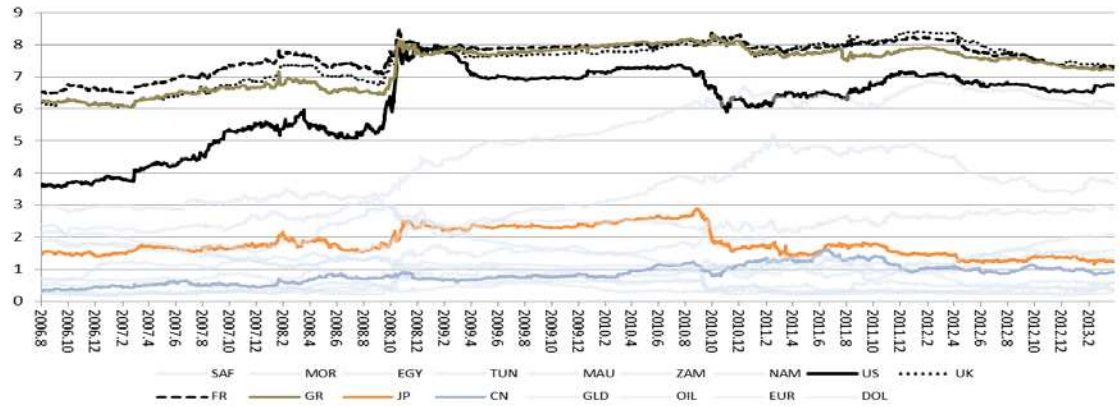
Appendix:

Abbreviations: SAF for South Africa, MOR for Morocco, EGY for Egypt, TUN for Tunisia, MAU for Mauritius, ZAM for Zambia, US for the United States, UK for the United Kingdom, FR for France, GR for Germany, JP for Japan, CN for China, GLD for Gold, OIL for Petroleum, EUR for Euro NEER and DOL for US dollar NEER.

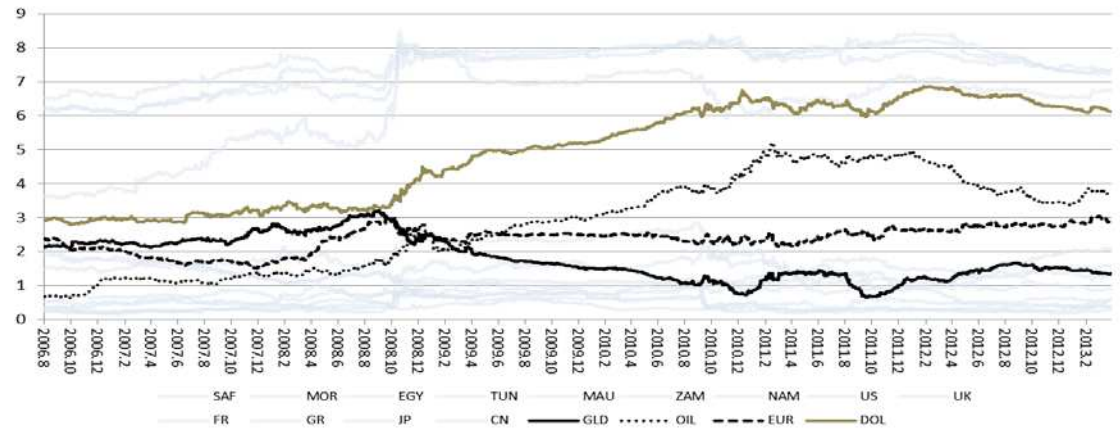
A1 (a) Return Spillovers (*Gross-Sum*, African Markets)



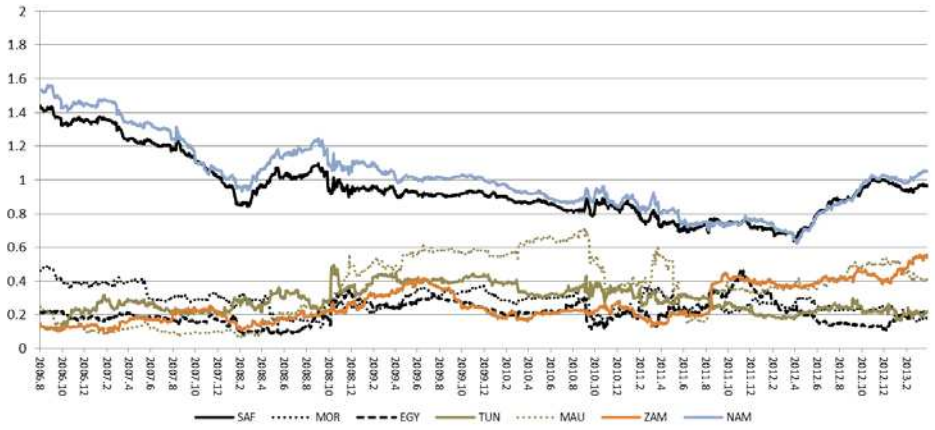
A1 (b) Return Spillovers (*Gross-Sum*, Global Markets)



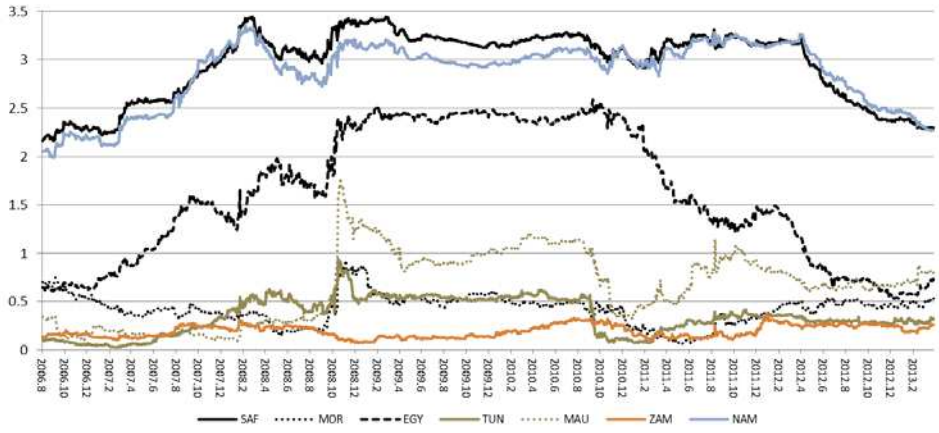
A1 (c) Return Spillovers (*Gross-Sum*, Commodity and FX Markets)



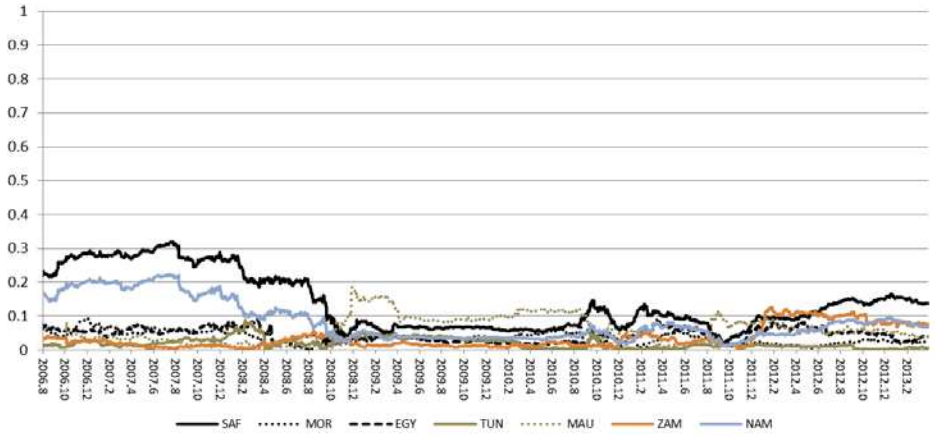
A2. Regional Effects (from Regional Markets to Individual African Markets)



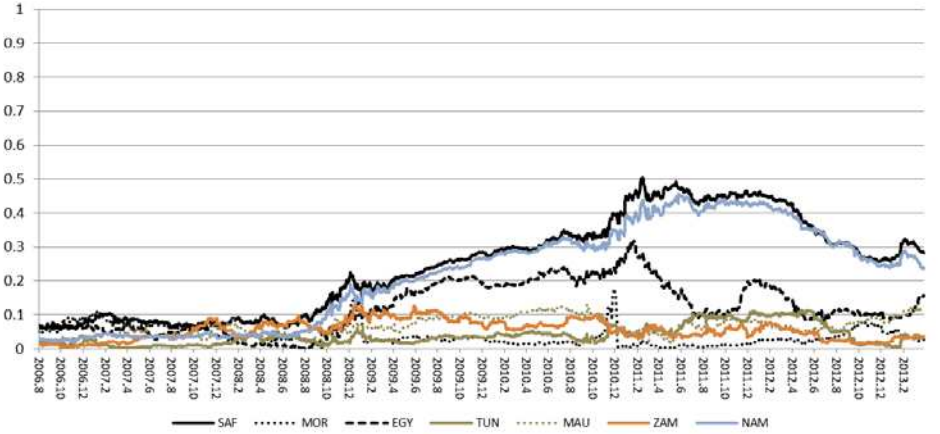
A3. Global Effects (from Global Markets to Individual African Markets)



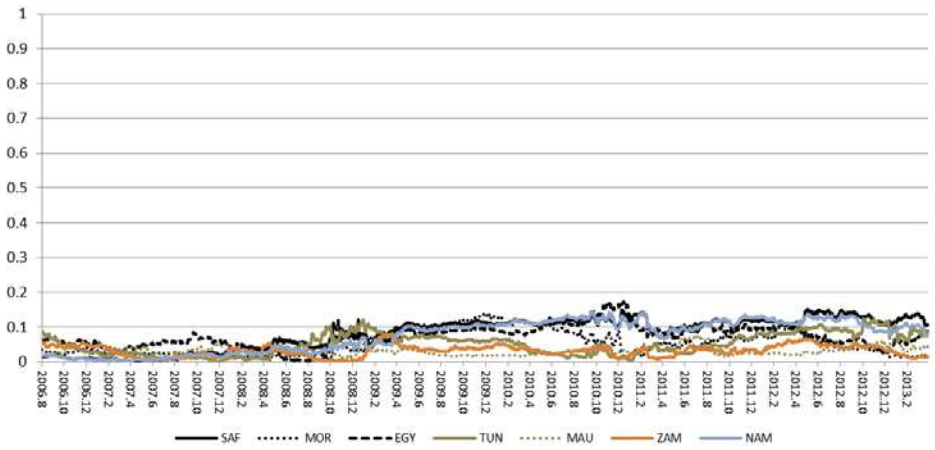
A4. Return Spillovers (from Gold to Individual African Markets)



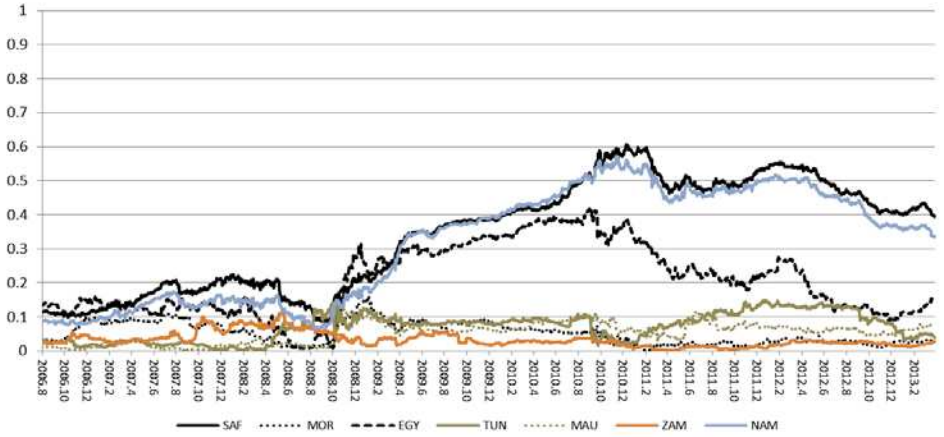
A5. Return Spillovers (from Petroleum to Individual African Markets)



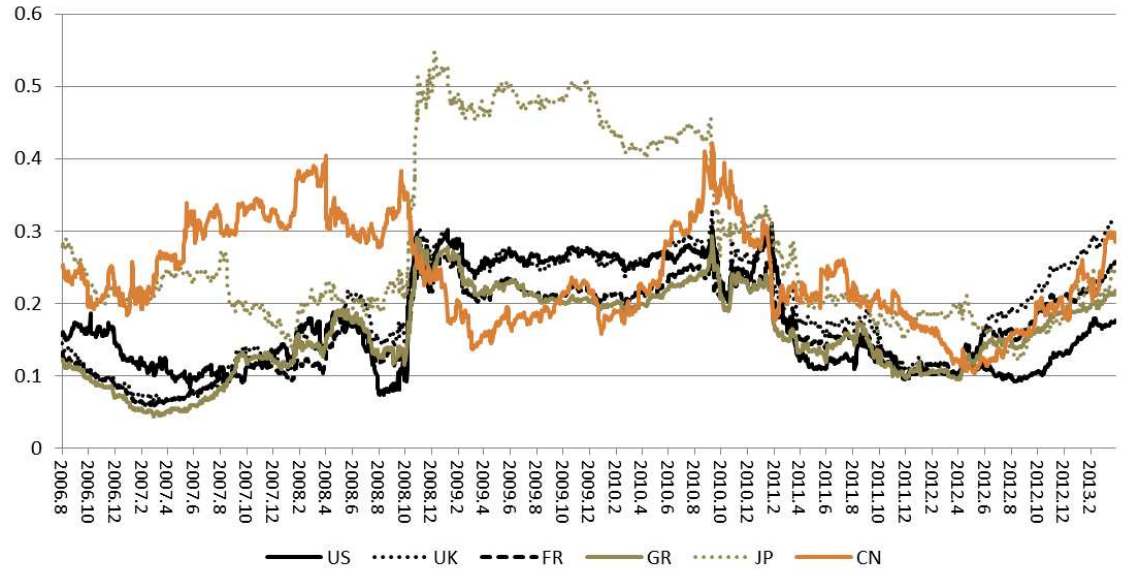
A6. Return Spillovers (from Euro to Individual African Markets)



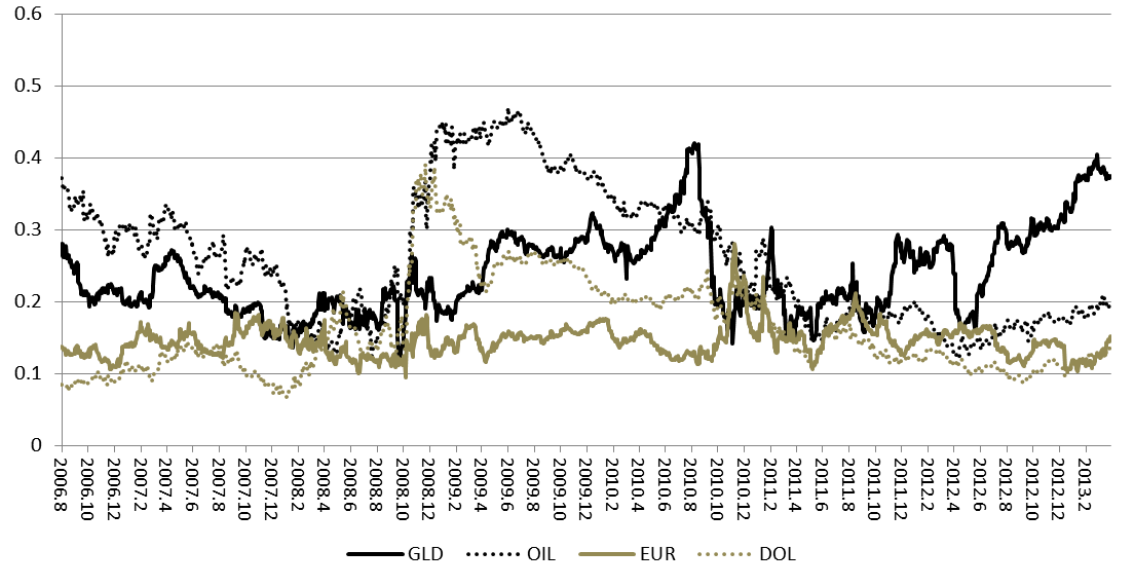
A7. Return Spillovers (from US Dollar to Individual African Markets)



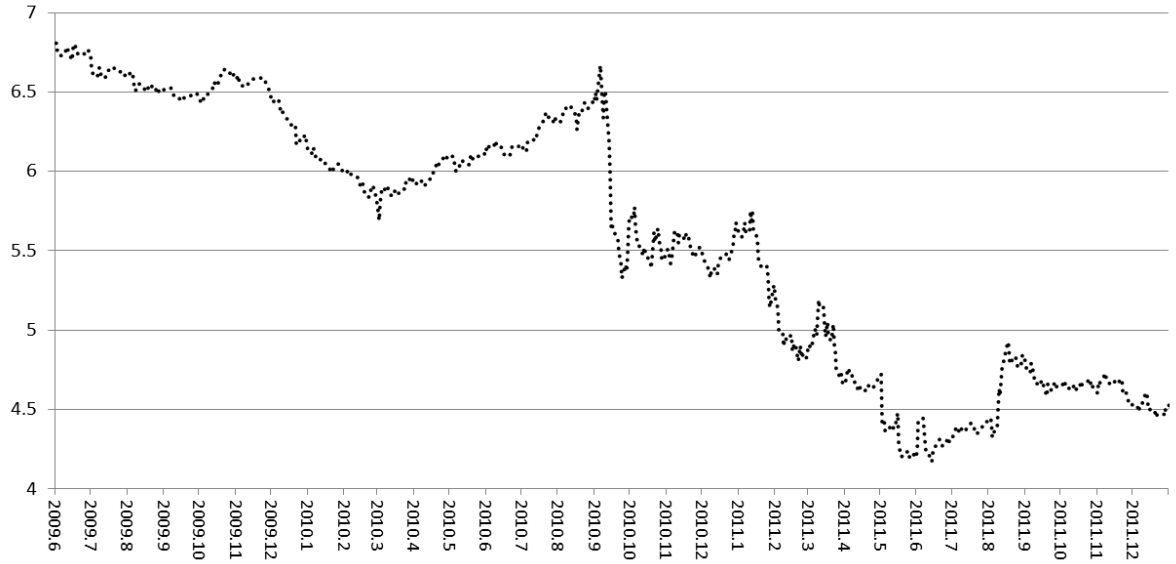
A8. Return Spillovers (from African Region to Individual Global Markets)



A9. Return Spillovers (from African Region to Individual Commodity and FX Markets)



A10. Return Spillovers (Africa) for 2009.6-2011.12



Note: This is the close-up picture of Figure 1 for the period between June 2009 and December 2011.

B1. Lag order selection of VAR model

	Lag order									
	1	2	3	4	5	6	7	8	9	10
AIC	84500.0	84299.8*	84359.0	84449.8	84681.2	84867.0	85077.2	85245.5	85454.3	85685.5
BIC	86241.9*	87677.6	89363.4	91071.2	92910.1	94693.4	96490.9	98236.1	100011.1	101797.6