

The Faculty of Commerce, Law and Management

MMFI Research Proposal:

Risk spillovers and portfolio management between developed and African capital markets



Sculpting global leaders

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Abstract

This paper investigates spillover effects and portfolio diversification between two major developed stock markets (UK, US) and four emerging stock markets in Africa (South Africa, Nigeria, Egypt and Kenya). To this end, we apply the BK-spillover index model to daily spot indices during the period 2000–2021. The findings show that both the developed and the African markets have a sizeable and asymmetric long memory process. Based on the model's estimates, we also examine the hedging efficiency. The findings highlight the significance of overweighting developed country companies in ideal portfolios relative to stocks from African markets. Finally, we assess the practical implications for mixed developed-African stock portfolios, based on finding strong evidence of diversification benefits and downside risk reductions that confirm the usefulness of using developed market stocks in the African stock portfolio risk management.

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United States	The Standard and Poor's 500, or simply the S&P 500, is a stock market index tracking the stock performance of 500 large companies listed on stock exchanges in the United States.
United Kingdom	The Financial Times Stock Exchange 100 Index, also called the FTSE 100 Index, FTSE 100, FTSE, or, informally, the "Footsie", is a share index of the 100 companies listed on the London Stock Exchange with the highest market capitalisation.
South Africa	The Financial Times Stock Exchange (FTSE)/ Johannesburg Stock Exchange (JSE) affectionately known as the FTSE/JSE Top40 Index, is a capitalization-weighted index.
Egypt	EGX 30, previously named CASE 30 Index, is a stock market index for securities in Egypt, designed and calculated by EGX.
Kenya	The Nairobi Securities Exchange 20 Share Index NSE20 is a major stock market index which tracks the performance of 20 best performing companies listed on the Nairobi Securities Exchange. The companies are selected based on a weighted market performance for a 12-month period based on market capitalization, number of shares traded, number of deals and turnover. The NSE20 is a major stock market index which tracks the performance of large companies based in Kenya.
Nigeria	The NGX All Share Index was formulated in January 1984 with a base value of 100. Only ordinary shares are included in the computation of the index. The index is value-relative and is computed daily. The disparity between the intraday and official close values is due to Exchange limitation.

Source: Bloomberg

1. Introduction

1.1 Background of study

In the last few decades, there has been a vast majority of African countries which have experienced fast economic growth. Among these countries, South Africa, Nigeria, Egypt, and Kenya are most compelling for their economic performance. The substantial development of capital markets has been one of the focal attributes responsible for transforming these economies from frontier to emerging markets. Emerging markets refers to financial (particularly capital) markets that independently or collectively emerge from the dominance of government funding of production in the economy (Kodongo and Ojah, 2014). The emergence of these capital markets has provided investors with high-risk appetite the opportunity to diversify their investments.

Asset allocation can be diversified through decreasing correlations and co-movements. Diversification is a function of portfolio management that is offered by the minimization of shared risk among assets within a singular portfolio. Shared risk may be examined through risk spillovers. Risk spillovers indicate the level of risk exposure experienced by one market due to another markets' volatility which portfolio investors use in investment allocation decisions. According to Collins and Biekpe (2003), an increase in risk exposure is due to contagion which is a by-product of the increase in global financial integration.

The relationship between risk and return is considered to be the backbone of Portfolio Management (Ayub, Shah, and Abbas, 2014; Elton et al., 2003). According to Baillie and DeGennaro (1990), most asset pricing models hypothesise a positive relationship between a stock portfolio's expected returns and risk, which is often modelled by the variance of the asset price. Financial literature describes risks in a plethora of ways, in this study we follow the definition of risk constructed by Holton (2004) which states that, "risk is the exposure to a

proposition of which one is uncertain”. Markowitz (1952) and Tobin (1958) linked risk with the variance in portfolio valuation. In this paper volatility will be used as a measure of risk.

Sharpe (1964) developed the implications when all investors follow the same objectives with the same information. This theory is called the Capital Asset Pricing Model or CAPM and shows that there is a natural relation between expected returns and variance. Expected capital return is derived by making use of the capital asset pricing model, which is information dependent. From a study conducted by Panda, Nanda and Paital (2019) we know that the market risk premium, the market volatility, and the systematic estimation risk of stocks are all information-dependent therefore market-wide and macroeconomic shocks that are correlated with shifts in market estimation risk.

The rapid growth in international trade as well as globalization has led to an increase in the integration of global economies. Real global integration consists of exports and imports where countries physically trade commodities and services while financial global integration consists of securitization (Kearney and Lucey, 2004). Although There has been a major increase in global financial integration, this growth has been significantly lower in emerging African markets due to the lack of depth in African capital markets (Giovannetti and Velucchi, 2013).

The characteristic which qualifies these African markets as emerging markets is their investability, a term coined by Levine and Zervos (1988). The emerging African markets chosen for this study not only meet the investability factors proposed by Levine and Zervos (1998) but are also the pillar economies of their designated regions. Since many African capital markets are still in their infancy, they face challenges in terms of listing their depths. This is a result of a shallow pool of listed companies with capital markets that are dominated by a few large firms that represent a high proportion of total market capitalization. In addition, stocks are rarely traded which leads to capital market illiquidity. Despite the problems of small size

and low liquidity, returns on African markets have generally been high (Alagidede, 2009; Adrianaivo and Yartey, 2010). According to Allen, Otchere and Senbet (2011) African capital markets experience tremendously underutilized options and provide attractive opportunities to attain portfolio diversification. In the past Sub-Saharan African markets were heavily regulated however due to financial sector reform there has been a relaxed control on foreign direct investment (Irving, 2005). As a result of financial sector reforms, there has been an increase in international equity market integration within emerging African markets.

1.2. Problem Statement

Financial crises triggered researcher's interest in the study of the relationship between financial markets of different countries and regions due to there being evidence of time variation and structural breaks in risk spillovers, particularly during the 2007 financial crisis. The effects of the crisis were consistent with the notion of contagion which suggested strong and sudden increases in cross-market synchronisation of chronologically subsequent volatilities (Jung and Maderitsch, 2014).

Numerous studies looking towards suitable risk spillover controls have been conducted after the global financial crisis of 2007 to assist policy makers and regulators in reducing the danger of a financial crisis. These proposed procedures have been applied to all industries, including mining, finance, and commodities, notably in Western economies as well as Asian markets such as China. Despite the danger that emerging markets run during global crises because of the rising globalization of the financial markets, there are few studies looking into risk spillovers, especially in developing African markets.

This paper seeks to contribute to existing literature by measuring the degree of risk transmissions among African financial markets where South Africa, Nigeria, Egypt, and Kenya will be used as a case study. Additionally, we also want to examine the degree of risk

transmission between the US and UK markets with the African markets listed above. The more integrated with the global financial markets the financial markets of each country become the bigger the change in correlation. The disadvantage to increased global integration is an increased subjection to financial crises. However, knowing the degree of risk transmission leads to more informed asset allocation, hence, the importance of studying risk spillovers.

1.3. Research Objectives

Financial crises triggered researcher's interest in the study of the relationship between capital markets of different countries and regions due to there being evidence of time variation and structural breaks in risk spillovers, particularly during the 2007 financial crisis. The effects of the crisis were consistent with the notion of contagion which suggested strong and sudden increases in cross-market synchronisation of chronologically succeeding volatilities (Jung and Maderitsch, 2014). According to Natarajan, Singh and Priya (2014), cross risk spillovers are used to reflect a unilateral causal relation between past risk in one market and current risk in another market. Intra-daily data between the sample period of January 2000 to September 2011 were used to investigate the risk transmission between three major capital markets, namely: Hong Kong, Europe, and the United States. A long-term study was conducted to analyse the impact of separate financial crises on each of these economies.

There are limited findings that suggest interlinkages of the capital markets are uniform across all African markets. However, calibrating the degree of interdependences, Collins and Biekpe (2003) discovered a substantial impact of correlations and interdependencies amongst African markets subsequent the Asian crisis that occurred in 1997 and therefore concluded that African capital markets lack significant interdependences with global emerging markets.

This paper contributes to financial economics literature by investigating the pattern of risk spillovers from developed to emerging African capital markets.

1.4. Research Questions

In recent times more researchers, academics and analysts have become largely interested in the study of capital markets in a country and understanding the influence of capital market crashes within and across the markets. In this study we investigate the cross-risk spillover effects that occur across African capital markets. The objective of studying the interdependence and risk spillovers in capital markets is to provide utilitarian insights into how information is transmitted and disseminated across capital markets. This will be accomplished using the Baruník and Křehlík (2018) spillover index. The main question of this paper is, if the degree of risk spillovers is weak between African and developed capital markets, how may African stocks be used in portfolio management for diversification purposes.

On October 19th, 1987, the Dow Jones Industrial Average (DJIA) stood at 1738 points. It fell 508,32 points, which constituted 22,6% of the value of the entire stock exchange. Over 600 million shares had been traded and the value of the stocks on the New York Stock Exchange had fallen by over \$750 million. This event triggered capital market crashes all over the world (Natarajan, Singh and Priya, 2014). It was seen that during that same period that capital market indices all over the world had also decreased. The above occurrences distinctly imply that there exists a substantial degree of interdependence among national capital markets. The interdependence between international capital markets increased significantly after the capital market crash of 1987 (Eun and Shim, 1989). Consistent with the research objectives, the study seeks to answer three questions:

- i. What is the degree of risk spillovers between African and developed capital markets?
- ii. Whether the dynamics of risk transmission were structurally firm and uniform over time.
- iii. Is the study of risk spillovers an accurate forecasting tool for portfolio diversification?

1.5. Research Design

This paper will make use of monthly stock prices from 3 January 2000 until 31 December 2021, The All-Shares Indices will signify the stocks from each country in their local currencies. The choice of the period has been influenced by the 2007 financial crisis which has proven to be of large significance in other studies analysing interdependencies and risk spillovers. The squared VIX index, derived from the US S&P500 options prices will be the measure of control.

Existing work on the interdependence and risk spillovers in capital markets focused on developing economies is limited but steadily increasing. Hence, this paper follows the work of Panda, Nanda and Paital (2019) on the empirical analysis of capital market interdependence and risk spillover in the capital markets of Africa and Middle East Region. The authors used a sample of 12 countries capital markets of Africa and Middle East region over a long study period of 17 years. In addition, they seek to explore the time varying properties of market returns with the use of advanced time series model. Findings from the world index used to capture the pair wise relationship of each capital market of the region with world market with respect to connectedness of market return and the transmission of risk showed that the interlinkages of the capital markets are not uniform across all the countries of the region.

1.6. Limitation of the Study

The period covered in this research is short even though current. Additionally, there are roughly fifty-four countries in Africa, and this study covers only four which limits how the work will be generalized as it is not representative of all the capital markets in Africa. Similarly, there are only two developed countries which will be representative of developed capital markets, however, these two markets are not a reflection of all developed markets due to financial practices and regulations.

2. Literature Review

There are multiple studies carried out which come to similar conclusions that risk spillovers exist amongst the financial markets in the global economy. The degree of risk spillovers is dependent on region. However, it is evident that the United States financial market is the only market that is interconnected to all global financial markets. The studies make use of econometric calculations similar to the ones that will be implemented in this study. The above studies suggest that the existence of interdependence is strengthened by the occurrence of a financial crises, therefore we can deduce that although there may be interlinkages between the South African, Nigerian, Egyptian and Kenyan capital markets, they may be very weak.

2.1. Risk spillovers defined

The dependency of a given asset's variance on the historical covariances, and variances of other assets is what we refer to as risk spillover. On the foundation of this concept, we suggest using a highly adaptable and manageable model to predict the volatility of a portfolio of international equities. The suggested approach to risk management views portfolio risk as a particular mix of daily realized variances and covariances taken from a high frequency dataset, which comprises equities and currencies. Leverage effects and partial integration in conditional volatility are present in all markets, according to risk spillover analysis.

Understanding the volatility of stock markets and the volatility transmission between them, especially between emerging and developed capital markets after a major crisis strikes, is one of the main challenges facing market participants (such as individual investors, institutional investors, traders, portfolio managers, etc.). The fact is that these market participants are aware of portfolio losses and systemic risk, especially during crises and infectious shocks and when they invest concurrently in stock markets of several countries. The market microstructure, including investment, liquidity, asset pricing, and financial risk management of the frontier,

emerging, and developed economies, has been significantly impacted by the global financial crisis of 2007. Numerous studies have looked at the topic of market co-movement and dependency as worldwide capital markets have grown increasingly intertwined, especially when carefully considering periods of financial crises.

2.2. Factors contributing to risk spillovers

Market spillovers become more severe with the start of the world financial crisis. For instance, during crises, market volatility typically rises quickly and spreads to other markets. One would naturally want to be able to assess and keep track of such spillovers to create "early warning systems" for emerging crises and to monitor the development of ongoing crises.

2.3. Portfolio Management

When the benchmark was only partially connected with the active investor's investment prospects, as well as with investment objectives related to the achievement of investment goals and deficits relative to the benchmark, Browne (1999) identified a generic problem in an incomplete market. The goals that were specifically addressed there include, minimizing the expected time to reach the performance goal; increasing the expected reward received upon reaching the goal; and minimising the expected penalty paid upon falling to the shortfall level. This maximizes the likelihood that the investor's wealth reaches a specific performance goal in relation to the benchmark before falling below it to a predetermined shortfall. The associated best practices identified there are all constant proportion, or constant mix, portfolio allocation techniques, in which the portfolio is regularly rebalanced to maintain a consistent proportion of assets in different asset classes regardless of the amount of assets.

2.4. Previous Literature findings and shortcomings

The effect of risk spillovers is the analysis of shock transmission, the level of volatility often correlates to the level of market exposure. Developed markets are highly integrated (Poddig and Rehkugler, 1996). This means that they higher exposure to shock transmission due to international risk sharing which affects long-run economic activity by altering resource allocation as well as the rate of saving (Giovannetti and Velucchi, 2013). There has been an upsurge in the empirical literature on shock transmissions from developed markets to emerging African markets. The relationship between African and developed capital markets may be studied by looking at the structure of dependence between these markets. A study conducted by Mensah and Alagidede (2017) focused on the nature of dependence across capital returns. The abovementioned study found asymmetries in capital return dependence which was an indication of weak tail dependence between African and developed markets. They concluded that African and developed markets did not have a strong relationship in extreme market conditions, hence, developed markets did not have significant spillover effects on African capital markets. In order for us to determine the degree of spillover effects across markets it is crucial for us to look at capital returns during a financial crisis. Sugimoto et al. (2013) examined the relationship of international and intra-regional markets with African capital markets during the U.S financial crisis as well as the European soviet debt crisis. African capital markets were found to have very little spillover effects on each other while experiencing larger spillover effects from developed counties. The degree of spillover effects in Africa are not as strong as those experienced within developed markets. This is due to the lag in the global integration of African markets (Giovannetti and Velucchi, 2013).

The study of stock market integration completed by Agyei-Ampomah (2011) observed the disposition and degree of relations between African capital markets as well as the interactions among these markets and that of local and international indices. According to evidence compiled in the study it has been emphasised that African capital markets are still segregated

from international markets notwithstanding current structural modifications and that the volatility of the domestic index is mainly exclusive to the country, thus a hedging mechanism may be accomplished through cross-country diversification.

Fowowe and Shuaibu (2016) argue that return and volatility spillovers amongst the Nigerian and South African markets along with primary global security markets are significant when markets from numerous areas are measured against each other. The methodology used by the study included calculating spillovers within and between markets by applying the universal VAR that generates estimate error variance decompositions as well as justifies correlated shocks by means of historically detected distribution of the errors. The empirical evidence also illustrates the high level of homogenization in the South African market has with global markets in comparison to the Nigerian market. The observed conclusion was that the smallest spillover index produced occurred between the Nigerian and South African markets. These findings indicate that additional effort needs to be focused towards implementing a more robust policy for financial integration within Africa.

An analysis of existing theoretical and empirical literature on risk spillovers in capital markets has been conducted in this study where we broadly discussed as well as defined CAPM and Efficient Market Hypothesis (EMH). From the empirical literature we found gaps in the literature which did not account for the occurrence of biases in the measurements of correlation coefficients. Correlation coefficients are biased calculations of dependence when markets become more volatile which may be why the results tend to lean towards there being interdependency between capital markets. In this paper we will make use of methodology similar to that of Jawerth and Sweldens (1994) to control these empirical problems.

2.5. Overview of the Literature

In recent years, there has been an increasing number of studies dedicated to spillover analysis between developed and African capital markets. In this paper we want to go a step further by studying risk spillover as a function of portfolio diversification. This paper will investigate spillover effects and portfolio diversification between two major developed capital markets (USA and UK) with four emerging African capital markets (SA, Nigeria, Egypt and Kenya). We will assess the practical implications for mixed developed-emerging stock portfolios, based on finding strong evidence of diversification benefits and downside risk reductions that confirm the usefulness of using developed market stocks in the emerging African stock portfolio risk management.

3. Methodology

In this section we will look at the effective methods used to predict market movements and evaluate the results of these interactions (Naifar and Dohaiman, 2013). This study will make use of the Barunik and Krehlik (2018) spillover index to examine the dynamic connectedness and spillovers between emerging African and developed stock markets to reveal the time- and frequency-domain dynamics of the one asset class during different market conditions. Previous studies suggest that there are three extensively spread mechanisms that account for capital market correlation, the first being aggregate shocks that influence the economic operations of many countries, secondly country-specific shocks that influence the economic operations of other countries, and lastly shocks that cannot be explained by fundamentals and are authentic contagion (Forbes and Rigobon, 1999). We will analyse asymmetric risk spillover effects across the capital markets.

3.1. Volatility and correlation

The most widely accepted approach to 'risk' in financial markets focuses on the measurement of volatility in certain returns distributions. The volatility of portfolio returns depends on the variances and covariances between the risk factors of the portfolio, and the sensitivities of individual assets to these risk factors (Alexander, 1998).

A standard non-parametric definition for volatility is that x is 'more volatile' than y if

$$P(|x| > c) > P(|y| > c)$$

for all c . So if y is a time series it becomes more volatile when $P(|y_{t+1}| > c) > P(|y_t| > c)$ for all c . But when y has a symmetric distribution, such as a normal distribution, this occurs if and only if $\sigma_{t+1}^2 > \sigma_t^2$ where σ_t^2 denotes the conditional variance of y^2 . However, variance is not standardized. If we were to plot a term structure of variances, across different maturities,

variance would simply increase with the holding period of returns. Thus, volatility is usually quoted as an annualised percentage standard deviation:

$$\text{volatility at time } t = (100\sigma_t\sqrt{A})\%$$

where A denotes the number of observations per year. We do this so that volatilities of different maturities may be compared on the same scale - as the variance increases with the holding period, so the annualising factor decreases. In this way, volatilities are standardized.

If one takes two associated returns series x and y - returns, we can calculate their correlation as

$$CORR(x, y) = \frac{COV(x, y)}{\sqrt{V(x)}\sqrt{V(y)}}$$

Which is,

$$\rho_{xy} = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

3.2. Shapiro Wilk Test

The Shapiro-Wilk test of normalcy confirms skewness and excess kurtosis (from Table 2). The resulting statistics for skewness and kurtosis respectively depict non-normal and leptokurtic distributions across the studied markets. Asymmetries in return distributions are confirmed by these findings. This offers a strong incentive to use the BK-18 approach – relative to the DY-12 time-invariant approach – to examine the dynamic and asymmetric connection between emerging African and developed stocks. Traces of volatilities may also be seen in the time series returns plots in Figure 2, indicating that the series is generating time-varying risk. The mean returns (see Table 2) on stocks over the entire sample were positive for all countries.

3.3. The BK-18 spillover index

Baruník and Křehlík (2018) use generalised forecast error variance decompositions (GFEVDs) to quantify connectivity, as inspired by Diebold and Yilmaz (2012). The matrix of a vector autoregressive (VAR) model with local covariance stationarity is used to decompose the data. We represent a n-variate procedure, $y_t = (y_{1,t}, \dots, y_{n,t})'$ given $t = 1, \dots, T$ and a VAR(ρ) which may be expressed as

$$y_t = \sum_{i=1}^p \varphi_i y_{t-i} + \varepsilon_t \quad (1)$$

where coefficient matrices and white noise with (prospective nondiagonal) covariance matrix Π are denoted as φ_i and ε_t . A regression is carried out between each variable in the system (1) and its 'own' ρ lags and the ρ lags of all the remaining variables. Accordingly, φ holds wide ranging information on the relationships between all variables. The expediency of working with a $(n \times n)$ matrix $(I_n - \varphi_1 L - \dots - \varphi_p L^p)$ with identity I_n must be noted. The VAR system is characterised by a moving average MA(∞) when the roots of the representative equation $|\theta(z)|$ lie outside of the unit circle

$$y_t = \psi(L)\varepsilon_t$$

With $\psi(L)$ depicting an infinitely lagged polynomial. The role of the n th variable, known as the GFEVD, to the variance of forecast error of the element j can be written as

$$(\theta_H)_{j,n} = \frac{\sigma_{nn}^{-1} \sum_{h=0}^H ((\psi_h \Sigma)_{j,n})^2}{\sum_{h=0}^H ((\psi_h \Sigma \psi')_{j,j})}$$

This could hold since the measure of connectedness is contingent on decomposed variance, which are the transformations of ψ_h and serve as the contribution of the shocks to the system. Because row contributions do not aggregate to 1, for the sake of completeness, a standardisation of the matrix θ_H is generated as

$$(\tilde{\theta}_H)_{j,n} = \frac{(\theta_H)_{j,n}}{\sum_{n=1}^N (\theta_H)_{j,n}}$$

The pairwise connectivity (Eq. (4)) may be aggregated for overall connectedness in a system. In line with Diebold and Yilmaz (2012), this may be defined as the proportion of variation in predictions provided by errors other than own error (which is the same as the ratio of the off-diagonal components' sum to the whole matrix's sum,) as shown in

$$C_H = 100 \times \frac{\sum_{j \neq n} (\tilde{\theta}_H)_{j,n}}{\sum \tilde{\theta}_H} = 100 \times \left(1 - \frac{\text{Tr}\{\tilde{\theta}_H\}}{\sum \tilde{\theta}_H} \right)$$

where $\text{Tr}\{\}$ represents the operator for tracing, and the arithmetic aggregate of all elements in the matrix is the denominator. As a result, connectedness denotes the forecast variance's relative contribution to the system's other variables. As a result, bi-directional connectivity may be assessed (“to” and/or “from” market i from all other markets k). The difference between “to” and “from” spillovers is also used to calculate “net” connectivity. As a result, a market with a positive net spillover act as a “net transmitter,” while one with a negative spillover acts as a “net receiver” of shocks. The spectral representation of connectivity is shown at this point. With a frequency response function of $\psi(e)^{-i\omega} = \sum_h e^{-i\omega h} \psi_h$ of coefficients that could be transformed by Fourier transforms ψ_h with $i = \sqrt{-1}$ a spectral density of y_t at frequency, ω can be defined as $\text{MA}(\infty)$ filtered series

$$S_{x(\omega)} = \sum_{h=-\infty}^{\infty} E(y' y_{t-h}) e^{-i\omega h} = \psi(e)^{-i\omega} \Pi \psi'(e)^{+i\omega}$$

Where $S_{x(\omega)}$ is the power spectrum which details the distribution of the variance of y_t over the frequency components ω . The causation spectrum over $\omega \in (-\pi, \pi)$ is defined in (7); noting that it reflects the fraction of the n th variable attributable to shocks in the k th variable at a particular frequency ω . Consequently

$$(F(\omega))_{j,n} = \frac{\sigma_{nn}^{-1} |\psi(e)^{-i\omega} \Pi_{j,n}|^2}{(\psi(e)^{-i\omega} \Pi \psi'(e)^{+i\omega})_{j,j}}$$

could be understood as within-frequency causation due to the denominator. To get a natural decomposition of GFEVD to frequencies, we weigh $(F(\omega))_{j,n}$ by the frequency share of the variance of the j th variable. We define the weighting function as

$$\Gamma_j = \frac{(\psi(e)^{-i\omega} \Pi \psi'(e)^{+i\omega})_{j,j}}{\frac{1}{2\pi} \int_{-\pi}^{\pi} (\psi(e)^{-i\lambda} \Pi \psi'(e)^{+i\lambda})_{j,j} d\lambda}$$

summing to real-valued numbers up to 2π and represents the index of the j th variable at a particular frequency. Connectivity must be measured across periods in practical financial applications. As a result, rather than measuring connectedness at single frequencies, it is more appropriate to do so across frequency bands. We take a formal representation of frequency band, d , as $d = (a, b): a, b \in (-\pi, \pi), a < b$ which we define the GFEVDs as

$$(\theta_d)_{j,n} = \frac{1}{2\pi} \int_a^b \Gamma_j(\omega) (F(\omega))_{j,n} d\omega$$

A scaled generalised variance decomposition may be constructed in the same frequency band d as

$$(\tilde{\theta}_d)_{j,n} = \frac{(\theta_d)_{j,n}}{\sum_n (\theta_\infty)_{j,n}}$$

Then, the within-frequency and frequency connectivity across d are expressed in (11) and (12), respectively,

$$C_d^W = 100 \times \left(1 - \frac{Tr\{\tilde{\theta}_d\}}{\sum \tilde{\theta}_d} \right)$$

$$C_d^B = 100 \times \left(\frac{\sum \tilde{\theta}_d}{\sum \tilde{\theta}_\infty} - \frac{Tr\{\tilde{\theta}_d\}}{\sum \tilde{\theta}_\infty} \right) = C_d^W \times \frac{\sum \tilde{\theta}_d}{\sum \tilde{\theta}_\infty}$$

It is important to note that C_d^W represents the connectivity that occurs inside a frequency band and is only weighted by the series' power on that frequency band, C_d^B , on the other hand, breaks down overall connectivity into discrete pieces that add up to the original connectedness metric, as presented by Baruník and Krehlík (2018).

$(\pi + 0,00001, \frac{\pi}{4}, \frac{\pi}{16}, \frac{\pi}{32}, \frac{\pi}{64}, 0)$ are the frequency bands we utilise, which is in line with the extant literature (Baruník and Krehlík, 2018; Tiwari et al., 2018; Tiwari et al., 2019; Owusu Junior, Alagidede and Tweneboah, 2020). Table 1 shows the daily ranges that correspond to the relevant bands.

3.4. Data

The daily stock market indices for 4 key African markets (South Africa, Nigeria, Kenya, and Egypt) along with two developed economies (United Kingdom and United States) are utilised in the processing and analysis. To concentrate on country-specific stock markets that make up the emerging African and conventional markets, we select the stock market indices for countries that have African stock indices.

The dataset spanned between 3 January 2000 and 31 December 2021, yielding 5741 common data observations. The daily stock indices were supplied by Refinitiv and are expressed in their local currency.

The log-returns of the daily stock indices were computed as

$$r_t = \ln(P_t) - \ln(P_{t-1}),$$

where r_t defines the continuously compounded returns, P_t represents the price of an asset in period t , and P_{t-1} represents the price of an asset in the previous period $t - 1$.

The use of indices instead of futures in this study is informed by past analysis of risk spillovers by Lin, Engle and Ito (1994) as well as Baur and Jung (2006) where they suggest that the use of forwards led to drawbacks in the efficiency results obtained since the forwards data collection had to be done on a continuous sample not greater than nine months. Thus, to be able to remedy this issue we will make use of indices.

Previous studies dedicated to spillover analysis, such as Lin, Engle, and Ito (1994) and Baur and Jung (2006), have used indices instead of futures. A slight drawback of using futures is that a continuous dataset is not available for a time horizon greater than nine months. Hence to remedy this issue we make use of capital market indices. Therefore, to obtain a continuous sample, we construct volatility time series for each future contract and roll to the contract closest to maturity.

4. Empirical Analysis Results

4.1 Volatility

#####

Table 1. Correlation Matrix

30 Day Volatility	South Africa	Nigeria	Egypt	Kenya	UK	US
South Africa	1					
Nigeria	0,0118	1				
Egypt	0,6141	-0,0142	1			
Kenya	0,3305	0,0116	0,2095	1		
UK	0,5054	-0,0027	0,2469	0,2105	1	
US	0,4939	0,0069	0,2609	0,1915	0,9428	1

a) 30 Day Volatility

60 Day Volatility	South Africa	Nigeria	Egypt	Kenya	UK	US
South Africa	1					
Nigeria	0,0267	1				
Egypt	0,6755	-0,0207	1			
Kenya	0,3816	0,3615	0,2303	1		
UK	0,9054	-0,0138	0,6394	0,3691	1	
US	0,9264	0,0022	0,6499	0,3754	0,9593	1

b) 60 Day Volatility

90 Day Volatility	South Africa	Nigeria	Egypt	Kenya	UK	US
South Africa	1					
Nigeria	0,0246	1				
Egypt	0,6929	-0,0172	1			
Kenya	0,4017	0,4765	0,2369	1		
UK	0,9121	-0,0208	0,6346	0,3885	1	
US	0,9313	0,0021	0,6599	0,3961	0,9645	1

c) 90 Day Volatility

1 Year Volatility	South Africa	Nigeria	Egypt	Kenya	UK	US
South Africa	1					
Nigeria	-0,0161	1				
Egypt	0,6819	0,1718	1			
Kenya	0,4851	0,5927	0,3754	1		
UK	0,9205	-0,0747	0,6065	0,4757	1	
US	0,9399	-0,0193	0,6594	0,4784	0,9709	1

d) 1 Year Volatility

There is negative correlation between the South African, Egyptian, UK and US all share indices with the VIX. The correlation between all the indices with the VIX is low since the volatilities depicted by the all-share indices are based on historical returns whereas the VIX is option implied volatility.

The correlation between the South African and UK index remains consistently high through the time lags due to duo listed companies. Similarly, South Africa has high correlation with the US implying that there may be a possibility of spillovers between South Africa and the developed markets. There is also a high correlation between South Africa and Egypt within the African markets. This indicates a possibility of spillovers between these two African markets. Egypt also experiences high correlation with the UK and the US, however significantly lower correlations than those shared with South Africa, which implies that Egypt may experience slightly less spillovers from the developed markets. Kenya experiences moderate correlation with the developed markets. There is very low correlation between Nigeria and the developed markets which may be due to the fact that Nigeria is an oil-based economy.

4.2. Time-frequency-domain analysis



Figure 1. Time series plot of emerging African and developed stock indices.

The time-frequency-domain analysis under the BK-18 spillover index helps to establish whether there is contagion by accounting for the evolution of total connectedness over time. We advance our analysis by investigating the spillover effects between the emerging and developed stock markets at various frequencies. This decomposition attempts to account for market participants' diverse expectations and desires across different time horizons. The short-medium- and intermediate-term spillovers, classified into four frequency bands (intra-week, week to a fortnight, a fortnight to a month, and month and beyond) are reported in Table 4 for emerging and developed markets.

Table 2. Interpretations to frequency bands.

Frequency	Bands	Days	Interpretation
d_1	3.14-0.79	1-4	Intraweek
d_2	0.79-0.20	4-16	Week-to-fortnight
d_3	0.20-0.10	16-32	Fortnight-to-month
d_4	0.10-0.00	32- ∞	Month-and-beyond

4.3. Overall spillover connectedness.

We observe from the net spillover indices for all the markets (emerging and conventional) in Table 3 that spillovers in the very short-term (intra-week) are comparatively higher than in the

medium-to long-term horizons. For instance, the return spillover within the first band, 3.14 to 0.79, which approximates to 1–4 days, is 16.01. This return spillover reduces to 5.01, 4.45, and 1.10 respectively for the second (0.79–0.20), third (0.20–0.10), and fourth (0.10–0.00) bands. Similarly, the spillover is seen to be decreasing over time among both emerging African stocks only and among developed stocks only. This finding is indicative that all the markets respond quickly to shocks in the first few trading days. At best, within the intraweek band over the period studied, the emerging African and conventional markets studied are more responsive to market shocks than in later days.

Table 3. Descriptive summary of the studied emerging African and developed markets.

Panel A	South Africa	Kenya	Egypt	Nigeria	UK	USA
Observations	5740	5740	5740	5740	5740	5740
Mean	0.0004	0.0000	0.0004	0.0019	0.0000	0.0002
Std. Dev	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002
Skewness	-0.3469	0.1669	-0.5862	0.9944	-0.4028	-0.4702
Kurtosis	8.3632	34.3192	12.7903	3.3343	11.3567	14.2792
Normtest. W	0.9746	0.9590	0.9644	0.9733	0.9143	0.7897

The findings reveal that when the selected emerging African and developed markets are studied together, the largest contributors of shocks to these markets are UK, US, and South Africa in the high-frequency bands (short-term), notably in the first spillover band. Consequently, we note that throughout the remaining spillover bands, UK, US and South Africa are found to be the largest contributors of shocks to the selected emerging African stock markets and developed stock markets. On the other hand, across all spillover bands, we find Nigeria to be the smallest contributor to the shocks between the markets studied. This implies that the Nigeria market has fewer shocks to present to other conventional markets.

It is worthy of notice that individual markets are also influenced by their own shocks. For instance, the Nigeria, Egypt, and Kenyan stock markets receive over 55% of spillovers from their own markets and are predominant at high frequencies.

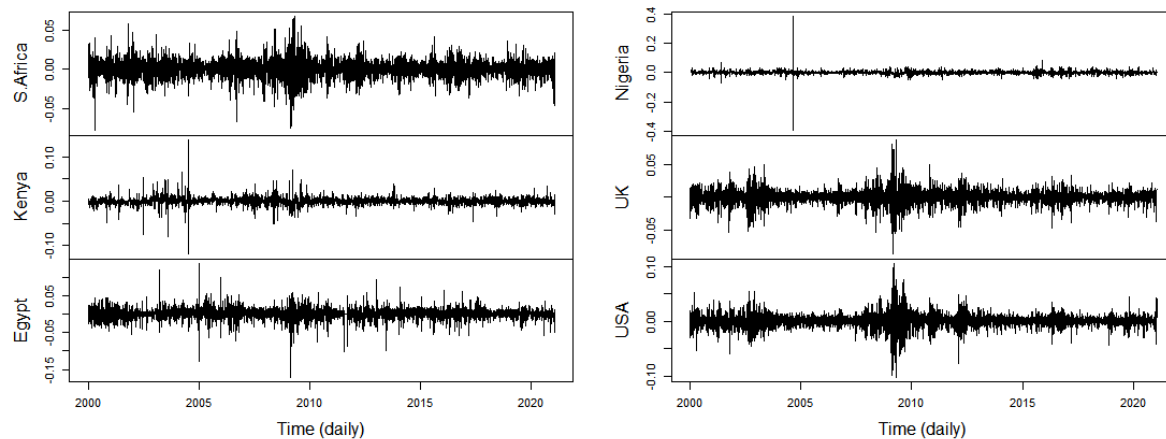


Figure 2. Return series for emerging African and developed stock indices.

Next, we isolate the two broad markets to study the transmission of volatilities across and within the markets. We identified, from the emerging African markets alone, that South Africa and Egypt offer the greatest contribution to market return spillovers in the very short-term (i.e., within band 3.14 to 0.79). Consequently, South Africa and Egypt remain the greatest contributors of market spillovers to the selected African markets over bands 2 to 5 with Kenya being the least contributor of return spillovers among the African markets. For the developed markets, the US was found to be the significant contributor of risk spillovers across the markets. While the UK, on the other hand, was found to make a slightly less significant contribution to volatility spillover to the developed markets. Comparatively, we reveal that the developed stock markets possess substantial volatilities across all time horizons than the African stock markets.

Studying the markets together in terms of receiving market volatilities, we report that South Africa receives high levels of volatility spillover in the short-term, specifically in the spillover

band 3.14 to 0.79. Between bands 2 and 4. Kenya is found to be the recipient of the largest volatility spillover among the studied emerging African and developed stock markets. When the broad markets are studied in isolation. South Africa suffers more risk spillovers from other emerging African markets in the spillover band 1 to 4. Between the two developed markets. UK suffers the greatest volatility spillover in the very short-term (3.14–0.79) whereas, within bands 2 to 4, USA receives the greatest risk spillovers.

Table 4. Total and Net spillover indices across frequency bands for emerging and developed stocks.

	South Africa	Nigeria	Egypt	Kenya	UK	USA	FROM_ABS	FROM_WTH
spillover band: 3.14 to 0.79; corresponds to 1 days to 4 days (Intraweek)								
South Africa	45.42	0.06	0.76	0.02	16.29	9.44	4.43	6.20
Nigeria	0.11	73.35	0.21	0.03	0.12	0.14	0.10	0.14
Egypt	1.68	0.02	60.95	0.11	1.83	2.43	1.01	1.42
Kenya	0.17	0.08	0.22	59.78	0.18	0.34	0.16	0.23
UK	15.47	0.01	0.62	0.05	41.72	16.45	5.44	7.61
USA	9.25	0.02	0.55	0.04	19.35	51.05	4.87	6.82
TO_ABS	4.45	0.03	0.39	0.04	6.29	4.80	16.01	
TO_WTH	6.23	0.05	0.55	0.06	8.82	6.72		22.43
Net	0.0160	-0.0688	0.6191	0.1202	0.8592	0.0672		
spillover band: 0.79 to 0.20; corresponds to 4 days to 16 days (Week to a fortnight)								
South Africa	10.95	0.00	0.25	0.00	5.21	4.17	1.61	7.70
Nigeria	0.08	18.69	0.12	0.03	0.08	0.10	0.07	0.34
Egypt	1.15	0.00	19.76	0.10	1.29	1.63	0.70	3.34
Kenya	0.16	0.08	0.22	27.04	0.20	0.30	0.16	0.77
UK	3.52	0.00	0.21	0.00	9.37	5.83	1.60	7.64
USA	1.59	0.00	0.16	0.00	3.53	9.31	0.88	4.23
TO_ABS	1.09	0.01	0.16	0.02	1.72	2.01	5.01	
TO_WTH	5.20	0.06	0.77	0.11	8.25	9.62		24.02
Net	-0.5217	-0.0567	0.5348	0.1369	0.1258	1.1243		
spillover band: 0.20 to 0.10; corresponds to 16 days to 32 days (Fortnight to a month)								
South Africa	1.56	0.00	0.04	0.00	0.75	0.61	0.23	7.54
Nigeria	0.01	2.70	0.02	0.01	0.01	0.02	0.01	0.36
Egypt	0.18	0.00	2.95	0.02	0.20	0.25	0.11	3.52
Kenya	0.03	0.01	0.04	4.30	0.03	0.05	0.03	0.89
UK	0.50	0.00	0.03	0.00	1.33	0.84	0.23	7.37
USA	0.22	0.00	0.02	0.00	0.50	1.31	0.12	4.02
TO_ABS	0.16	0.00	0.02	0.00	0.25	0.29	4.45	
TO_WTH	5.08	0.07	0.80	0.12	8.09	9.53		23.70
Net	-0.0761	-0.0091	0.0840	0.0237	0.0223	0.1705		

spillover band: 0.10 to 0.00; corresponds to 32 days to Inf days (A month and beyond)

South Africa	2.34	0.00	0.06	0.00	1.13	0.91	0.35	7.52
Nigeria	0.02	4.06	0.03	0.01	0.02	0.02	0.02	0.36
Egypt	0.27	0.00	4.45	0.03	0.31	0.39	0.16	3.54
Kenya	0.04	0.02	0.06	6.53	0.05	0.08	0.04	0.90
UK	0.75	0.00	0.05	0.00	1.99	1.25	0.34	7.34
USA	0.33	0.00	0.04	0.00	0.75	1.96	0.19	4.00
TO_ABS	0.24	0.00	0.04	0.01	0.38	0.44	1.10	
TO_WTH	5.07	0.07	0.81	0.13	8.07	9.52		23.66
			-	-				
Net	-0.1142	-0.0137	0.1272	0.0362	0.0341	0.2572		

Note that from the spillover tables, 'TO_ABS' measures return spillovers from market/country j to other markets. 'FROM_ABS' measures return spillovers from other markets to market j. 'TO_WTH' measures return spillovers from market j to other markets, including from own innovations to country k. 'FROM_WTH' measures return spillovers from other markets to market j, including from own innovations to market k (Owusu Junior, Alagidede et al., [14]; Tiwari et al., [31,57]). The largest market contributions per frequency band are in bold italics. A positive (negative) 'Net' suggests that the country/market is a net transmitter (recipient) of shocks.

4.4. Pairwise connectedness

We report pairwise connectedness to examine diversification prospects between pairs of African and developed equities. The pairs of African and developed equities are summarised in Table 5.

Table 5. Frequency-domain pairs of emerging and developed stocks.

South Africa - Nigeria	South Africa - Egypt	South Africa - Kenya	South Africa - UK	South Africa - USA
-0.0088	-0.1527	-0.0242	0.1370	0.0327
	Nigeria - Egypt	Nigeria - Kenya	Nigeria - UK	Nigeria - USA
	-0.0308	0.0080	0.0182	0.0190
		Egypt - Kenya	Egypt - UK	Egypt - USA
		0.0181	0.2016	0.3136
			Kenya - UK	Kenya - USA
			0.0204	0.0495
				UK - USA
				-0.4820
South Africa - Nigeria	South Africa - Egypt	South Africa - Kenya	South Africa - UK	South Africa - USA
-0.0132	-0.1506	-0.0262	0.2818	0.4299
	Nigeria - Egypt	Nigeria - Kenya	Nigeria - UK	Nigeria - USA
	-0.0200	0.0071	0.0137	0.0169
		Egypt - Kenya	Egypt - UK	Egypt - USA
		0.0203	0.1797	0.2448
			Kenya - UK	Kenya - USA
			0.0329	0.0503

				UK - USA
				0.3823
South Africa - Nigeria	South Africa - Egypt	South Africa - Kenya	South Africa - UK	South Africa - USA
-0.0021	-0.0238	-0.0045	0.0424	0.0641
	Nigeria - Egypt	Nigeria - Kenya	Nigeria - UK	Nigeria - USA
	-0.0032	0.0011	0.0022	0.0027
		Egypt - Kenya	Egypt - UK	Egypt - USA
		0.0036	0.0284	0.0385
			Kenya - UK	Kenya - USA
			0.0058	0.0086
				UK - USA
				0.0565
South Africa - Nigeria	South Africa - Egypt	South Africa - Kenya	South Africa - UK	South Africa - USA
-0.0032	-0.0361	-0.0069	0.0639	0.0966
	Nigeria - Egypt	Nigeria - Kenya	Nigeria - UK	Nigeria - USA
	-0.0048	0.0017	0.0033	0.0041
		Egypt - Kenya	Egypt - UK	Egypt - USA
		0.0055	0.0430	0.0583
			Kenya - UK	Kenya - USA
			0.0089	0.0132
				UK - USA
				0.0850

4.5. Robustness

To determine optimal lags, we will run an unrestricted VAR, therefore we assume that there is no cointegration between the three returns. The optimal lags for the VAR analysis are chosen based on the Akaike information criterion (AIC). Two lags have been selected for every period of this section. Similarly, to study performed by Yang et al. (2002), it is evident that the residuals are well behaved and devoid of autocorrelation issues from the diagnostic statistics test.

Table 6. Vector Autoregressive analysis of emerging and developed stocks.

Vector Autoregression Estimates
Included observations: 5728 after adjustments
Standard errors in () & t-statistics in []

	LNSA	LNNIG	LNEGY	LNKEN	LNUK	LNUS
LNSA(-1)	-0.092653 (0.01670)	0.018662 (0.01780)	0.064976 (0.02121)	0.012543 (0.01188)	-0.019025 (0.01546)	-0.016357 (0.01839)

	[-5.54738]	[1.04853]	[3.06299]	[1.05550]	[-1.23056]	[-0.88939]
LNSA(-2)	0.017346 (0.01649) [1.05186]	-0.023389 (0.01757) [-1.33094]	0.046977 (0.02094) [2.24292]	-2.53E-05 (0.01173) [-0.00216]	0.033994 (0.01527) [2.22695]	0.055433 (0.01816) [3.05274]
LNNIG(-1)	-0.027372 (0.01234) [-2.21787]	0.043401 (0.01315) [3.30004]	-0.019140 (0.01567) [-1.22106]	0.016796 (0.00878) [1.91274]	-0.004745 (0.01142) [-0.41533]	-0.011944 (0.01359) [-0.87891]
LNNIG(-2)	0.011318 (0.01233) [0.91829]	0.108827 (0.01313) [8.28577]	0.028824 (0.01565) [1.84131]	0.009259 (0.00877) [1.05581]	-0.002027 (0.01141) [-0.17765]	-0.006221 (0.01357) [-0.45838]
LNEGY(-1)	-0.003923 (0.01053) [-0.37269]	0.041253 (0.01122) [3.67792]	0.126051 (0.01337) [9.42887]	0.020659 (0.00749) [2.75862]	0.004977 (0.00974) [0.51081]	0.017474 (0.01159) [1.50768]
LNEGY(-2)	-0.019797 (0.01038) [-1.90756]	0.018602 (0.01106) [1.68196]	-0.013573 (0.01318) [-1.02970]	0.019662 (0.00738) [2.66269]	-0.007446 (0.00961) [-0.77505]	0.005936 (0.01143) [0.51941]
LNKEN(-1)	-0.023462 (0.01854) [-1.26558]	0.012967 (0.01975) [0.65638]	0.062376 (0.02355) [2.64918]	0.259763 (0.01319) [19.6942]	-0.031776 (0.01716) [-1.85170]	-0.020418 (0.02041) [-1.00022]
LNKEN(-2)	0.037549 (0.01847) [2.03261]	-0.005808 (0.01969) [-0.29504]	0.022753 (0.02346) [0.96978]	0.062553 (0.01314) [4.75923]	0.029466 (0.01710) [1.72317]	0.013807 (0.02034) [0.67877]
LNUK(-1)	-0.051227 (0.02072) [-2.47178]	0.014998 (0.02208) [0.67910]	0.026058 (0.02632) [0.98996]	-0.009507 (0.01475) [-0.64474]	-0.259065 (0.01918) [-13.5041]	0.013324 (0.02282) [0.58388]
LNUK(-2)	-0.049663 (0.02008) [-2.47313]	0.030598 (0.02140) [1.42988]	-0.013584 (0.02550) [-0.53262]	0.016886 (0.01429) [1.18185]	-0.093998 (0.01859) [-5.05679]	-0.030005 (0.02211) [-1.35694]
LNUS(-1)	0.311746 (0.01530) [20.3798]	0.026157 (0.01630) [1.60463]	0.180380 (0.01943) [9.28439]	0.049064 (0.01088) [4.50808]	0.354181 (0.01416) [25.0130]	-0.095133 (0.01684) [-5.64796]
LNUS(-2)	0.102017 (0.01613) [6.32313]	-0.007031 (0.01719) [-0.40894]	-0.017404 (0.02049) [-0.84932]	0.015176 (0.01148) [1.32205]	0.100954 (0.01493) [6.75964]	-0.005406 (0.01777) [-0.30428]
C	0.034958 (0.01509) [2.31738]	0.027717 (0.01608) [1.72418]	0.027031 (0.01916) [1.41082]	-0.006288 (0.01073) [-0.58585]	-0.000428 (0.01396) [-0.03068]	0.016300 (0.01661) [0.98130]

Table 6 has 6 endogenous variables. It illustrates the relationships between the African capital market and developed returns. We note that the first set of values represent the coefficient of each variable followed by the standard error in parenthesis and lastly the t-statistic.

The first lag results illustrate the impact of previous returns on each of the listed returns. From table 5, we note that both the South African and Egyptian returns are impacted by the first lag of the South African return since the t-statistic of each variable is larger than the critical t-value of 2,05 at a 5% significance level. The first lag coefficient depicts a negative relationship

between South African returns and its previous returns therefore a percentage increase of previous returns would result in a decrease of the current returns. The opposite may be seen in the Egyptian returns with the previous South African returns having a positive impact on the Egyptian returns thus, a percentage increase of previous returns would result in an increase of the current Egypt returns. The South African current returns along with the Nigerian current returns are negatively and positively impacted by the Nigerian previous returns. The current African returns apart from South Africa are all positively impacted by the previous Egyptian returns. And lastly the Kenyan returns are only statistically significant with regards to their own current returns. From these results we notice that Egypt suffers more risk spillovers from other emerging African markets, however it is also the largest volatility spillover contributor. This aligns with the results obtained from the BK-18 spillover index.

In general, for the developed markets, the US was found to be the significant contributor of risk spillovers across the markets. While the UK, on the other hand, was found to make a slightly less significant contribution to volatility spillover to the developed markets. Comparatively, we reveal that the developed stock markets possess substantial volatilities across all time horizons than the African stock markets. the US returns impact When the broad markets are studied in isolation the US is a larger contributor of risk spillovers, while the UK suffers the greatest volatility spillover between the two developed markets. It is essential to note that the results from the VAR estimations corroborate the initial findings documented from the Baruník and Krehlík (2018) approach.

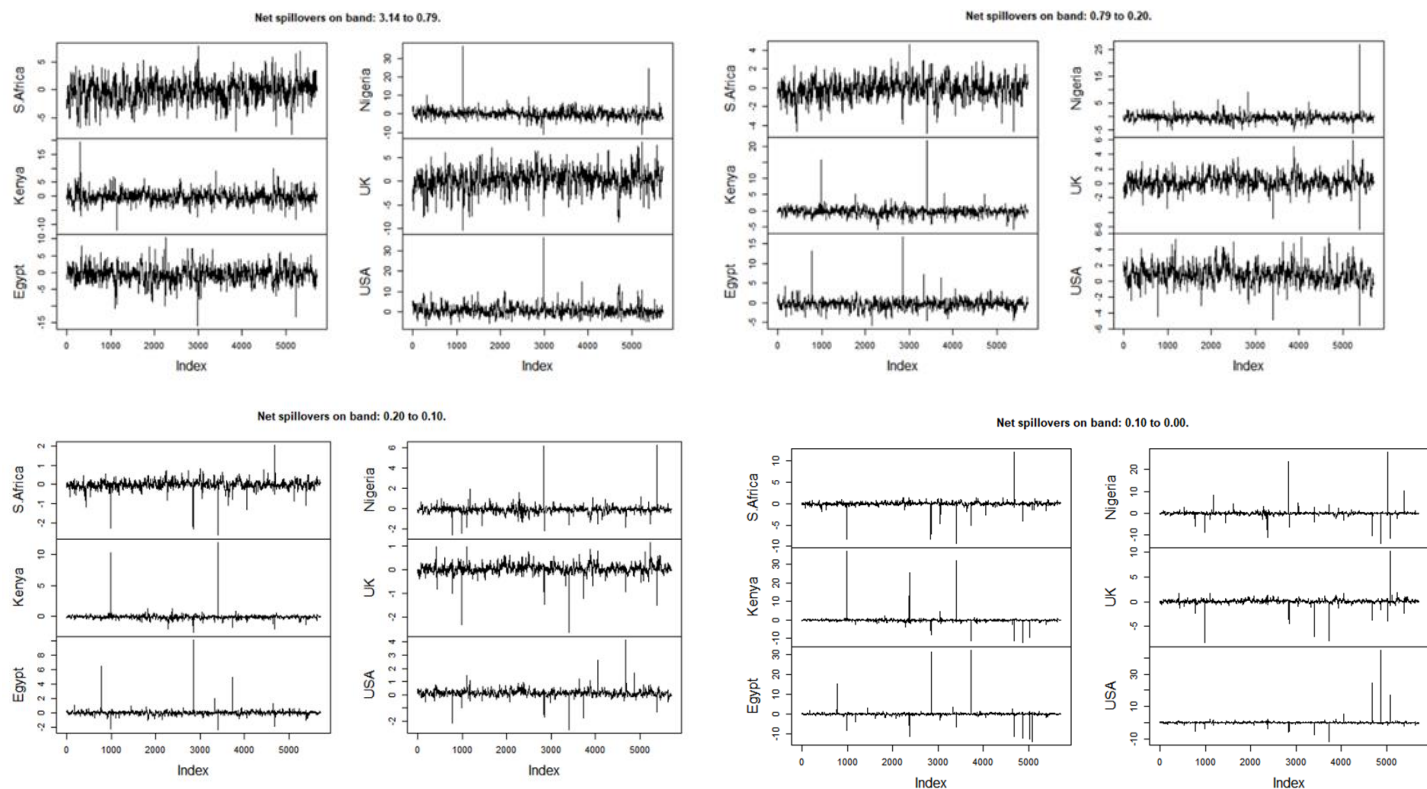
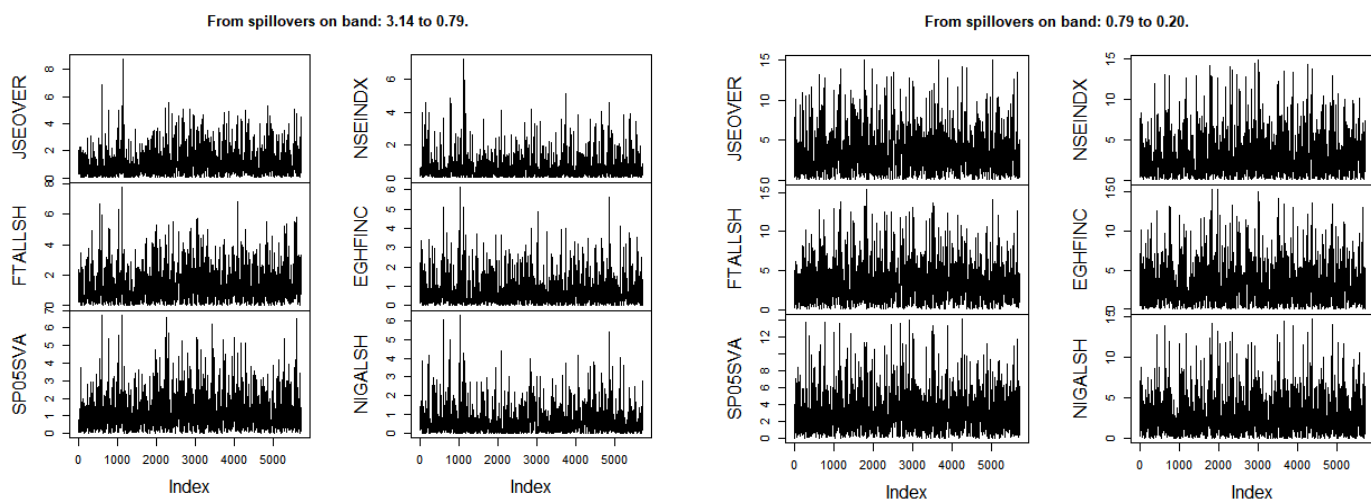


Figure 3. Net total directional connectedness.



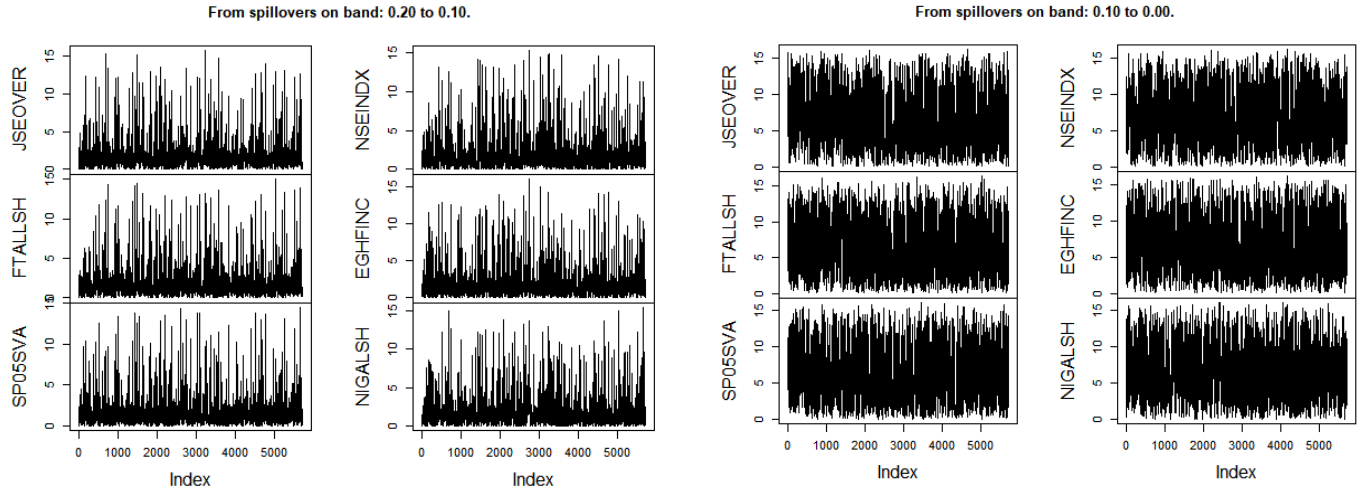
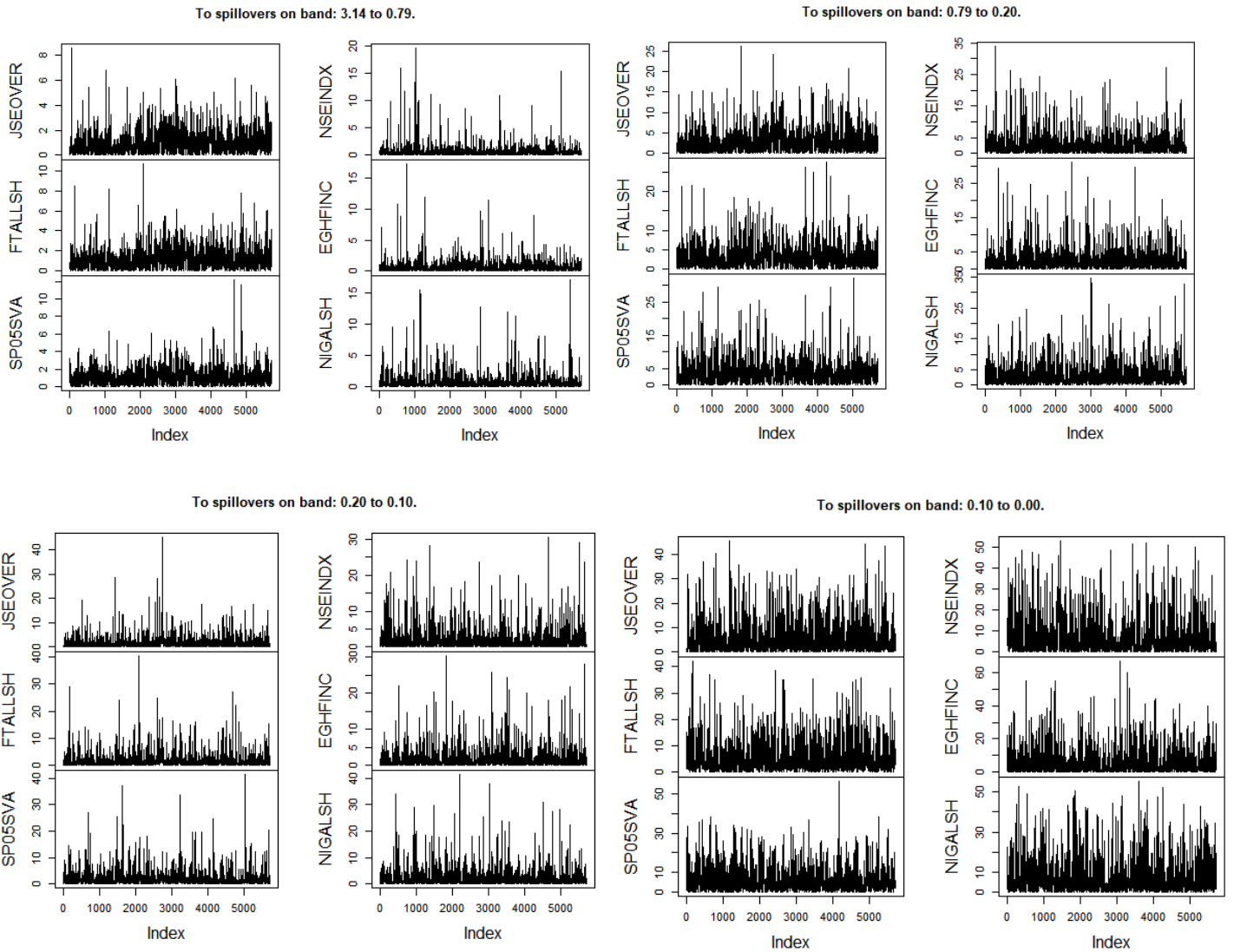


Figure 4. Directional connectedness.

(a) “FROM” Spillovers



(a) “TO” Spillovers

5. Practical implications

5.1. Market participants

Similar to many spillover studies conducted using the BK-18 spillover index we found that the short-term spillover bands 3.4-0.79 consisted of the larger share of total spillovers experienced by both the African and Developed markets. These results imply that the short-term transitory conditions may be the potential causal effect for majority of the total spillovers between the African and developed stocks. The results found are consistent with the EMH such that in the short-term, asset prices fully reflect all pertinent information (Fama, 1970, 1998), resulting in exuberant market dynamics. The evidence of large spillovers in the short-term suggest reduced

opportunities for diversification. During turbulent trading days, speculators may have to focus on African and developed markets in the medium-to long-term horizons, where volatilities are less prevalent.

More crucially, our research reveals that diversification between African and developed equity markets would only be viable over the medium and long periods. The EMH may not hold practically over the medium- and long-term horizons due to the possibility that foreign investors have modified and rebalanced their portfolios in accordance with their intended behavioural outcomes. Investors would want to maximize (mitigate) portfolio returns (risks) over investment horizons; therefore, should they find themselves in volatile trading times, it is best that they adjust to the diverse market responses based on their level of risk tolerance. This observation is reinforced by the AMH, HMH, and CMH of Lo (2004), Müller et al. (1993), and Owusu Junior et al. (2021), in that order. Consequently, in the intermediate- and long-term, African, and developed markets are characterised by active, adaptive, and heterogeneous behaviours.

5.2. Regulators and/or governments

Stocks from the South Africa and Egypt possess high spillovers and, therefore, investors should be wary of these equities during asset allocation and portfolio construction. South Africa is an integrated emerging market which explains the greater shocks experienced by the capital market in comparison to the other African markets. This is because the South African capital markets possess duo listed stocks which appear in the UK capital markets. Spillovers from the US are almost expected since there is a common rhetoric in finance which states that “when America sneezes, the whole world catches a cold,” as put forward by Adam. The results seemingly agree with this statement however it is important to highlight that Nigeria and Kenya suffer significantly lower spillovers from the US. Furthermore, African markets experience

significantly lower spillovers from the US when compared to spillovers experienced by the UK from the US, which suggests that developed markets are affected by spillovers considerably more than African markets across spillover bands.

6. Conclusion

This study made use of the Barunik and Krehlik (2018) spillover index to examine the dynamic connectedness and spillovers between emerging African and developed stock markets to reveal the time- and frequency-domain dynamics of the one asset class during different market conditions. The daily stock market indices for 4 key African markets (South Africa, Nigeria, Kenya, and Egypt) along with two developed economies (United Kingdom and United States) are utilised in the processing and analysis. The dataset spanned between 3 January 2000 and 31 December 2021, yielding 5741 common data observations. The daily stock indices were supplied by Refinitiv and are expressed in their local currency.

We examine whether the fundamental relationship between African and developed stocks remains the same as well as the degree to which stocks from African and developed markets are connected during stressful times; whether connectedness between African and developed

stocks differs across investment horizons; and whether connectedness between African and developed markets evolve from the majority of shocks among Islamic and conventional markets. By using the BK-18 framework, we discovered that intraweek spillovers are somewhat bigger than those in the medium- to long-term horizons, indicating that all markets react swiftly to shocks in the first few trading days. The examined African and developed markets are therefore more susceptible to market shocks than in later times, in line with the EMH of Fama (1970, 1998). We conclude that short-term spillovers are more significant than intermediate-term spillovers for African and developed markets.

We identified, from the emerging African markets alone, that South Africa and Egypt offer the greatest contribution to market return spillovers in the very short-term (i.e., within band 3.14 to 0.79). Consequently, South Africa and Egypt remain the greatest contributors of market spillovers to the selected African markets over bands 2 to 5 with Kenya being the least contributor of return spillovers among the African markets. South Africa receives high levels of volatility spillover in the short-term, specifically in the spillover band 3.14 to 0.79. Between bands 2 and 4. Kenya is found to be the recipient of the largest volatility spillover among the studied emerging African and developed stock markets.

The implications of our research will be enormous for investors and governments. Equity investors need to keep in mind the asymmetry and time-variability of spillovers. Particularly in the near term (up to four trading days), when spillover is more pronounced, investors may use knowledge of market trends and volatility to hedge their holdings against poor stock returns. The HMH and CMH claim that due to a variety of circumstances, equity investors may adjust their investment approach. In comparison to developed companies, African stocks offer diversification advantages regardless of the time horizon.

Equity fund and/or portfolio managers and policymakers could forecast the impact of their policies and reforms by using data on frequency dynamic spillover intensities and directions. Given the results from the directional and pairwise connectedness, knowledge about the dynamic interrelations across different time scales or investment horizons is essential to arrive at optimal asset management (Salisu et al., 2020). Timely rebalancing of portfolios, on the part of international investors and/or portfolio managers, is essential to benefit from the diversification, haven, and hedge opportunities between African and developed markets.

7. References

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