# Market Integration and Informational Efficiency of Africa's Stock Markets

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## Abstract

Market integration and informational efficiency of stock markets are key policy variables, yet have long been studied as separate concepts. In this article, we address the forthright question of whether a more integrated stock market is also a more informationally efficient market using a panel of 11 of Africa's leading stock markets for the period 2002-2014. We proxy market integration using the adjusted pricing error from an equilibrium international asset pricing model. The aggregate market-level price delay, which captures the relative speed of adjustment by each aggregate stock market to global common news, is used as an inverse measure of informational efficiency. We find

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compelling evidence that corroborates the hypothesis that markets that are more integrated with the world market tend to be more efficient as well. We suggest that policy efforts towards market integration and informational efficiency must be complementary as the two policy goals are closely related.

*Keywords:* Stock market integration, informational efficiency, emerging markets, frontier markets, Africa's stock markets.
*JEL Classification:* F36, G14, G15

## 1 - Introduction

The world has witnessed active moves by countries, especially emerging and frontier economies to liberalise their markets since the 1980s. The goal was to make such markets generally accessible to investors globally which should ultimately facilitate economic growth. Generally, the liberalisation packages comprised the removal of statutory restrictions on investments which had hitherto prevented foreign investors from participating in local markets (Hooy and Lim, 2013). As a result, the volume of international capital flows to emerging and frontier markets, in particular, increased significantly. However, the occurrence and ramifications of financial crises around the world during the 1997-2011 period have generated discussion on the desirability of full-scale financial liberalisation and market integration. Many have wondered if the real benefits of market integration adequately justify the volatility and spillovers associated with an integrated world capital market. Besides, there are disagreements and evidence of lack of definite conclusion on the growth-enhancing benefits of capital market openness (see Edison et al., 2004; Henry, 2007; Kose et al., 2009). One thing, however, is obvious from evidence, liberalisation policies have increased the integration of stock markets worldwide (see for example Carrieri et al., 2011; Bekaert et al., 2011). In keeping with this global consensus, a relevant policy question thus arises and relates to whether the increased market integration with world stock markets is associated with higher degrees of informational efficiency in stock markets. This policy question is even more relevant for emerging markets considering their unique characteristics and position within the global financial system.

In this study, we examine the link between stock market integration and informational efficiency (market efficiency) in Africa's stock markets by *testing the hypothesis that a more globally integrated market is also a more informationally efficient market* (in the spirit of Hooy and Lim, 2013). The link between market integration and market efficiency is very under researched. Perhaps the only studies that have endeavoured to address the issue empirically are Li et al. (2004), Bae et al. (2012) and Hooy and Lim (2013). Whilst Li et al. (2004) and Bae et al. (2012), respectively, analysed the efficiency effect of financially opened markets at the firm and country levels, Hooy and Lim (2013) concentrated on developed and leading emerging markets. Thus no study has empirically examined the relationship between market integration and market efficiency in African stock markets. Consequently, we close this gap and extend

the empirical literature on market integration from an African perspective. This study is important because within a unified framework we are able to consider simultaneously the two separate but core policy variables from a purely developing-world perspective. Academia, market participants, and policymakers are increasingly concerned with the effects of increasing global integration because of their far-reaching consequences on the world economies and financial markets.

The informational efficiency upshot of market integration deserves considerable policy attention globally and in Africa especially for at least two reasons. First, African stock markets have largely been found to be informationally inefficient, yet efficient price discovery is a key function of stock markets and the promotion of informational efficiency is a basic goal of capital market regulators. In an informationally efficient market, the arrival of new information is swiftly incorporated into security prices and market participants are deemed to be very well informed. Informationally efficient markets promote investor confidence, provide feedback on corporate decisions and ensure that corporate executives are pursuing shareholder wealth-enhancing strategies (Durnev et al., 2004; Chen et al., 2007). Majumder (2012) pointed out that wrong investment strategy can endanger the optimal allocation of resources. Importantly, efficient markets have serious implications for government policies and the general wellbeing of society. In fact, Morck et al. (1990) long ago highlighted that market efficiency would be immaterial if the stock market did not influence economic activities. Dow and Gorton (1997) exemplified the link between an efficient stock price and efficient allocation of investment resources in a theoretical model, showing that the stock market indirectly guides business managers by transmitting information about potential investment opportunities and company cash flows[4].

Second, the informational efficiency effect of market integration deserves the singular attention of policymakers and market regulators in order to avoid misallocation of resources which can hinder long-term economic growth. This is particularly important given that African stock markets are mostly perceived to be less efficient than and less integrated with the rest of the world. Besides, core policy goals emphasise the need to enhance greater market integration and promote greater market efficiency. It is therefore pertinent to ask the relevant policy question of whether there exists a positive association between these two important policy goals of ensuring that markets are

[4] Related to Dow and Gorton's theoretical contribution, a number of theoretical studies have recently considered the feedback effect from stock prices to real investment decisions such as Goldstein and Guembel, 2008; Dow et al., 2011).

integrated and efficient. Indeed, policymakers might have to reconsider any commitment to further integrate the world capital markets if increased market integration resulting from financial liberalisation is negatively associated with informational efficiency (Hooy and Lim, 2013). On the other hand, policymakers would have to intensify their commitment to integrating the world capital markets if greater levels of market integration are associated with higher degree of market informational efficiency. Also, the absence of significant association would show that the two are and can be pursued as independent policy goals. Indeed, Lence and Falk (2005) demonstrate within standard dynamic general equilibrium asset-pricing model that market integration and market efficiency are independent of each other. Thus whichever way it turns out, the results would provide a unique and important contribution to this area of research as the literature is very sparse globally and completely non-existent in Africa. African markets are fast becoming an attractive destination for international investments. There is thus a need for an understanding of the drivers of informational efficiency. A study of the link between market integration and informational efficiency should provide useful insights for policymaking and regulation of financial markets.

For the rest of the article, Section 2 discusses the relevant literature and formulates the hypothesis, Section 3 describes the methodology and presents the data and preliminary analyses. Sections 4 and 5 present discussions of the results and conclusions, respectively.

## 2 - Literature review and hypothesis formulation

Market integration and market informational efficiency are central concepts in the international financial markets literature. The literature on stock market integration is huge and keeps growing. Similarly, market efficiency has received more empirical attention and wider coverage than any other topic in the finance literature. However, these two important concepts in finance have often been studied separately and therefore have remained largely distinct concepts in the finance literature. Their nexus is often implied but not explicitly analysed (Hooy and Lim, 2013). Besides, the focus of empirical studies has been to examine the extent to which markets are integrated with or segmented from the world market when studying market integration, and to test whether a

financial market is efficient or inefficient when studying market efficiency[5]. Yet theory suggests with empirical backing that market integration is associated with market efficiency (Hooy and Lim, 2013). It should however be noted that greater market integration is not necessarily an indication of higher market efficiency (Lim, 2009). Unless a market is fully integrated with the world market, efficient pricing of assets on the basis of information available to market participants does not guarantee dividends that are comparable to global standards.

The literature has commonly defined market integration in terms of the law of one price. The law of one price within a mean-variance framework suggests that securities with similar risk profile should offer the same risk-adjusted returns. That is, in an integrated world capital market, the price of securities risks should equalise across markets. Lim (2009) highlights that it is erroneous to define market integration based on the degree of correlations because differing industry structures can cause low correlations between very integrated markets. This view is corroborated by Carrieri et al. (2007) and Pukthuanthong and Roll (2009) i.e., that the unconditional correlations of broad market index returns are inappropriate measure of market integration. The study of market integration has gained popularity because of its effects on investors, corporations and economies. Adverse effects associated with higher market integration include greater short-term costs to companies and markets as growing interdependence is characterised by crashes and shock spillovers across markets. Besides, an integrated world stock market is indicative that asset returns are the same everywhere and that potential benefits from international diversification available to global investors and country funds would be eliminated. There are however upsides to greater market integration such as international risk sharing, lower cost of capital and greater capital flows, efficient stock prices, technology transfers, improved financial systems, enhanced welfare gains and greater economic growth (Prasad et al., 2003). In short, market integration can lead to market informational efficiency, which is very desirable.

The premise of the Efficient Market Hypothesis (EMH) is that, in an informationally efficient financial market, security prices should reflect the best

[5] Studies on integration of African markets are substantial (see Collins and Biekpe, 2003; Alagidede, 2010; Agyei-Ampomah, 2011; Adebola and Dahalam, 2012). Also, a number of studies have tested the informational efficiency of Africa's stock markets (see Appiah-Kusi and Menyah, 2003; Jefferis and Smith, 2005; Lim, 2007; Alagidede and Panagiotidis, 2009; Abdmoulah, 2010; Smith and Dyakova, 2013; Youssef and Galloppo, 2013). Although results are mixed, the general consensus is that African markets are largely inefficient.

possible estimate of their true economic value. The assumption is that stock prices fully incorporate all information so that changes in asset prices reflect only news and/or unanticipated events. Also, in an informationally efficient market, stock prices are deemed rational and reflect only useful characteristics such as asset risk (Alagidede, 2010). Under such circumstances, asset prices are deemed unpredictable and unforecastable. The present study stems from a number of theoretical models that consider the advantages of market integration resulting from market reforms that sought to liberalise the world capital markets. Albuquerque et al. (2009), for instance, propose a model in which global investors are in possession of global private information deemed valuable for trading in various countries simultaneously. The rationale is that market integration should lead to improved informational efficiency in the local financial markets. Local market participants typically underreact to global private information owing to the presence of information asymmetry between them and their foreign counterparts. Thus stocks that are inaccessible to global investors poorly incorporate global information into their prices. Conversely, greater accessibility which results from market integration is said to improve information dissemination (Bae et al., 2012) and market efficiency.

Also, a number of earlier models have suggested a linkage between the speed of information incorporation and the extent of market participation (Merton, 1987; and Hou and Moskowitz, 2005). A shared argument advanced in the literature is that severe market restrictions due to institutional forces and information and transaction-related costs can cause delayed share price adjustment. Similarly, Bae et al. (2012) recently argued that local market frictions that restrict foreign investments in emerging stock markets may inhibit prompt incorporation of global market information. The removal of market restrictions in emerging stock markets is perceived as enhancing informational efficiency. Moreover, the importance of analysing the efficiency effects of some market reforms has been recognised in the study of such domains as private property rights protection (Morck et al., 2000), securities laws (Daouk et al., 2006), corporate transparency (Jin and Myers, 2006), short-selling regulations (Bris et al., 2007), insider trading laws (Fernandes and Ferreira, 2009), trade opening (Lim and Kim, 2011), and financial liberalisation (Li et al., 2004; Bae et al., 2012). The rationale behind all these studies is to highlight the linkage between market integration and the informational efficiency of stock markets and the policy implications for such a nexus.

The empirical literature on the link between market integration and market efficiency has so far been very limited. Perhaps the most relevant studies that have analysed the empirical link between the two variables are Li et al.

(2004), Bae et al. (2012), and Hooy and Lim (2013). Li et al. (2004) studied the market efficiency effect of capital market liberalisation by comparing individual stock return co-movements across emerging markets. The results show that higher firm-specific variation is related to greater capital market openness, suggesting that greater foreign accessibility to stocks is closely associated with improved informational efficiency of domestic stock markets. Similarly, Bae et al. (2012) used the degree of accessibility of foreign investors to emerging stock markets to assess the influence of investibility on the diffusion of common news across markets. The results indicate that returns of highly-investible securities with large foreign investor accessibility lead returns of non-investible stocks that are closed to foreign investors. The evidence additionally shows that greater investibility facilitates prompt incorporation of global and local market information into stock prices. Hence, the finding implies that greater foreign investor participation in the local market facilitates rapid information incorporation, which is consistent with the idea that increased market integration creates greater informationally efficient prices in emerging markets. In particular, Bae et al. (2012) suggest that foreign investors are better positioned to process global information and thus end up enhancing market informational efficiency. Generally, foreign investor participation in emerging stock markets increases with growing market integration and facilitates speedy diffusion of global market information among investible securities in national financial markets. However, the use of investible weight by Bae et al. (2012) has been severely criticised because it measures the evolution and intensity of stock market openness in a *de jure* instead of a *de facto* manner (Hooy and Lim, 2013).

In a recent study, Hooy and Lim (2013) explicitly addressed the issue relating to whether a more integrated market is associated with a higher degree of informational efficiency. An adjusted pricing error from a standard international asset pricing model is used as a surrogate for market integration. Informational efficiency is measured as an inverse of the aggregate country-level price delay. Using data from 49 developed and emerging countries the study found evidence in support of the hypothesis that the more integrated markets become with the world market, the more informationally efficient they become. The study however focused on developed and major emerging stock markets, incorporating only three markets from Africa (Egypt, Morocco, and South Africa). Several other African countries have recently qualified as frontier markets based on S&P/Dow Jones Index classification, suggesting a greater level of openness of these markets to foreign accessibility and investments. Besides, addressing the relationship between market integration

and market efficiency is more crucial in emerging and frontier markets where integration with the world is significantly less than complete (Li et al., 2004).

## 2.1 Hypothesis formulation

The hypothesis formulated and tested in this study is that "there exists a positive association between stock market integration and the informational efficiency of stock markets in Africa". In the spirit of Hooy and Lim (2013), stock market integration in this study is measured using an adjusted pricing error from an equilibrium international asset pricing model (ICAPM) suggested by Stehle (1977). We also apply their price delay measure to determine market informational efficiency. Hence, informational efficiency of the stock market is measured by the speed with which each aggregate stock market responds to global common information (see Hooy and Lim, 2013).

Attempts have been made at various levels in the past to assess relative informational efficiency among markets across the world. The World Bank Group's composite indicator for gauging the relative informational efficiency among stock markets around the world is a good example. Until recently, a well-known country-level measure has been the R-square statistic obtained by regressing individual stock returns on contemporaneous domestic market index returns (a proxy for local market-wide information) and the United States market index returns (representing worldwide market information). This is then aggregated across stocks applying either variance weights or equal weights (see Jin and Myers, 2006; Fernandes and Ferreira, 2009). This measure is said to be inversely related to the amount of firm-specific information contained in stock prices; suggesting that a lower R-square means that stock prices have more firm-specific information in them (Morck et al., 2000). Intuitively, the share price of a firm should convey little firm-specific information when a strong correlation exists between the firm's stock return and market return. In spite of its popularity, the validity of the regression method that yields the R-square statistic has been challenged (see for instance Ashbaugh-Skaife et al., 2006; Hou et al., 2006; Kelly, 2007; and Teoh et al., 2008). Unlike the information-efficiency model involving the R-square statistic, the price delay model is robust at capturing the informational efficiency and can be used to compare the speed of adjustment to global market occurrences for a broad cross-section of stock markets (Lim, 2009).

An alternative measure to the speed of stock price adjustment to specific event or information is the popular event study methodology pioneered by Fama et al. (1969). However, the price delay measure has the double

advantage of measuring the speed of information incorporation while at the same time examining factors causing the delay of stock prices in response to local market-wide information (Lim 2009). In rationalising the hypothesis of a positive association between stock market integration and informational efficiency in this study, we applied Hooy and Lim's (2013) approach by comparing the proportion of stock returns accounted for by global against domestic factors in the following three different scenarios:

a. If a market is fully segmented from the rest of the world (i.e. the case of perfect segmentation), its stock returns are exposed mainly to domestic market shocks, and for that reason, a significant delayed response to global information is expected;
b. If a market is fully integrated with the rest of the world (i.e. the case of perfect integration), the market is more sensitive to global events and its stock returns are expected to respond swiftly to global information; and
c. In between the two extreme situations lies an intermediate case of a partially integrated market in which stock returns are determined by a combination of domestic and global factors. The importance of the global factors, however, increases with the degree of market integration.

Essentially, we hypothesise that an African stock market that becomes more integrated with the world stock market also becomes more informationally efficient. Of course, financial market theory suggests that, although investors are exposed to both global common and country-specific risks within fully integrated capital markets, only the global common risks are priced because unsystematic country-specific risks can be completely diversified internationally.

## 3 - Methodology and data

This section describes how the two policy variables of market integration and market efficiency are measured empirically in the present study. As noted previously, the methodology is based largely on the Hooy and Lim's (2013) approach.

### 3.1 Empirical measures of market integration and market efficiency

In the spirit of Hooy and Lim (2013), we empirically measure stock market integration using the single factor International Capital Asset Pricing Model (ICAPM) proposed by Stehle (1977). This is a simple but widely accepted equilibrium asset pricing model, which by its formulation allows for both the direct and indirect forms of investment barriers (Hooy and Lim, 2013). The model is specified in the following form:

$$r_t^m = \gamma + \psi r_t^w + \varepsilon_t \qquad (1)$$

where $r_t^m$ is the domestic market excess return at week t, $r_t^w$ is the world market excess return at week t, and $\varepsilon_t$ is white noise. The intercept ($\gamma$) in equation (1) is a mispricing measure and would equal zero (0) indicating the absence of mispricing in ICAPM, if a market is perfectly integrated with the rest of the world. Thus the mispricing measure ($\gamma$) is correlated with higher bureaucratic barriers, transaction cost, tax on international investments and barriers to firm information (Korajczyk, 1996). Following Hooy and Lim (2013) and Levine and Zervos (1998), the empirical measure of integration is the absolute value of the pricing error in equation (1) multiplied by (-1) as follows:

$$INTEGRATE = -|\gamma| \qquad (2)$$

A higher (lower) value of INTEGRATE indicates greater (less) integration between the domestic stock market and global markets.

Also, the empirical measure of market efficiency or informational efficiency is the stock price delay measure. In cross-company studies within a single market, the stock market index is frequently used to determine the price delay measure through which the relative speed with which individual firms react to market common information can be captured. In a cross-market study, however, the appropriate approach is to use a global market-wide information set which allows the price delay measure to capture the relative speed of adjustment of each market to the global common information (Hooy and Lim, 2013). To this end, we employed the country-level price delay measure proposed by Hooy and Lim (2013), which involves an unrestricted ICAPM in the following specification:

$$r_t^m = \alpha + \psi r_t^w + \sum_{k=1}^{4} \Omega_k r_{t-k}^w + \varepsilon_t \qquad (3)$$

The R-squares from equations (1) (restricted version) and (3) (unrestricted version) are then used to estimate the price delay measure in the following form:

$$DELAY = 1 - \frac{R^2_{restricted}}{R^2_{unrestricted}} \qquad (4)$$

The price delay measure is an inverse measure of informational efficiency, and a higher value of DELAY would indicate a lower degree of efficiency of the stock market and vice versa. Also, a higher value of the DELAY suggests that lagged world market returns ($r^w_{t-k}$) accounts for more variations in the domestic market index returns, and that there is greater delay from the domestic market in responding to global market-wide factors that has common effects across markets.

### 3.2 Empirical model specification

In this study, the pooled Ordinary Least Squares (OLS) regression method is used to examine the empirical relationship between market integration and market informational efficiency. The determinants of stock price delay are well-grounded both in the theoretical and empirical literature. Cross-sectional determinants for stock price delay identified in various studies include firm size, trading volume, analyst coverage, market friction, institutional ownership, short sales restriction, intra-industry phenomenon, and the degree of investibility (see the study by Lim, 2009 and references therein). We originally intended to control for the influence of these determinants in our analysis. However, due to data accessibility issues, the final analysis concentrated on the macro-level counterparts for firm size (SIZE) and trading volume (VOLUME). Thus the following pooled cross-sectional OLS regression model is estimated in the present study:

$$DELAY_{i,t} = \gamma + \delta INTEGRATE_{i,t} + \mathrm{X'}_{i,t}\psi + v_{i,t} \qquad (5)$$

where $\delta$, which is our parameter of interest, measures the effect of market integration on informational efficiency. The vector $\mathrm{X'}_{i,t}$ denotes the two control variables (SIZE and VOLUME) with $\psi$ as coefficient vector. $\gamma$ is an intercept measure while $v_{i,t}$ is the error term capturing all other omitted variables in the regression model. In this specification, the standard errors allow for clustering at the country-level as they are robust to heteroscedasticity in the variance-covariance matrix (see Hooy and Lim, 2013).

### 3.3 Data and preliminary analyses

The data consists of weekly closing stock-price indices of eleven African stock markets from 7th January, 2000 through to 26th December, 2014

obtained from Morgan Stanley Capital International (MSCI). The dataset is made up of the main stock market indices of Botswana, Cote D'Ivoire, Egypt, Ghana, Kenya, Mauritius, Morocco, Namibia, Nigeria, South Africa, and Tunisia. All indices are in US Dollar to ensure uniformity in currency and lay emphasis on global factors rather local macroeconomic factors. The value-weighted MSCI All-Country World Index is used to proxy for global factors, while the United States 3-month Treasury bill rates serve as a proxy for the global risk free rate. The MSCI World Index is a broad global equity benchmark and its performance is frequently used as a surrogate for the performance of the world equity markets. The two control variables (SIZE and VOLUME) are calculated using the panel data on the market capitalisation of listed companies and turnover ratio from the World Bank's World Development Indicators (WDI, 2016). The SIZE (stock market size) is proxied by the natural logarithm of the market capitalisation of listed companies, while the VOLUME (trading volume) is proxied by the natural logarithm of one plus the turnover ratio (see Hooy and Lim, 2013 for a similar treatment).

For the empirical analyses, the weekly price indices were transformed into continuously compounded weekly returns using the formula $R_t = [\ln(P_t) - \ln(P_{t-1})] \times 100$. We initially estimated equation (1) annually using weekly index returns (obtaining 15 annual observations for each stock market) and subsequently computed INTEGRATE for each market based on equation (2). Similarly, equation (3) is estimated annually using weekly index returns and the DELAY is then computed for each market based on equation (4). Prior to the empirical results however, the statistical properties of the data set are verified. Table 1 reports the descriptive statistics (Panel A) and correlation matrix (Panel B) of the relevant variables. The values of the standard deviation suggest that there is considerable variation in the countries, which allows for pooled cross-sectional regression analysis. The DELAY and INTEGRATE measures are negatively skewed, showing that most of the actual series are generally greater than the mean. In contrast, SIZE and VOLUME are positively skewed, which suggests that actual series of these variables are largely below their mean values. In terms of distribution of the series, INTEGRATE is leptokurtic with Kurtosis above three, while the rest of the variables can be said to be flat with short tails. The Jarque-Bera statistics however suggest that the variables are not normally distributed as the normality tests are rejected in all cases.

**Table 1: Descriptive statistics and correlation matrix**

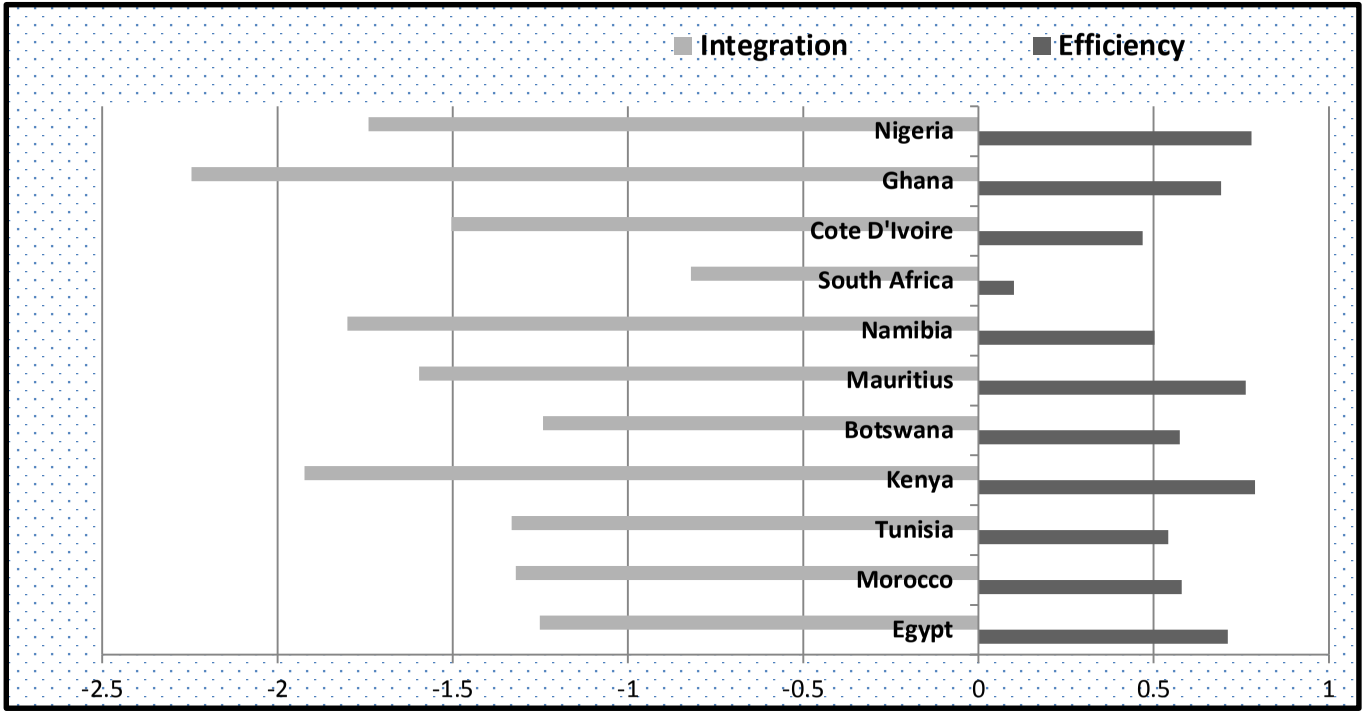
| | DELAY | INTEGRATE | SIZE | VOLUME |
|---|---|---|---|---|
| ***Panel A: summary statistics*** | | | | |
| Mean | 0.591341 | -1.524805 | 3.314665 | 2.241214 |
| Median | 0.714286 | -0.674544 | 3.230655 | 2.164472 |
| Maximum | 0.999664 | -0.002928 | 5.674269 | 4.178399 |
| Minimum | -0.450549 | -10.58555 | 1.445401 | 0.538374 |
| Std. Dev. | 0.369302 | 1.758987 | 0.931030 | 0.969006 |
| Skewness | -0.544974 | -1.789287 | 0.553088 | 0.415806 |
| Kurtosis | 2.010418 | 7.048540 | 2.871607 | 2.149062 |
| Jarque-Bera | 14.89990*** | 200.7284*** | 8.525753** | 9.732753*** |
| Observations | 165 | 165 | 165 | 165 |
| ***Panel B: correlation matrix*** | | | | |
| DELAY | 1.000000 | | | |
| INTEGRATE | -0.269019*** | 1.000000 | | |
| SIZE | -0.233714*** | 0.234058*** | 1.000000 | |
| VOLUME | -0.106060 | 0.127461 | 0.60637*** | 1.000000 |

Notes: **** and ** indicate significance at 1 and 5 percent levels, respectively. Jarque-Bera is the Jarque-Bera Test Statistic. DELAY is a measure of the country-level price delay and serves as an inverse measure of informational efficiency, where a higher value indicates a lower degree of informational efficiency. INTEGRATE is a measure of the degree of market integration with the World, measured by the negatively signed pricing error. A higher value of INTEGRATE (that is a value closer to zero) shows a greater level of integration between the local market and the World equity market.*

The unconditional correlations in Panel B indicate that all the regressors (INTEGRATE, SIZE and VOLUME) are negatively correlated with the dependent variable, stock price delay. Among the three explanatory variables, the highest correlation coefficient occurs between market integration and informational efficiency; followed by the correlation between market size and informational efficiency. The correlation between market size and trading volume is however the highest among all the correlation coefficients reported in Panel B. It is worthwhile pointing out that all of the reported correlation coefficients except two are statistically significant but the extent of association is weak generally. While this may be indicative of low co-movements among the stock markets, it also suggests that multicollinearity is not a major concern.

In Figures 1 and 2 we present a graphical illustration of the behaviour of the two policy variables of market integration and informational efficiency. Figure 1 plots the average values of INTEGRATE and DELAY computed over the sample period from 2000 to 2014 for each of the 11 markets. As noted before, DELAY is the country-level stock price delay and an inverse measure of informational efficiency. Thus a higher value of DELAY (i.e. a value closer to one) signifies a lower degree of informational efficiency, while a lower value (i.e. a value closer to zero) indicates a higher degree of informational efficiency. Also, INTEGRATE is measured by the negatively signed pricing error, where a higher value (i.e. a lesser negative or value closer to zero) signifies a greater level of integration between the domestic stock market and the world market. Conversely, a lower value of INTEGRATE (i.e. a more negative value) is indicative of low level of local market integration with the world market. Figure 1 shows that a number of African markets (South Africa, Cote D'Ivoire, Namibia, Botswana, Tunisia, and Egypt) exhibit relatively higher levels of integration with the world market, although the extent of the global integration differs greatly across markets. The South African stock market exhibits the greatest level of market integration (i.e. possesses the least negative value, -0.8203) and hence is considered as the most integrated African market with the world market. Also, the emerging markets of Egypt and Morocco (with INTEGRATE values of -1.2512 and -1.3195, respectively) similarly exhibit a higher degree of market integration and hence can be described as being integrated with the world market. Moreover, the frontier markets of Botswana and Tunisia indicate moderately higher (i.e. lesser negative) values of integration measure (i.e. -1.2422 and -1.3318, respectively), suggesting improved integration with the world market.

**Figure 1. Cross-sectional variation in market integration and informational efficiency.**




Notes: The figure plots the average values of INTEGRATE and DELAY over the sample period 1995-2007 for each of the 11 countries.

In Table 2, we rank African stock markets based on their levels of integration with the world equity market, and the results affirm the position of the South African market as the most integrated African market. Next to South Africa are the stock markets of Egypt, Morocco, Botswana and Tunisia. The stock market in Ghana followed by the Kenyan stock market exhibit the lowest level of market integration, indicating that these markets remain relatively more segmented from the world stock markets. Similarly, the stock markets in Nigeria, Mauritius, Namibia and the West African regional stock market in Cote D'Ivoire also exhibit lower levels of market integration and hence remain partially segmented from the world stock market. A preliminary impression about the statistics reported in Table 2 is that markets that are more integrated with the world equity market (i.e. have lower negative values) tend to be more efficient as well (also possess smaller positive values). Some exceptions however exist as a market may appear to be integrated with the world financial market, but remain relatively inefficient (as in the case of Egypt). Conversely, a market may seem to be efficient and yet appear to be partially segmented from the rest of the world (a good example is Namibia). Barring the few instances, the general impression gathered from Figure 1 and Table 2 is that Africa's markets that have shown some improvement in their integration with the world market also appear to exhibit a higher degree of informational efficiency.

**Table 2: Ranking of African stock markets based on efficiency and integration**

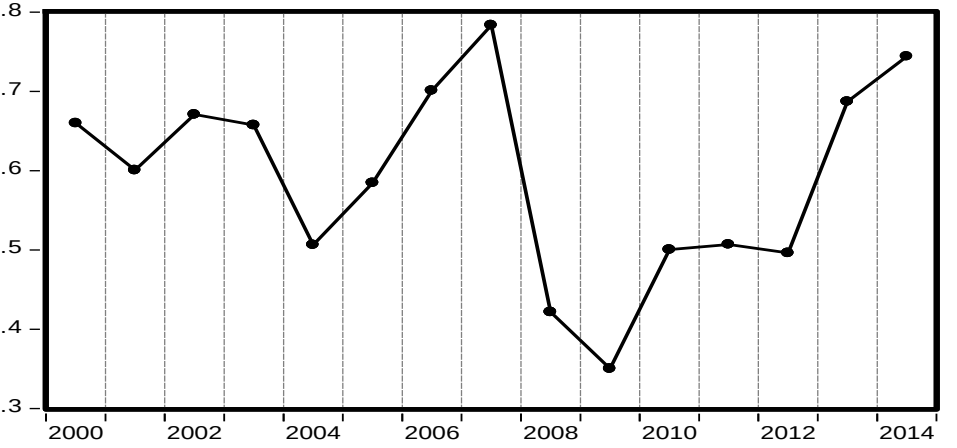
| Market | Efficiency | Ranking | Integration | Ranking |
|---|---|---|---|---|
| Egypt | 0.711547 | 8 | -1.251205 | 3 |
| Morocco | 0.580157 | 6 | -1.319493 | 4 |
| Tunisia | 0.541552 | 4 | -1.331825 | 5 |
| Kenya | 0.789158 | 11 | -1.923147 | 10 |
| Botswana | 0.574664 | 5 | -1.242231 | 2 |
| Mauritius | 0.763132 | 9 | -1.595544 | 7 |
| Namibia | 0.502899 | 3 | -1.800181 | 9 |
| South Africa | 0.101022 | 1 | -0.820281 | 1 |
| Cote D'Ivoire | 0.468785 | 2 | -1.503754 | 6 |
| Ghana | 0.692478 | 7 | -2.245318 | 11 |
| Nigeria | 0.779358 | 10 | -1.739880 | 8 |

In Figure 2, we plot the time-series evolution of the computed values of INTEGRATE (Panel A) and DELAY (Panel B) averaged across all African countries over the sample period 2000-2014. We observe that African market integration with the world stock market is generally unstable over the entire fifteen-year sample period as periods of increasing integration are followed by periods of declining integration, but it has been at a pretty stable level since 2010 (see Panel A of Figure 2). For example, the 2000-2003 periods saw a rising level of market integration in Africa as the curve moved closer to zero. The 2004-2007 periods, however, portrayed a sharp declining trend in integration which subsequently reverted in 2008. The integration of African stock markets with the world can, however, be said to have improved remarkably since 2008 which may be suggesting that the 2007-2008 global financial crisis has brought about greater levels of convergence among financial markets worldwide. In Panel B of Figure 2, the degree of informational efficiency of African stock markets seems to exhibit more erratic behaviour over time compared to market integration in Panel A. A similar pattern to market integration can however be perceived as periods of improved informational efficiency are followed by periods of worsening market informational efficiency.

Thus the informational efficiency of African stock markets appears to follow a trend towards improvement amidst periods of worsening efficiency. It appears that there was sharp improvement in informational efficiency around 2006-2009 period. Even though the informational efficiency seems low in the 2010-2014 period, the overall impression seems to suggest gradual improvement in market informational efficiency over time.

**Figure 2. Time-series variations in market integration and informational efficiency.**


Panel A: Time-series evolution of INTEGRATE (market integration)

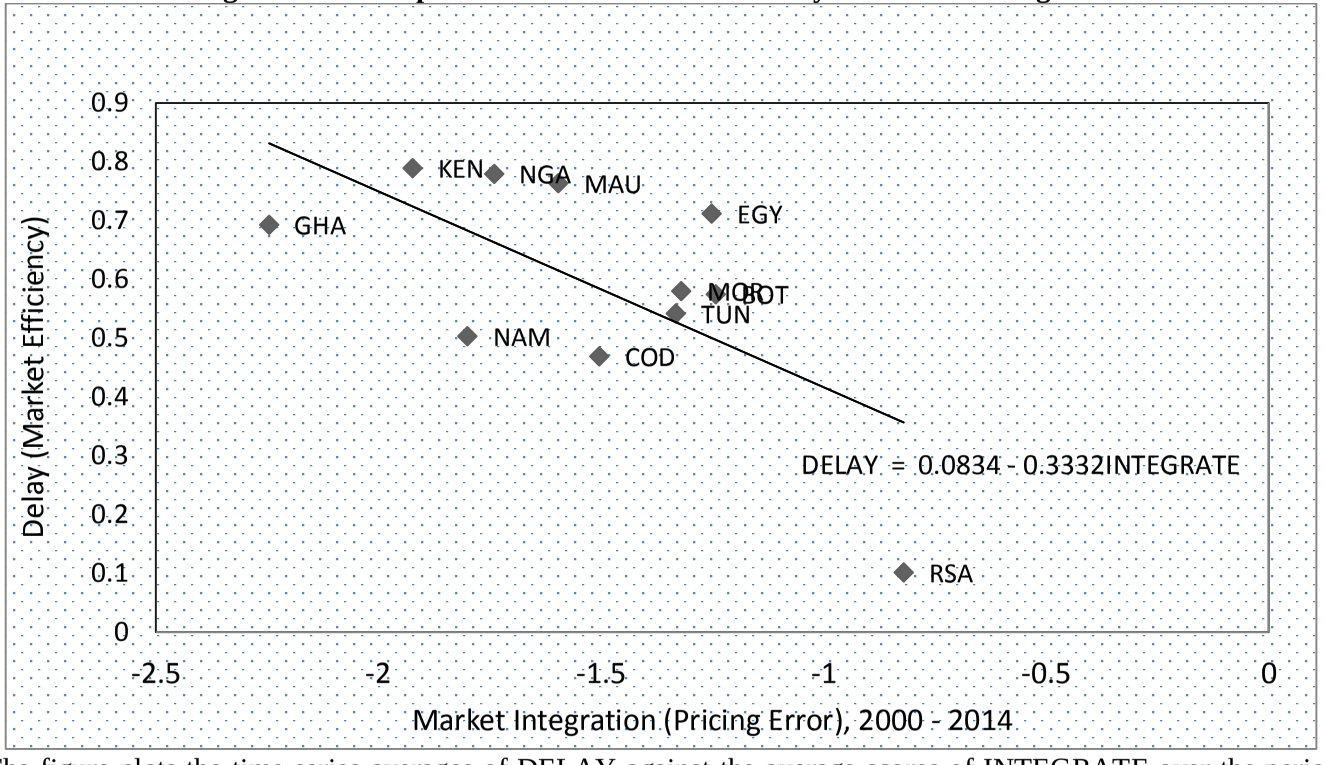



Panel B: Time-series evolution of DELAY (informational efficiency)
Notes: The figure plots the time-series evolution of the computed values of INTEGRATE in Panel A and DELAY in Panel B over the sample period 2000-2014, averaged across all 11 countries in Africa.

Given the presence of some instability and reversals over the period, it is difficult to establish or infer whether or not any long-term trend exists based on these graphical representations. Consequently, we sought a preliminary view

of the relationship between the two key policy variables. In Figure 3, a scatter plot graphs the time-series averages of DELAY against the average values of INTEGRATE for each of the 11 stock markets. The scatter plot clearly shows a moderate negative relationship between stock price delay (the dependent variable) and market integration (the independent variable). Since stock price delay is an inverse measure of informational efficiency, the negative relationship portrayed by the graph clearly implies a positive association between market integration and market informational efficiency. Moreover the slope equation $DELAY = 0.0834 - 0.3332INTEGRATE$ lends further credence to the relationship between the two relevant policy variables. Subsequent formal panel analyses in the ensuing sections provide statistical support to the positive relationship between the variables.

**Figure 3: Scatter plots for informational efficiency and market integration**




The figure plots the time-series averages of DELAY against the average scores of INTEGRATE over the period 2000-2014.

## 4 - Empirical results and discussion

In this section, we evaluate the hypothesis of the positive relationship between market integration and informational efficiency, which implies that stock markets that are more integrated with the world market are also more informationally efficient. This goal is accomplished under three main statistical analyses: first, in the next sub-section we estimated a baseline pooled OLS regression model and reported the results in Table 3; second, alternative estimation methods were applied to evaluate the hypothesis and the results reported in Table 4; and third, sub-sample analysis which seeks to provide robustness verification of the empirical estimates was undertaken and the results reported in Table 5.

### 4.1 Results of panel unit root and stationarity tests

Prior to performing the formal statistical analysis of the positive relationship between market integration and informational efficiency, however, the panel series properties of the two core policy variables and two control variables were verified using various panel unit root tests. The results of these panel unit root tests are reported in Table 3. The results of all the panel unit root tests (Levin-Lin-Chu, Im-Pesaran-Shin, ADF Fisher-Type) indicate that the two key policy variables are stationary at levels. The stationarity of the two control variables is also affirmed by both the LLC and IPS tests.

**Table 3: Results of panel unit root tests**

| Variable | Levin-Lin-Chu (LLC) Test | Im-Pesaran-Shin (IPS) Test | ADF Fisher-Type (ADF-F) Test |
|---|---|---|---|
| DELAY | -8.8820*** | -3.1769*** | 90.7210*** |
| INTEGRATE | -10.1747*** | -3.1517*** | 94.4750*** |
| SIZE | -5.6285*** | -1.7536** | 18.3306 |
| VOLUME | -6.4104** | -2.1777*** | 41.7006*** |

*Notes: *** and ** indicate significance at 1 and 5 percent levels, respectively.*

## 4.2 The standard pooled OLS regression results

Table 4 presents the results of baseline pooled OLS regression analysis reported based on five different scenarios (named as Model 1 through to Model 5). In model 1 we performed a simple univariate pooled regression with the market integration measure (INTEGRATE) as the only explanatory variable. The result shows that INTEGRATE has a negative and statistically significant relationship with DELAY. In fact, the negative coefficient is statistically significant at the 1 percent level of significance. Since stock price delay is an inverse measure of informational efficiency, the negative coefficient indicates that a greater level of market integration is associated with a lower value of stock price delay and a higher degree of market informational efficiency. More specifically, a greater level of market integration leads to a higher degree of market efficiency. In particular, a percentage point change in stock market integration leads to a change in the market's informational efficiency in the reverse direction by 0.0565 percentage points.

Next, we introduced a time trend in the initial model to ascertain whether or not the result in Model 1 may have been influenced by the common trend in the two variables. The results with the time trend are reported as Model 2. The inclusion of the time trend does not weaken the explanatory power of market integration because INTEGRATE still exhibits a statistically significant negative influence (with a coefficient of -0.0515) on stock price delay. Nonetheless, the time trend has a negative and significant coefficient (-0.0020), and its inclusion has contributed some 6.4 percent to the coefficient of determination ($R^2 = 0.136$).

In our subsequent analysis, we then added the control variables one after the other and reported the results in Models 3 and 4. Our variable of interest, INTEGRATE still possesses its negative and statistically significant coefficient, suggesting that stock market informational efficiency is a positive function of stock market integration. The results further indicate that market size and trading volume, respectively, have a negative and statistically significant relationship with stock price delay. The implication is that both the market size and trading volume positively influence market informational efficiency. This relationship is in accordance with economic intuition. Larger markets attract informed traders and sophisticated foreign investors whose superior activities keep the market active and efficient eventually. Larger markets are also more liquid markets where foreign investors with global information facilitate market efficiency (Bae et al., 2012).

**Table 4: Baseline pooled OLS results: DELAY as dependent variable**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Intercept | 0.5052 | 0.6754 | 0.8374 | 0.8269 | 0.8570 |
| | (13.73)*** | (11.11)*** | (7.42)*** | (8.28)*** | (7.48)*** |
| INTEGRATE | -0.0565 | -0.0515 | -0.0457 | -0.0470 | -0.0457 |
| | (-3.57)*** | (-3.35)*** | (-2.91)*** | (-3.04)*** | (-2.91)*** |
| Size | | | -0.0515 | | -0.0226 |
| | | | (-2.36)*** | | (-2.21)** |
| Volume | | | | -0.0546 | 0. 0398 |
| | | | | (-1.90)* | (-1.01) |
| Trend | | -0.0020 | -0.0017 | -0.0022 | -.0020 |
| | | (-3.46)*** | (-3.02)*** | (-3.84)*** | (-3.13)*** |
| Breusch-Pagan | 1.42 | 1.01 | 1.70 | 1.60 | 2.85 |
| [Chi2/Prob > Chi2] | [0.2328] | [0.3145] | [0.4267] | [0.4488] | [0.5835] |
| VIF > 4 / Max VIF | None/1.00 | None/1.01 | None/1.06 | None/1.02 | None/2.11 |
| Observations | 165 | 165 | 165 | 165 | 165 |
| $R^2$ | 0.072 | 0.136 | 0.151 | 0.155 | 0.157 |

** and *** are significance at 5% and 1% levels of significance respective, t-statistics are presented in parentheses, and square brackets contain p-values. The general rule of thumb is that VIFs greater than 4 require further investigation, while VIFs exceeding 10 signal the presence of serious multicollinearity in data necessitating correction.

On the theoretical front, Albuquerque et al. (2009) constructed a model in which global investors possess valuable global private information that enables the simultaneous trading in different markets. Their model assumes that stock returns are influenced by both local and global factors, and that only global investors receive significant signals relating to the global factors. The presence of information asymmetry causes local investors to underreact to global news, leading to a delayed price adjustment to global information in equities that are inaccessible to foreign investors. Empirically, evidence indicates that the removal of capital barriers and pursuance of liberalisation that promotes market integration can help improve the informational efficiency of emerging and frontier stock markets (Bae et al. 2012). Initially, Chordia and Swaminathan (2000) had found trading volume to be a significant determinant of the speed of stock price adjustment to common information.

In the last column in Table 4 (Model 5) we sought to evaluate the explanatory power of market integration (INTEGRATE) in the time-series and cross-sectional variation in informational efficiency (stock price delay) by entering INTEGRATE, the two control variables and the time trend simultaneously in the regression model. The results show conclusively that INTEGRATE has a negative and statistically significant effect on DELAY, suggesting that a greater level of market integration goes hand-in-hand with a higher degree of market informational efficiency. Specifically, a percentage increase in market integration leads to some 0.0457 percentage point increase in informational efficiency. Market size also retains its explanatory power with a negative and statistically significant coefficient, while trading volume loses its explanatory power. The findings in this study wholly corroborate prior evidence of the positive association between market integration and informational efficiency by Hooy and Lim (2013), Bae et al. (2012), Lim and Hooy (2010), and Li et al. (2004). In particular, Hooy and Lim (2013) and Lim and Hooy (2010) concluded that the positive association between the two variables is more associated with developing countries as most of them only started to liberalise their markets during the 1980s and 1990s.

### 4.3 Alternative estimation techniques as robustness check

The standard pooled OLS regression results provide strong evidence in support of our hypothesis of a positive relationship between market integration and market informational efficiency. Next, we determine whether our core findings are robust across different estimation approaches. These alternative

estimation methods are: (1) a two-way fixed effect model which accounts for time-series and cross-sectional dependence; (2) a random effect model which allows for random intercepts and assumes uncorrelated regressors with the country effect and could yield more efficient estimates relative to the fixed effect model; (3) the population-average GLS estimator which corrects for residuals correlation; and (4) the dynamic generalised method of moments, GMM, estimator which allows the dependent variable, stock price delay to follow a dynamic process (with the inclusion of lagged delay as a regressor). The GMM estimation technique also uses the first-differences and the levels equations as instruments. It is expected to provide more robust estimates than the fixed effect and random effect models as it efficiently tackles econometric concerns such as the time-invariant unobserved country-specific, endogeneity and the absence of perfect instrumental variables. The results from these alternative estimators are reported in Table 5. Convincingly, our main findings remain unaffected by these different estimation techniques.

Market integration and informational efficiency of African stock markets are positively related as the INTEGRATE retains its negative and statistically significant coefficient for all the models (i.e. fixed effect, random effect, population average GLS, and dynamic GMM). It is important to note that the Hausman specification test employed revealed that the random effect model is more appropriate than the fixed effect model. Specifically, in terms of the random effect model, the result shows that a percentage increase in market integration in Africa's emerging and frontier markets leads to 0.0438 percentage points increase in stock market informational efficiency. For the population average GLS estimation, stock market efficiency improves up to a 0.0441 percentage point following one percent increase in stock market integration. From the GMM estimation standpoint, a percentage increase in stock market integration is associated with 0.0604 percentage point improvement in the informational efficiency of African stock markets. Importantly, market integration (INTEGRATE) has the greatest influence on informational efficiency than both control variables of market size (SIZE) and trading volume (VOLUME).

It is also important to point out that stock price delay is found to be a dynamic process since the one period lag of DELAY is statistically significant. The positive and significant coefficient for the one period lagged delay suggests that delayed stock price adjustment to common information reinforces itself during the next periods. A stock market that experienced a greater degree of delayed price adjustment to global news previously is likely to suffer an even greater delay in price adjustments during the next period.

**Table 5: Alternative estimation techniques as robustness check**

| | Fixed Effect | Random Effect | Population Average GLS | Dynamic GMM |
|---|---|---|---|---|
| Intercept | 0.5775 | 0.7134 | 0.7219 | 0.6301 |
| | (2.73)*** | (4.50)*** | (4.75)*** | (3.01)*** |
| INTEGRATE | -0.0422 | -0.0438 | -0.0441 | -0.0604 |
| | (-2.88)*** | (-3.01)*** | (-3.05)*** | (-3.08)*** |
| Size | -0.0401 | -0.0721 | -0.0743 | -0.0390 |
| | (-0.61) | (-1.38) | (-1.47) | (-0.62) |
| Volume | 0.0362 | 0.0021 | 0.0204 | -0.0385 |
| | (0.57) | (0.42) | (0.42) | (-0.65) |
| Observations | 165 | 165 | 165 | 154 |
| $R^2$ | 0.089 | 0.114 | | |
| F-Statistic | 3.12(0.028) | n/a | | |
| Wald Statistics | | 12.33(0.006) | 13.03(0.005) | 20.93(0.000) |
| Lagged DELAY | | | | 0.1638(2.33)*** |

Notes: The Hausman specification with $_{H0}$: Random Effect is appropriate and $_{H1:}$ Fixed Effect is appropriate, yields the Hausman Statistics (3.00) and probability (Prob>chi2 = 0.3912) which supports the null hypothesis that the random effect model is appropriate against the alternative that the fixed effect model is appropriate.

Specifically, previous informational inefficiency would cause further informational inefficiency during the next period. The implication is that once a stock market is slow in incorporating global common news into its prices, it would require exogenous interventions to improve its speed of price adjustment.

### 4.4 Sub-sample analysis of market integration-informational efficiency link

Financial crises do have a significant impact on stock market integration. The short-term damages associated with financial crisis include declining asset prices across different markets, the occurrence of speculative runs and capital flight, and general instability in the affected regions (Chiang et al., 2007). A long-term impact is loss of investor confidence and eventual lower economic growth. It is also argued that the detrimental effects of an unanticipated event in one market are easily transmitted to integrated markets (Li and Majerowska, 2008). Neaime (2012) studies how the 2007-2008 global financial crisis affected the global and regional financial linkages been MENA stock markets and the more advanced markets. An important deduction from Neaime (2012) is that the spillover effects of the global financial crisis on countries and their markets vary according to their degree of market integration with the crisis-originating market or the rest of the world. Based on the foregoing assertion, we sought to investigate whether the 2007-2009 sub-prime mortgage credit crunch and subsequent global financial crisis influences the positive association between market integration and market efficiency from Africa's perspective. To achieve this goal, we split the sample into two comprising a crisis period (2007-2009) and a non-crisis period (all other years excluding the crisis periods). The baseline pooled OLS regression method was then used to estimate the results reported in Table 6. The main findings in this study stay unaffected as the results for both crisis and non-crisis periods indicate that market integration and market efficiency are positively related. In particular, a percentage increase in market integration leads to a 0.1488 and a 0.0347 percentage point increase in market efficiency, respectively, for the crisis and non-crisis sub-samples. These coefficients are statistically significant at the 1 percent level.

**Table 6: Sub-sample analysis of market integration-informational efficiency link**

| | Non-Crisis Periods | Crisis Periods | Emerging Markets | Frontier Markets | Africa Excl. SA |
|---|---|---|---|---|---|
| Intercept | 0.8389 | 0.4929 | 1.6248 | 0.2168 | 0.3920 |
| | (6.64)*** | (2.38)** | (6.23)*** | (1.38)*** | (3.04)*** |
| INTEGRATE | -0.0347 | -0.1488 | -0.0387 | -0.0509 | -0.0507 |
| | (-1.99)** | (-3.89)*** | (-1.13) | (-3.12)*** | (-3.29)*** |
| Size | -0.1117 | -0.0581 | -0.3578 | 0.0662 | 0.0194 |
| | (-2.49)** | (-0.84) | (-5.15)*** | (1.39) | (0.45) |
| Volume | 0.0353 | -0.0069 | 0.0961 | 0.0797 | 0.0522 |
| | (0.82) | (-0.11) | (1.19) | (1.72)* | (1.44) |
| Observations | 132 | 33 | 45 | 120 | 150 |
| $R^2$ | 0.099 | 0.367 | 0.474 | 0.1125 | 0.0851 |
| F-Statistic | 4.70 | 5.60 | 12.29 | 4.90 | 4.53 |
| Prob > F | 0.0038*** | 0.0037*** | 0.0000*** | 0.0030*** | 0.0046*** |

** and *** are significance at 5% and 1% levels of significance respective, while t-statistics are presented in parentheses.

Subsequently, the sample is similarly split into three more additional subsamples consisting of emerging markets (South Africa, Egypt and Morocco), frontier markets (the remaining 8 stock markets), and the rest of Africa excluding South Africa, which is the only truly advanced and sophisticated financial market in Africa (see Aawaar and Tewari, 2016:60). The key findings remain largely unchanged, except the emerging market sub-sample which shows the anticipated but statistically insignificant sign of the coefficient. It is important to note that frontier market integration with the world market is positively associated with their degree of informational efficiency. Specifically, the finding shows a percentage change in Africa's frontier market integration with the global stock market leads to 0.0509 percentage points change in the same direction in informational efficiency. This finding is reinforced by the result of the sub-sample relating to the rest of Africa excluding South Africa. The findings thus suggest that as markets become increasingly integrated with the world stock market, the extent of informational efficiency of the markets also increases. Therefore, financial liberalisation policies in emerging and frontier equity markets remain a crucial factor in ensuring both the level of integration and efficient functioning of their stock markets. In Table 6, market size retains its explanatory power only in the non-crisis period and emerging markets sub-samples. Similarly, trading volume lost its explanatory power in all sub-sample analyses except for the frontier markets sub-sample. In brief, the positive association between market integration and informational efficiency remains persistent and robust across different sub-sample periods.

## 5 - Conclusion and policy implications

The link between the market integration and informational efficiency of stock markets remains largely uncharted in the finance literature. In this study, we ventured into this emerging research area by analysing empirically the association between market integration and informational efficiency with particular reference to stock markets in Africa. Our estimation methodology follows the widely recognised International Capital Asset Pricing Model (ICAPM) by Stehle (1977) in the form specified by Hooy and Lim's (2013). The dependent variable, market efficiency or informational efficiency is proxied by the country-level price delay measure which by design captures the relative speed with which the aggregate stock market of a country reacts to global common information. The independent variable, market integration is

proxied by the adjusted pricing error from an equilibrium ICAPM, which by formulation allows for both the direct and indirect forms of investment barriers. The empirical results based on the data from 11 African stock markets (mainly emerging and frontier markets) show compelling evidence of significant and positive relationship between market integration and informational efficiency. In brief, the findings imply that a more integrated stock market is more informationally efficient one, and the findings are robust across different estimation methods.

The positive link between market integration and informational efficiency is closely associated with developing stock markets, suggesting that the liberalisation policies undertaken in these countries led to increased foreign investment accessibility and improved market efficiency. We conclude in this study that market integration and informational efficiency of stock markets in Africa are not independent policy goals because a globally integrated stock market is also a globally informationally efficient market. Its pricing process swiftly responds and incorporates global common information rather than local market-specific common information.

Even though this development has significant implications for international diversification opportunities, the advantages of an integrated market (such as greater capital flows, international risk sharing, efficient prices, technology transfers, and growth) should serve as motivation for pursuing greater market integration in Africa. Emerging and frontier markets need to renew their policy efforts to further integrate their capital markets with the rest of the world's financial system. It is however important to note that policies should not be based just on *de jure* capital market integration, but rather should be implemented alongside the *de facto* lines of market integration. It is important to ensure that the integration-enhancing policies focus on creating an accessible and enabling investing environment in the domestic market for foreign investors. As highlighted by Hooy and Lim (2013), for a developing country to realise the efficiency-enhancing advantages of market integration, the focus of policy efforts should be the removal of both explicit and implicit investment barriers in the domestic financial markets.

## Conflict of interest

No conflict of interest, real or potential, exists.

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