Dynamic relationship between trading volume, returns and returns volatility: an empirical investigation on the main African’s stock markets

Daouda Lawa tan Toe1 · Salifou Ouedraogo1

Revised: 29 May 2022 / Accepted: 10 July 2022 / Published online: 28 July 2022
© The Author(s), under exclusive licence to Springer Nature Limited 2022

Abstract
In this empirical investigation, we examine the relationship between trading volume, return and volatility for eleven African Stock Exchanges. This study covers the period from September 24, 2010 to September 24, 2020, i.e., a total of 3037 daily observations per country. The relationship between trading volume and return is examined using the Granger causality test. For the relationship between trading volume and returns volatility, we use an asymmetric EGARCH (1, 1) model. The results indicate that returns do not cause volume while volume causes return in some countries’ Stock Exchanges. Regarding the volatility of the daily return, the study shows on the one hand that the persistence in the volatility is low and the trading volume increases this persistence on the majority of Stock Exchanges. On the other hand, lag trading volume affects the daily volatility of the markets.

Keywords Trading volume · Volatility · EGARCH model · Granger causality test

JEL Classification G12 · C32

Introduction
Since the development of the Efficient Market Hypothesis (EMH) by Fama (1970), many empirical investigations tested its validity on several financial markets globally. The relationship between trading volume, return and volatility is part of this framework. The nature of the relationship between these three variables in previous studies was very heterogeneous due to the lack of a specific theoretical foundation. However, the growing interest in this relationship led to the development of several explanatory theories. The Sequential Information Arrival Hypothesis (SIAH) developed by Copeland (1976), Jennings et al. (1981), and Smirlock and Starks (1998) argues that the lagged value of volatility is predictive of current trading volume and vice versa. The Mixture of Distribution Hypothesis (MDH) put forward by Clark (1973), Harris and Gurel (1986) and Andersen (1996), supports that the link between volume and volatility is conditioned by the extent of information in the market. The “Visibility Hypothesis” (Miller, 1977; Mayshar, 1983) emphasizes that when the attention of many investors is focused on a stock, trading volume and price increase.

The development of these theories led to a vast empirical investigation of the relationship between market trading volume and the returns for individual stocks and indices. Chui et al. (2000) and Hameed and Kusnadi (2002) examined the relationship between previous weekly trading volume and current weekly returns in the Pacific capital markets. The authors find that over an intermediate time horizon, returns are higher for stocks with higher trading volume in most Pacific Basin capital markets. Using monthly data from the NYSE/AMEX, Statman et al. (2006) provide evidence that trading volume is positively related to lag returns for many months. In their study of the dynamic relationship between stock returns, volatility and trading volume in five emerging stock markets, Pisedtasalasai and Gunasekarage (2007) find that returns

---

1 Department of Economics and Management, University Thomas SANKARA (UTS), 12 BP 417 Ouagadougou 12, Burkina Faso

Daouda Lawa tan Toe
lilekans081088@gmail.com
Salifou Ouedraogo
salifou_ou@yahoo.fr
can predict trading volume and that trading volume has a very limited impact on predicting stock returns. The investigations of Assogbavi et al. (2007) based on a Vector Autoregressive analysis of weekly data for individual stocks show strong evidence of bidirectional causality suggesting that stock price changes adjust to lagged trading volumes over a one-week period and that trading volume adjusts to lagged price changes over the same period.

Examining the lag patterns between trading volume and short-term price in seven Asia-Pacific markets, Wongchoti et al. (2008) suggest that Lee and Swaminathan’s (2000) momentum life cycle better explains the trading volume and price patterns. For Kumar et al. (2009) who focused on the nature of the relationship between trading price and volume in the Indian stock market, there is a weak dynamic relationship between the two variables. Chuang et al. (2009) show via quantiles regressions that the causal effects of volume on return are generally heterogeneous across quantiles and that those of return on volume are more stable.

Pathirawasam (2011) documents that past changes in trading volume are negatively related to stock returns. The author explains this negative relationship by investors’ misspecification of future earnings or illiquidity of low volume stocks. Caginalp and Desantis (2011) emphasize in their investigations that if the stock price increases, but the trading volume decreases, then the growth of the stock price is considered by technical analysts as unstable. In his analysis on the dynamic relationship between returns and trading volume in Indonesia, Malaysia, Singapore, South Korea, Taiwan, and Thailand, Lin (2013) shows that except for the case of Singapore, trading volume contains information to predict returns.

Remorov (2014) focuses on the behavior of stock prices and volume during stock market crashes. For the author, trading volume is inversely proportional to the square of the stock price during large price declines. Tran and Mai (2015) report that dividend announcements have positive effects on stock prices and trading volumes. Israeli (2015) shows that trading volume responses to earnings announcements provide information about future returns that cannot be inferred from price responses or the magnitude of earnings surprises. Using daily data from the Calcutta Stock Exchange in India, Bose and Rahman (2015) find that contemporaneous or lagged trading volume as an indicator of latent information coming into the market does not convey enough information to induce traders to make a view on trading interest.

Christiana et al. (2016) use Markov switching autoregressive model and bivariate VAR model to analyze the empirical relationship between stock return and trading volume based on stock market cycles. They found that there is a positive contemporaneous return–volume relationship in both bull and bear markets, which is only significant in bull markets; no evidence of asymmetry in contemporaneous relationship; and a positive unidirectional causality from stock return to trading volume. Wang et al. (2018) studied the dynamic relation between trading volume and stock returns from the perspective of out-of-sample stock return predictability. Their findings suggest that higher returns do follow more intensive trading, especially in the pre-2000 period.

The research of Lamoureux and Lastrapes (1990) is in line with the work on the relationship between trading volume and stock market volatility. These authors examined this relationship in the US financial market and found that incorporating trading volume into the conditional variance equation leads to the elimination of volatility persistence. Later, Foster and Viswanathan (1995) uses data covering the period 1990–1994 to test the Mixture to Distribution Hypothesis on the crude oil market. He concludes that not only are volume and volatility related, but they are also influenced by the same factors (the arrival of information). Against the findings of Lamoureux and Lastrapes (1990), Gallo and Pacini (2000) suggest that in the U.S. market, trading volume reduces the persistence of volatility. Chen et al. (2001) find that trading volume does not deteriorate the forecasting quality of the parameters in the conditional variance equation. In Sabri’s (2008) examination of the impact of trading volume on stock price volatility in eight Arab stock markets (four Arab oil states and four Arab non-oil states), the findings indicate that volume–volatility is the most predicted variable of the increase in price volatility, and that volume and price are integrated with each other.

Through an alternative approach to traditional linear and nonlinear causality tests, Ong (2015) finds that trading volume plays a dominant role in the dynamic relationship between return and volatility, and between trading volume and volatility for S&P 500 stocks. Based on the GARCH model and data from the 20 largest Fortune 500 stocks, Carroll and Kearney (2012) find that trading volumes and return volatility are positively correlated, thus suggesting the validity of the MDH. Walden (2018) conclude that volatility and trading volume are influenced by the network’s asymmetry and irregularity. Using account level data of all portfolio holdings and trades on the Helsinki Stock Exchange between 1997 and 2003, they support the aggregate predictions, altogether suggesting that the market’s network structure is important for these dynamics.

Although prior studies already documented the relationship between trading volume, return and volatility in many developed countries, the topic has less been focused in less developed countries specifically in the African context. Indeed, many African financial markets are still in their infancy and struggle to mobilize the resources needed for the continent’s development due to their low credibility to investors. The identification of factors that can cause market malfunction or allow investors to define optimal investment
strategies could lead to the revitalization of these markets. Thus, the knowledge of this relationship is of critical interest to African market participants.

Indeed, since trading volume can reflect the level of speculation, this study provides insight into the effect of speculation on market returns and volatility. Moreover, as Cornell (1981) points out, knowledge of the relationship between volume and price variability allows the definition of new contracts. A high volume-price relationship implies that the success of new futures contracts is conditional on the existence of sufficient uncertainty about the prices of the underlying asset. This research has a double objective. On the one hand, it allows to enrich the existing literature on the relationship between volume, return and volatility in the African context and, on the other hand, it allows to define the necessary adjustments to be made by the market authorities in order to give credibility to the different African stock markets and attract the maximum number of investors.

The remainder of this research is organized into three sections. In the first section, we develop the methodology to empirically test the association between volume, return and volatility; the second section is dedicated to the empirical results and discussions. Finally, the last section concludes and provides implications for decision makers.

**Brief overview of African stock markets**

In 2021, there were 29 stock markets in Africa, representing 38 nations’ capital markets. Among these stock markets, two are regional stock exchanges: The Bourse Regionale des Valeurs Mobilières (BRVM) for West African Economic and Monetary Union’s countries (Benin, Burkina Faso, Guinea Bissau, Ivory Coast, Mali, Niger, Senegal and Togo) located in Abidjan; and the Bourse des Valeurs Mobilières de l’Afrique Centrale (BVMAC) for Central African Economic and Monetary community (Central African Republic, Chad, Republic of Congo, Equatorial Guinea and Gabon) located in Libreville, Gabon. Twenty-One of the 29 stock exchanges in Africa are members of the African Securities Exchanges Association (ASEA).

The Egyptian Exchange (EGX), which was founded in 1883, is the oldest stock exchange in Africa. One of the oldest bourses (exchanges) on the continent is the Casablanca Stock Exchange of Morocco, founded in 1929. Today the Casablanca Stock Exchange, in Morocco is the 5th largest exchange in Africa, while Johannesburg Stock Exchange (1st), the Nigerian Stock Exchange, the Namibian Stock Exchange (NSX), Zimbabwe Stock Exchange make up the four biggest ones on the continent.

Overall, African equity capital market (ECM) activity in 2020 was the lowest it has been in the last decade, recording a significant decline in both volume and value (2% and 23% respectively). The drop in equity markets was largely driven by the impact of the repercussions of the COVID-19 pandemic as well as global and economic uncertainty. Domestic deals (Africans participation) accounted for 71% of ECM volume and value recorded in 2020. Over the past decade, domestic activity accounted for 72% and 78% of ECM volume and value, respectively. There was a significant decline in outbound ECM activity between 2019 and 2020.

In terms of Market Capitalization, the Johannesburg Stock Exchange (JSE), founded in 1887 is the biggest stock exchange in Africa ($987 billion). The Namibian Stock Exchange is the second biggest stock exchange in Africa, as it has been making use of the Johannesburg Stock Exchange’s equity trading systems and services to trade, clear and settle its securities. These two markets are followed by Morocco ($48 billion), Egypt ($46 billion) and Nigeria ($44 billion).

The trading volume for some of the most important stock exchange is presented in the chart below. It is noticeable that countries such as Nigeria, Egypt and Kenya record the highest ADV from 2010 to 2020. Some markets record no daily transaction. However, these stocks market are considered in our study since it allows to understand the volume-price relationship. The Average Daily Volume (ADV) for the selected African stock markets is reported in the Fig. 1 below.

**Data and methodology**

**Data**

Our data in the framework of this study include daily market index prices and trading volumes for eleven African Stock Exchanges. The choice of these Stock Exchanges is explained by the fact that they have a high number of listed firms and enough data for our various statistical tests. The study period runs from September 24, 2010 to September 24, 2020, i.e., a total of 10 years of daily observations. Although the South African market is the biggest in the continent, it was excluded from our analysis because based on our database, information about index price and volume were not available on the same duration as other markets. Taking into account the South African market would lead to shortening the observation time period for other stock markets. In addition, because of its size and unique characteristics, taking into account the South African market in the analysis could lead to biased findings. To address the concern related to the differences in the listing days in different countries, we adjusted days to have identical time series for all indices. From days when a country’s index is not listed while most other countries have a listing session, we assume that the index listing price is equal to its previous session closing
price and that the trading volume is zero. Proceeding this way, we end up with a sample of 3037 daily observations per country. The raw data for the different series are collected from the African market database.\footnote{African Markets is a provider of financial market data, news, analysis and research with a focus on Africa. The platform is entirely dedicated to African stock markets with the added functionality of access to historical data that include share price, market performances, trade volume and daily news.}

**Methodology**

To test the trading volume-return relationship for the eleven stock markets in the sample, we followed Chen et al. (2001) by testing the contemporaneous correlation through two alternative forms of price change. These two forms are written as follows:

\[ v_t = a + bR_t + \mu_t \]  
\[ v_t = a + b|R_t| + \mu_t \]  

In the two equations above, \( v_t \) represents the trading volume and the independent variable \( R_t \) is the natural log of the relative price change\footnote{Ratio of the index price one period to the index price of the previous period.} (Eq. 1) and the absolute value of the natural log of this change (Eq. 2). \( \mu_t \) represents the error term. \( a \) and \( b \) are parameters to be estimated.

Next, we test the causal relationship between the two variables using the Granger (1969) causality test. Indeed, if an event \( x \) occurs before an event \( y \), we can deduce that \( x \) causes \( y \). More formally, Granger (1969) argues that if predicting \( y \) using past \( x \) is more accurate than predicting \( y \) without past \( x \) in the sense of mean squared error (\( i.e., if \sigma^2(y_t|I_{t-1}) < \sigma^2(y_t|I_{t-1} - x_t), \) with \( I_t \) the information set), then \( x \) Granger causes \( y \). The bivariate autoregressive to test for causality between the trading volume and returns variables are written as follows:

\[ v_t = \alpha_0 + \sum_{i=1}^{3} \alpha_i v_{t-i} + \sum_{j=1}^{3} \beta_j R_{t-j} \]  
\[ R_t = \gamma_0 + \sum_{i=1}^{3} \gamma_i R_{t-i} + \sum_{j=1}^{3} \delta_j v_{t-j} \]  

where \( v_t \) is the trading volume, \( v_{t-i} \) and \( v_{t-j} \) are the trading volume lagged by \( i \) and \( j \) period, respectively. \( R_t \) is the index return; \( R_{t-i} \) and \( R_{t-j} \) the index return lagged by \( i \) and \( j \) period, respectively. \( \alpha, \beta, \gamma \) and \( \delta \) are parameters to be estimated.

In Eq. 3, if \( \beta_j \) is statistically significant, this implies that past returns and past trading volumes better predict future trading volume. In this case, return Granger causes volume. If the standard Fisher-test fails to reject the null hypothesis that \( \beta_j=0 \) for all \( j \), then returns do not cause volume.

In Eq. 4, if causality runs from volume to return, then, the coefficients \( \delta_j \) will be jointly different from zero. If \( \beta \) referenced in Eq. 3 and \( \delta \) in Eq. 4 are nonzero, there is a bidirectional relationship between return and volume. For the Vector Autoregressive (VAR) estimates, we used a lag of 3 based on the Akaike Information Criteria (AIC).
For the measurement of volatility, the GARCH model is more adequate than standard econometric models. However, the GARCH model presents several problems at the econometric level. Indeed, it is restrictive in the sense that it requires that the estimated coefficients be positive. Moreover, the conditional variance in the GARCH model depends on the magnitude of the error terms but not on the sign. The EGARCH model developed by Pagan and Schwert (1990) and Nelson (1991) alleviates these problems by modeling the standardized Moving Average residuals as independent variables in the variance equation while preserving the estimation of the amplitude effect.

In order to check the explanatory power of the flow of information on the market in the returns volatility, we consider the trading volume as a proxy measuring information. To do so, the daily trading volume is considered and the model to be estimated is written as follows:

\[ R_t = a + bR_{t-1} + \epsilon_t \]
\[ \epsilon | I_{t-1} \sim \mathcal{N}(0, h_t) \]

\[ ln h_t = \bar{\omega} + \alpha \left( \frac{|\epsilon_{t-1}| + \gamma \epsilon_{t-1}}{\sqrt{h_{t-1}}} \right) + \beta ln h_{t-1} + \chi V_{t-1} \]

In the conditional variance equation (Eqs. 5 and 6), \( \bar{\omega} \) is the intercept, \( \alpha \) represents the impact of a magnitude of a shock, \( \beta \) measures the impact of the sign of a shock. \( V_{t-1} \) is the lagged trading volume. \( h_t \) represents the conditional variance.

If \( \chi > 0 \) and the trading volume have a serial correlation, then, \( \alpha \) and \( \beta \) will be small values and statistically insignificant. The persistence of variance that is measured by \( (\alpha + \beta) \) becomes negligible if the uneven flow of information \( (V_t) \) is taken into account.

According to Najand and Yung (1991), one can only make statistical inferences based on Eq. 6 if the trading volume is an exogenous variable. Thus, we used the one-period lagged trading volume variable \( (V_{t-1}) \) in the model specification.

**Main findings and discussion**

Before analyzing the relationship between trading volume, returns and volatility, it is first necessary to examine some descriptive statistics on the units studied. These statistics are reported in the Table 1 as follows:

| Countries     | Market index returns | Skewness | Kurtosis | JBera | Obs. |
|---------------|----------------------|----------|----------|-------|------|
| Botswana      | Mean                 | −1.58E-05| −2.573643| 1268.076| 3037 |
|                 | Median               | 0.000000 | 0.000000 | 0.000000| 3037 |
|                 | Std. Dev.            | 0.000000 | 0.000000 | 0.000000| 3037 |
|                 | Percentiles          | 25        | 75       | 95     | 99   |
|                 |                      | −1.8015   | 1.573643 | 4.2615  | 9.7576 |
|                 |                      | −1.0000   | 0.000000 | 0.000000| 0.0000 |
|                 |                      | 254337.00 | 4.123643 | 1.400000| 9.7500 |
|                 |                      | 70691.00  | 0.000000 | 0.000000| 0.0000 |
|                 |                      | 100000.00 | 3.823643 | 1.230000| 9.7550 |

Table 1: Descriptive statistics on daily returns and trading volume. Source: authors.
The descriptive statistics suggest that, on average, most of the indices studied have a positive return with a low daily volatility reaching a maximum of about 1%. The trading volume is much higher in markets such as Nigeria and Egypt compared to markets such as Zambia and WAEMU. The Market index return skewness coefficients are not far from those of a normal distribution. However, they are predominantly negative, implying that the returns distribution has a thick tail. This means that the probability of obtaining negative returns is higher. As for the kurtosis, coefficients of returns and volume on all stock exchanges considered are well above 3. Therefore, the deviation of the return distribution from normality is mainly due to the leptokurtic character of the daily return distribution. This analysis is confirmed by the Jarque Bera probabilities which are all equal to zero.

**Relationship between trading volume and market index returns**

Table 2 reports the estimated coefficients for the regression of returns on trading volume. The results of the estimations are quite different depending on the stock exchanges.

In panel A, the regression of the relative price variation on the daily trading volume shows that the trading volume is not influenced by the return for most indices. Only the financial markets of Egypt, Kenya, Nigeria and Tunisia show positive and statistically significant coefficients. This positive association between volume and return is in accordance with the results of most of the past studies which find that the price-volume relation is contemporaneous. The increase in trading volume represents the growing demand and interest in the market (from the market participants) which, tends to make the price moves more abruptly. The buying and selling activities made by traders influence the price to move up and down and since more traders are actively buying and selling, the price changes will be more aggressive.

Egypt, Kenya, Nigeria and Tunisia stock markets are among the most developed on the continent and have the highest average daily trading volume and the highest volatility in daily returns suggesting that the existence of a significant relationship between returns and trading volume is a function of the extent of price variation in the market. Similar results emerge from the investigations of Wang et al. (2018) who suggest that periods of high returns are followed by intense trading volume. When considering the absolute value of the return (Panel B), the results indicate that except the BRVM, Uganda, Tanzania, and Zambia indices, there is indeed a contemporaneous relationship between the absolute value of the daily return and the daily trading volume. This is consistent with the findings of Mpofu (2012) on the South African market.

The examination of a causal relationship between the two variables is presented in Tables 3 and 4. This relationship is tested through a bivariate model. In Table 3, we test the null hypothesis that return does not Granger cause volume. The estimates show that except Tunisia, across all other African financial markets, the Fisher-statistics are not significantly different from zero, hence, the null hypothesis cannot be rejected. This suggests that there is no causal relationship between returns and daily trading volume on the majority of African Stock Exchanges. These empirical results are consistent with those of Rostani et al. (2018) in the Tehran market. On the other hand, they contrast with the findings of Mpofu (2012) in the South African context. The author reports evidence supporting that trading volume is influenced by the lagged value of return on the FTSE/JSE index. Similarly, Christiana et al. (2016) documented that on the Jakarta Composite Index, the causal relationship between return and volume is unidirectional and runs from return to volume.

Focusing the analysis on the causality that runs from volume to return (Table 4), it turns out that except for the Egyptian (significant at 5%) and Nigerian (significant at 1%) and Tunisian (significant at 1%) stock exchanges, the null hypothesis of the Granger test cannot be rejected for the other 9 financial markets. This argues that the daily trading volume has no predictive power of future returns on the majority of the African stock exchanges. The results for the Egyptian, Nigerian and indices are in line with some theoretical models suggesting that trading volume contains predictive information for stock prices. Consequently, they highlight the inefficiency of these financial markets in the semi-strong form. Our results also corroborate some empirical findings similar to Jiranyakul's (2016a, b) findings on the Thai market. They are also consistent with Kudryavtsev (2017) who explores the effect of anchoring on stock trading volumes. Based on the hypothesis that if on the days when the market index rises (falls), a given stock’s return is higher (lower) than the market return, potentially perceived as a psychological “anchor”, then investors may treat that as a salient event and subsequently increase their trading activity in the stock. He finds support for this hypothesis. Ultimately, Granger’s causality highlights the absence of a bidirectional effect on all the stock markets in our sample and thus contrast with some empirical investigations. Indeed, Chen et al. (2001) show that return and volume influence each other while underlining a more pronounced causality from return to volume.
Table 2: Contemporaneous relationship between daily trading volume and return

| Countries Index | Botswana | Waemu | Egypt | Kenya | Mauritius | Morocco | Nigeria | Tanzania | Tunisia | Uganda | Zambia |
|-----------------|----------|-------|-------|-------|-----------|---------|---------|----------|---------|--------|--------|
| BSE             | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| BRVM            | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| EGX30           | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| NSE             | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| SEM             | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| MASI            | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| NGSE            | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| DSE             | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| TUNINDEX        | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| USE             | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |
| LUSE            | 1943163  | 172617.3 | 1.36E+08 | 20563345 | 4377411 | 572537.0 | 2.84E+08 | 780787.1 | 557639.2 | 1246801 | 2154115 |

Panel A: regression of daily trading volume on index returns

| Variable | Countries | coefficient | t-stat | p-value |
|----------|------------|-------------|--------|---------|
| a        | Botswana   | 1943163     | 15.54  | ***     |
|          | Waemu      | 172617.3    | 6.81   | ***     |
|          | Egypt      | 1.36E+08    | 55.98  | ***     |
|          | Kenya      | 20563345    | 16.37  | ***     |
|          | Mauritius  | 4377411     | 55.00  | ***     |
|          | Morocco    | 572537.0    | 3.88   | ***     |
|          | Nigeria    | 2.84E+08    | 55.28  | ***     |
|          | Tanzania   | 780787.1    | 7.41   | (5.28)  |
|          | Tunisia    | 1246801     | 5.28   | (5.28)  |
|          | Uganda     | 2154115     | 2.04   | (2.04)  |
|          | Zambia     | 2.04        | 2.04   | (2.04)  |

Panel B: regression of daily trading volume on the absolute value of index returns

| Variable | Countries | coefficient | t-stat | p-value |
|----------|------------|-------------|--------|---------|
| a        | Botswana   | 1904145     | 15.07  | ***     |
|          | Waemu      | 149712.2    | 4.65   | ***     |
|          | Egypt      | 1.09E+08    | 34.43  | ***     |
|          | Kenya      | 17640899    | 13.47  | ***     |
|          | Mauritius  | 4103903     | 17.40  | ***     |
|          | Morocco    | 402755.1    | 35.35  | ***     |
|          | Nigeria    | 2.21E+08    | 2.89   | ***     |
|          | Tanzania   | 659941.1    | 40.08  | ***     |
|          | Tunisia    | 481405.5    | 6.10   | ***     |
|          | Uganda     | 1272806     | 4.40   | ***     |
|          | Zambia     | 1990153     | 4.40   | ***     |

This table provides the estimated coefficients for the regression of index returns on trading volume for the eleven stock exchanges considered. In panel A, the return is measured by the natural log of the relative price change while in panel B, the absolute value of this change is considered. The estimated equations are $v_t = a + bR_t + \mu_t$ and $v_t = a + b|R_t| + \mu_t$ for panel A and panel B respectively. In these equations, $v_t$ represents the daily trading volume and $R_t$ represents the daily return for the indices. $\mu_t$ is a random error term. Values in parentheses represent t statistics. *** and ** denote 1; 5 and 10% significance level, respectively.
In this table, the Granger causality tests are reported. The direction of causality is from return to volume. The parameters are estimated with the Vector Autoregressive (VAR) model. The number of lags based on the Akaike Information Criterion (AIC) is 3. The F-statistics test the null hypothesis that return does not Granger cause trading volume. Values in parentheses are F-statistics. Parameters are estimated based on the following equation:

\[ v_t = \alpha_0 + \sum_{i=1}^{3} \alpha_i v_{t-i} + \sum_{j=1}^{3} \beta_j R_{t-j} \]

\( v_t \) represents the trading volume; \( v_{t-i} \) the trading volume lagged by \( i \) periods, \( R_{t-j} \) the index return lagged by \( j \) periods. \( \alpha_0, \alpha_i \) and \( \beta_j \) are parameters to be estimated. ***, ** and * denote 1; 5 and 10% significance level respectively.

### Table 3: Granger causality test (return to volume causality)

| Countries | Index | Botswana | Waamu | Egypt | Kenya | Mauritius | Morocco | Nigeria | Tanzania | Tunisia | Uganda | Zambia |
|-----------|-------|----------|-------|-------|-------|-----------|---------|---------|----------|---------|--------|--------|
|           | BSE   | BRVM     | EGX30 | NSE   | SEM   | MASI      | NGSE    | DSE     | TUNINDEX | USE     | LUSE   |
| \( \alpha_0 \) |       |          |       |       |       |           |         |         |          |         |        |        |
|           |       |          |       |       |       |           |         |         |          |         |        |        |
|           | 1833378.8*** | 155386.6*** | 46788798*** | 17766567*** | 3220584*** | 3355413*** | 2.24E+08*** | 777194.8*** | 299778.2*** | 753630.9*** | 1948510*** |
|           | (13.27) | (6.014) | (13.559) | (25.328) | (11.072) | (14.425) | (23.473) | (3.8260) | (18.277) | (4.551) | (4.727) |
| \( \alpha_1 \) | 0.062*** | 0.059*** | 0.294*** | 0.118*** | 0.108*** | 0.200*** | 0.125*** | 0.003 (0.208) | 0.229*** | 0.062*** | 0.038** |
|           | (3.457) | (3.258) | (16.321) | (6.514) | (5.985) | (11.153) | (6.899) | (12.683) | (3.486) | (2.100) |        |
| \( \alpha_2 \) | -0.009 | 0.013 (0.765) | 0.215*** | -0.014 | 0.074*** | 0.074*** | 0.046** | 0.001 (0.076) | 0.126*** | 0.142*** | 0.065** |
|           | (0.529) | (11.662) | (4.115) | (4.080) | (2.538) |         |         | (6.789) | (8.059) | (3.635) |        |
| \( \alpha_3 \) | 0.001 (0.108) | 0.025 (1.389) | 0.147*** | 0.032* (1.781) | 0.081*** | 0.137*** | 0.040** | -0.001 | 0.105*** | 0.192*** | -0.005 |
|           | (0.817) |         |         | (8.187) | (7.602) | (2.224) | (5.08) | (10.777) | (1.32) |        |        |
| \( \beta_1 \) | 2750302 | -2124952 | 1.80E+08 | 10000154 | -800319.3 | -104007.4 | 5.10E+08 | 7830967 | 2300341 | 7113277 | -16949261 |
|           | (0.152) | (0.602) | (1.071) | (0.213) | (0.013) | (0.357) | (0.856) | (0.369) | (1.194) | (0.466) | (0.267) |
| \( \beta_2 \) | 956816.7 | -2089581 | 99716221 | -11477362 | 18748549 | 602193.8 | 7.72E+08 | 5063685 | 2181792 | 1613553 | 1201799 |
|           | (0.047) | (0.592) | (0.585) | (0.240) | (0.308) | (0.205) | (1.264) | (0.238) | (1.108) | (0.105) | (0.018) |
| \( \beta_3 \) | -719548.8 | -6100637* | 16594933 | -6102896 | -1491879. | -3988741 | -2.61E+08 | 14266941 | 183761.2 | -23348782 | -62124427 |
|           | (0.039) | (1.730) | (0.098) | (0.130) | (0.024) | (1.370) | (0.440) | (0.672) | (0.095) | (1.531) | (0.981) |
| F-stat    | 0.01463 | 0.29614 | 0.85707 | 0.04349 | 0.07210 | 0.11406 | 1.64820 | 0.04704 | 2.17545* | 0.07110 | 0.03638 |
| Adj. \( R^2 \) | 0.001999 | 0.003823 | 0.279020 | 0.012896 | 0.029413 | 0.085793 | 0.024199 | 0.000199 | 0.119700 | 0.073906 | 0.006345 |
### Table 4: Granger causality test (volume to return causality)

| Countries | Index | Botswana | Waamu | Egypt | Kenya | Mauritius | Morocco | Nigeria | Tanzania | Tunisia | Uganda | Zambia |
|-----------|-------|----------|-------|-------|-------|-----------|---------|---------|----------|---------|--------|--------|
|           |       | BSE      | BRVM  | EGX30 | NSE   | SEM       | MASI     | NGSE    | DSE      | TUNINDEX| USE    | LUSE   |
| $\alpha_0$ |       | -5.63E-05 | -3.09E-05 | -0.0004 | 0.0002 (0.748) | -8.07E-05 | -0.0001 | -0.0006** | 0.0001  | -0.0001 | 5.85E-05 | 8.07E-05 |
|           |       | (0.407) | (0.232) | (1.80) | (0.917) | (0.887) | (2.117) | (1.058) | (1.124) | (0.296) | (0.685) |
| $\gamma_1$ |       | -0.565*** | -0.027 | 0.154*** | 0.214*** | 0.158*** | 0.132*** | 0.239*** | -0.127*** | 0.217*** | 0.038*** | -0.007 |
|           |       | (31.322) | (1.527) | (8.454) | (11.821) | (8.749) | (7.300) | (13.149) | (6.994) | (11.950) | (2.132) | (0.431) |
| $\gamma_2$ |       | -0.290*** | -0.017 | 0.014 (0.783) | 0.017 (0.941) | 0.038*** | 0.006 (0.332) | 0.053*** | -0.137*** | 0.021 (1.168) | 0.056*** | 0.003 (0.021) |
|           |       | (14.459) | (0.984) | (2.113) | (2.871) | (7.590) | (1.215) | (3.125) | (0.003) | (3.125) | (0.003) | (3.125) |
| $\gamma_3$ |       | -0.116*** | 0.048*** | 0.013 (0.729) | 0.006 (0.336) | 0.003 (0.171) | 0.031 (1.707) | -0.020 | -0.007 | 0.029 (1.643) | 0.019 (1.054) | 0.044*** (2.479) |
|           |       | (6.462) | (2.692) | (0.13) | (0.103) | (0.121) | (1.133) | (0.419) | (0.419) | (6.462) | (2.692) |
| $\delta_1$ |       | 6.42E-12 | 1.35E-10 | 2.68E-12 | 5.85E-12 | 2.32E-12 | 1.68E-10 | 1.55E-12*** | -1.38E-11 | 8.38E-11 | -6.73E-12 | -2.49E-12 |
|           |       | (0.352) | (1.444) | (1.368) | (0.828) | (0.424) | (1.491) | (2.777) | (0.885) | (0.489) | (0.316) | (0.477) |
| $\delta_2$ |       | -1.49E-12 | -7.42E-11 | 3.09E-12 | 8.93E-12 | 8.57E-11 | 5.78E-13 | 3.31E-13 | 4.91E-10*** | -1.35E-12 | 7.43E-14 |
|           |       | (0.082) | (0.792) | (1.547) | (0.442) | (1.626) | (0.748) | (1.030) | (0.021) | (2.816) | (0.063) | (0.014) |
| $\delta_3$ |       | 7.01E-12 | -1.63E-10* | -1.82E-12 | -1.47E-11** | -1.40E-13 | 6.78E-11 | 1.65E-13 | 7.22E-12 | -1.80E-10 | 1.51E-11 | -3.44E-13 |
|           |       | (0.385) | (1.749) | (0.931) | (2.073) | (0.602) | (0.295) | (0.463) | (0.451) | (0.709) | (0.065) | (0.065) |
| F-stat.   |       | 0.06188 | 1.32015 | 2.90292** | 0.40253 | 1.52363 | 1.25268 | 4.86390*** | 0.39361 | 4.34725*** | 0.02124 | 0.11790 |
| Adj. $R^2$ |       | 0.245063 | 0.005493 | 0.02876 | 0.05061 | 0.03007 | 0.020134 | 0.071286 | 0.031289 | 0.056145 | 0.005619 | 0.002166 |

In this table, the Granger causality tests are reported. The direction of causality is from volume to return. The parameters are estimated with the Vector Autoregressive (VAR) model. The number of lags based on the Akaike Information Criterion (AIC) is 3. The F-statistics test the null hypothesis that trading volume does not Granger cause returns. Values in parentheses are F-statistics. Parameters are estimated based on the following equation: $R_t = \alpha_0 + \sum_{i=1}^{3} \gamma_i R_{t-i} + \sum_{j=1}^{3} \delta_j V_{t-j}$

$V_t$ represents the trading volume; $V_{t-j}$ the trading volume lagged by j periods, $R_{t-i}$ the index return lagged by i periods. $\alpha_0$, $\gamma_i$ and $\delta_j$ are parameters to be estimated. ***, ** and * denote 1; 5 and 10% significance level respectively.
Table 5 Estimation of the classical EGARCH (1, 1) model for returns volatility

| Countries | Index  | BSE       | BRVM      | EGX30     | NSE       | SEM       | MASI      | NGSE      | DSE       | TUNINDEX   | USE       | LUSE       |
|-----------|--------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|------------|
| Botswana  | a      | −2.57E-10 | −0.0002*  | 0.0004**  | 0.0001    | −0.000207***| −5.81E-05| −0.000154| 0.000133***| 0.0001     | −3.11E-05 | 1.95E-05  |
|           |        | (−1.85E-06)| (−1.690) | (2.340)   | (1.511)   | (−6.163)  | (−0.635) | (−1.1430)| (14.686)  | (1.578)    | (−0.180)  | (0.256)   |
| Gaem       | b      | 0.109***  | −0.023    | 0.164***  | 0.241***  | 0.221***  | 0.123***  | 0.210***  | −0.088*** | 0.205***   | 0.108***  | −0.014     |
|           |        | (7.763)   | (−1.183)  | (7.801)   | (14.839)  | (11.449)  | (6.348)   | (10.925)  | (−7.542)  | (10.818)   | (5.309)   | (−0.834)   |
| Egypt     | α̅     | −5.296*** | −2.783*** | −1.204*** | −0.836*** | −0.777*** | −0.812*** | −0.694*** | −0.202*** | −0.847***  | −1.688*** | −0.340***  |
|           |        | (−9.649)  | (−12.640) | (−15.148) | (−13.556) | (−73.283) | (−11.491)| (−12.759)| (−57.309) | (−33.133)  | (−23.110) | (−26.742)  |
| Kenya     | β      | −0.273*** | 0.227***  | 0.175***  | 0.288***  | 0.228***  | 0.249***  | 0.229***  | 0.143***  | 0.267***   | 0.279***  | 0.149***   |
|           |        | (−30.532) | (17.290)  | (15.211)  | (20.556)  | (54.557)  | (19.039)  | (21.960)  | (99.096)  | (30.468)   | (23.316)  | (48.295)   |
| Mauritius | γ      | −0.407*** | 0.043***  | −0.107*** | 0.056***  | −0.008*   | −0.036*** | 0.018***  | −0.105*** | −0.048***  | −0.036*** | 0.012***   |
|           |        | (−34.052) | (4.581)   | (−13.772) | (7.523)   | (−2.380)  | (−5.126)  | (3.107)   | (−49.832) | (−6.920)   | (−4.180)  | (4.829)    |
| Morocco   | LL     | 11455.99  | 10771.75  | 9077.438  | 10660.48  | 12907.66  | 11589.40  | 10389.58  | 10737.72  | 12334.49   | 9650.647  | 11487.44   |
| Nigeria   | a + β  | −0.68     | 0.27      | 0.068     | 0.344     | 0.22      | 0.213      | 0.247     | 0.038     | 0.219      | 0.243     | 0.161      |
| Tanzania  |        |           |           |           |           |           |           |           |           |            |           |            |
| Tunisia   |        |           |           |           |           |           |           |           |           |            |           |            |
| Uganda    |        |           |           |           |           |           |           |           |           |            |           |            |
| Zambia    |        |           |           |           |           |           |           |           |           |            |           |            |

This table presents the estimates of the EGARCH model. The coefficients $a$ and $b$ correspond to the estimate of the return equation $R_t = a + bR_{t-1} + f_{t-1} - 1 - N(0, h_t)$. The parameters $\omega$, $\alpha$, $\beta$ and $\gamma$ are the estimated coefficients of the classical EGARCH model. $\chi$ corresponds to the coefficient of the daily trading volume in each of the financial markets considered lagged by one period. The quantity $\alpha + \beta$ represents the persistence in the volatility. The conditional variance equation is $\ln h_t = \omega + \alpha \left( \frac{R_{t-1}}{\sqrt{h_{t-1}}} \right) + \beta \ln h_{t-1}$. Values in parenthesis are the z statistics

LL stands for Log likelihood

$h_t$ is the conditional variance, $h_{t-1}$ is the one periods lagged variance, $V_{t-1}$ is the trading volume. ***, **, * represent significance levels at 1, 5, and 10%, respectively.
Relationship between trading volume and return volatility

The estimates of the EGARCH (1, 1) model described in Eq. 5 obtained by maximizing the log likelihood are reported in Table 5. We note that on all the African stock exchanges considered, the value of the log likelihood is very high, which shows that the daily returns are adequate to capture the time dependence of the returns volatility. Moreover, the values of the alphas are all statistically significant at the 1% level. The value of the beta coefficients for all the conditional variance equations and for all the countries is largely lower than the value of the alphas, thus showing a greater revision of the future volatility following an important news on the market. We can also see a negative effect of the leverage effect because the values of the coefficients are all positive. As for the magnitude (alpha + beta) that reflects the persistence in the returns volatility, we note that it is low and very far from unity. This result reflects the low persistence of shocks in the returns volatility. In other words, the effect of a shock does not take long time to die out in the market.

Controlling for the lagged trading volume dimension in the conditional variance equation of the EGARCH model, as shown in Table 6, the value of the alpha coefficients remains significant for all countries. Moreover, apart from Nigeria, the betas are also statistically different from zero. This shows that considering trading volume as an informational element does not deteriorate the quality of alphas and betas in explaining the returns volatility on African Stock Exchanges. This result is consistent with the findings of Chen et al. (2001) and Ahmed et al. (2005). We can thus deduce that compared to the volume of daily transactions, the past volatility explains better the current volatility of the market. However, it is worth emphasizing a very slight drop in the persistence of volatility (Alpha + Beta) induced by the inclusion of volume in the conditional variance equation for Botswana (−0.13), Egypt (−0.001), Tunisia (−0.001) and Uganda (−0.001). In fact, these stocks markets are different from other considered in this study in the sense that they record higher mean trading volume which might imply that the persistence in volatility is conditional to the importance of volume. This phenomenon has been documented in other frontier markets such as India (Naik and Padhi, 2014) and Thailand (Jiranyakul, 2016a, b).

Our results show a significant relationship between trading volume and market volatility for six countries. Indeed, high trading activity reduces volatility in the Botswana and Uganda markets, while in the Egyptian, Kenyan, Mauritian and Nigerian stock markets, volatility increases with higher trading volume. The positive effect of trading on market volatility for some of our indices is explained by the Mixture of Distribution Hypothesis (MDH), which holds that trading volume and returns evolve according to the same latent information. Consequently, the arrival of unexpected information leads to a rise or fall in prices depending on the quality of the information (good or bad). In this sense, a high trading volume reflects a good outlook for the stock and is therefore a good signal for other investors. Our results are in line with the findings of Mahajan and Singh (2000) who showed a positive and significant relationship between volume and volatility in the validation of the “mixture of distribution” and the “sequential arrival hypothesis of information inflow”. Findings are also consistent with Gervais et al., (2001) who showed that trading volume usually large (small) over period of a day or a week, tend to experience large (small) returns over the subsequent month. However, findings contrast with the empirical findings of Miseman (2019) as the authors point out that volume has limited power over the future dynamics of returns.

The negative association between trading activity and volatility in the Botswana and Uganda’s stock indices is a counterintuitive result. It can, however, as Pathirawasam (2011) points out, be explained by investors’ misspecification of future earnings or the illiquidity of stocks with low trading volume.

Conclusion and implications

The motivation for this empirical investigation was to examine the relationship between daily trading volume, returns and volatility on the main African Stock Exchanges. We considered 11 countries stock market data covering a ten-year period. Findings indicate that there is a positive association between trading volume and the relative price changes in the stock markets of Egypt, Kenya, Nigeria and Tunisia (Table 2). Except the WAEMU, Tanzania, Uganda and Zambia’s stock market, this positive relationship also exists between trading volume and the absolute value of daily returns (Table 2, Panel B). This first finding indicates a contemporaneous relation between return and volume implying that high trading volume stocks outperform low trading volume stocks. In fact, given the size of these stock exchanges among African stock markets, they record the most significant price changes which influence investors decision.

Examination of Granger causality relationship indicates the absence of a feedback effect identified in several empirical works. Indeed, return does not cause volume in all the countries sampled, while trading volume is found to be a crucial informational element in predicting return in Egypt and Nigeria (Table 4). Indeed, the Egyptian and Nigerian stock market are among the most active stock markets of the continent in term of daily trading volume. Thus, fluctuation in volume is seen as a signal for investors to whether buy or sell the stock, hence the impact on prices. This might imply that the causality from volume to return is conditional to the market size.
Table 6 Estimation of the EGARCH (1, 1) model for the influence of trading volume on return volatility

| Countries  | Botswana | Waemu | Egypt | Kenya | Mauritius | Morocco | Nigeria | Tanzania | Tunisia | Uganda | Zambia |
|------------|----------|-------|-------|-------|-----------|---------|---------|----------|---------|--------|--------|
| Index      | BSE      | BRVM  | EGX30 | NSE   | SEM       | MASI    | NGSE    | DSE      | TUNINDEX| USE    | LUSE   |
| $a$        | 1.24E-08 | (7.51E-05) | −0.0002* | (−1.921) | −0.0001 | (−6.702) | −0.0001 | (−1.256) | −0.0006*** | (−4.079) | −1.59E-09 | (3.44E-05) | 7.32E-05 | 3.35E-05 | −3.72E-05 |
| $b$        | 0.017**  | (2.137) | 0.025  | (−1.311) | 0.163*** | (14.918) | 0.222*** | (6.273)  | 0.243*** | (12.008) | 0.243*** | (10.605) | 0.204*** | 0.110*** | −0.039 |
| $\bar{\omega}$ | −9.798*** | (−8.997) | −2.802*** | (−12.693) | −7.482*** | (−15.879) | −0.831*** | (−13.557) | −0.792*** | (−73.682) | −0.820*** | (−11.531) | −7.187*** | −1.087*** | −0.843*** | −1.681*** | −3.049*** |
| $\alpha$   | −0.335*** | (−25.721) | 0.230*** | (17.247) | 0.189*** | (11.572) | 0.290*** | (20.987) | 0.232*** | (18.963) | 0.251*** | (17.277) | 0.454*** | 0.460*** | 0.266*** | 0.278*** | 0.360*** |
| $\beta$    | −0.475*** | (−32.204) | 0.044*** | (4.607) | −0.122*** | (−8.773) | 0.058*** | (7.986) | −0.006* | (−1.744) | −0.037*** | (−5.234) | −0.023 | −0.046*** | −0.048*** | −0.046*** | 0.03*** |
| $\gamma$   | 0.048    | (0.462142) | 0.732*** | (33.709) | 0.156*** | (2.905) | 0.934*** | (162.225) | 0.942*** | (148.962) | 0.938*** | (8.517) | 0.282*** | 0.911*** | 0.939*** | 0.835*** | 0.718*** |
| $\chi$     | −4.91E-11*** | (−5.240) | 1.62E-10* | (1.190) | 3.25E-12* | (1.860) | 1.39E-11*** | (2.304) | 6.25E-12** | (2.006) | 1.15E-10 | (1.219) | 2.10E-12*** | 2.16E-13 | 5.17E-11 | −6.88E-12*** | 1.28E-13 | (−0.236) |
| LL         | 11436.22 | 10773.61 | 8945.098 | 10662.95 | 12909.24 | 11590.31 | 10275.13 | 10570.90 | 12334.60 | 9650.718 | 11244.67 |
| $\alpha + \beta$ | −0.81 | 0.274 | 0.067 | 0.348 | 0.226 | 0.214 | 0.431 | 0.414 | 0.218 | 0.242 | 0.391 |

This table presents the estimates of the EGARCH model by incorporating trading volume into the conditional variance equation. Values in parentheses represent test statistics. The coefficients $a$ and $b$ correspond to the estimate of the return equation $R_t = a + bR_{t-1} + \epsilon_t$, where $\epsilon_t \sim N(0, h_t)$. The parameters $\bar{\omega}$, $\alpha$, $\beta$, and $\gamma$ are the estimated coefficients of the classical EGARCH model. $\bar{\omega}$ corresponds to the coefficient of the daily trading volume on each of the financial markets considered lagged by one period. The parameters $\alpha$ and $\beta$ represent the persistence in the volatility. The conditional variance equation is $\ln h_t = \bar{\omega} + \alpha \left( \frac{\epsilon_{t-1}}{V_{t-1}} \right) + \beta \ln h_{t-1} + \chi V_{t-1}$. Values in parenthesis are the z statistics.

LL stands for Log likelihood.

$ht$ is the conditional variance, $ht-1$ is the one period lagged variance, $Vt-1$ is the trading volume. ***, **, * represent significance levels at 1, 5, and 10%, respectively.
Therefore, the visibility hypothesis suggesting that under market constraints, if more traders’ attention is attracted to a stock, its trading volume and price will increase is verified.

The results from the estimation of the EGARCH model indicate that the model is adequate. They show that the persistence in volatility on the different stock exchanges is very low, reflecting the fact that the volatility shocks on these markets do not last over time. Moreover, the trading volume does not alter the explanatory quality of the EGARCH model’s parameters. Indeed, it slightly reduces the persistence in volatility for the indices of Botswana, Egypt, Tunisia and Uganda, while in the other markets, we observe a slight increase in this persistence. This indicates that the current volatility is better explained by past volatilities. Consistent with the Mixture to Distribution Hypothesis, our results (Table 6) provide robust evidence that trading volume contributes to return volatility in 6 stock markets (Botswana, Egypt, Kenya, Mauritius, Nigeria, and Uganda).

This empirical investigation leads to implications for investors and market authorities. The study has shown that in the majority of the main African stock markets, volume has a predictive power of future returns, so investors can incorporate this dimension into their investment strategy. In fact, buying the stock when volume is high and selling low traded volume stocks could be beneficial for these investors, \textit{ceteris paribus}. In addition, as pointed out by Kudryavtsev (2017), investors can compare between stock and market returns which emphasis the role played by stock market indexes. Therefore, intensifying trading activity may affect individual stock prices.

For regulators of the various markets considered, the findings call for vigilance on the one hand to avoid an artificial rise in the securities of some companies that could trade on their own securities in order to increase the volume and mislead investors. On the other hand, there is an effort to be made to guarantee the credibility of these markets because the conclusions of our investigation point to the inefficiency of these markets.

Although our findings corroborate some previous investigations and contrast with some others, future research could focus on specific sectors on the stock market in order to enhance a better understanding of the price-volume relationship.

**Appendix: Information on African’s stock markets**

| Economy  | Exchange                      | Location       | Founded | Listings | Abbreviation |
|----------|-------------------------------|----------------|---------|----------|--------------|
| Algeria  | Algiers Stock Exchange        | Algiers        | 1997    | 5        | SGBV         |
| Botswana | Botswana Stock Exchange       | Gaborone       | 1989    | 44       | BSE          |
| Cameroon | Douala Stock Exchange         | Douala         | 2001    | 2        | DSX          |
| Cape Verde | Bolsa de Valores de Cabo Verde | Praia          | 1998    |          | BVC          |
| Egypt    | Egyptian Exchange             | Cairo, Alexandria | 1883    | 265      | EGX          |
| Gabon    | Bourse des Valeurs Mobilieres de l’Afrique Centrale | Libreville | 2003 | BVMAC |
| Ghana    | Ghana Stock Exchange          | Accra          | 1990    | 37       | GSE          |
| Ivory Coast | Bourse Regionale des Valeurs Mobilieres | Abidjan | 1998 | 39 | BRVM |
| Kenya    | Nairobi Securities Exchange   | Nairobi        | 1954    | 64       | NSE          |
| Lesotho  | Maseru Securities Exchange    | Maseru         | 2016    |          | MSM          |
| Libya    | Libyan Stock Market           | Tripoli        | 2007    | 7        | LSM          |
| Malawi   | Malawi Stock Exchange         | Blantyre       | 1995    | 14       | MSE          |
| Mauritius | Stock Exchange of Mauritius   | Port Louis     | 1988    | 170      | SEM          |
| Morocco  | Casablanca Stock Exchange     | Casablanca     | 1929    | 81       | Casa SE      |
| Mozambique | Bolsa de Valores de Mozambique | Maputo         | 1999    |          | BVM          |
| Namibia  | Namibian Stock Exchange       | Windhoek       | 1992    | 47       | NSX          |
| Economy     | Exchange                        | Location   | Founded | Listings | Abbreviation |
|-------------|---------------------------------|------------|---------|----------|--------------|
| Nigeria     | Abuja Securities and Commodity Exchange | Abuja      | 1998    |          | ASCE         |
|             | Nigerian Stock Exchange          | Lagos      | 1960    | 223      | NSE          |
| Rwanda      | Rwanda Stock Exchange             | Kigali     | 2011    | 10       | RSE          |
|             | East Africa Exchange              | Kigali     |         |          | EAX          |
| Seychelles | Merj Exchange Limited             | Victoria   | 2012    | 48       | MERJ         |
| Somalia     | Somali Stock Exchange             | Mogadishu  | 2015    | 2        | SSE          |
| South Africa| JSE Limited                      | Johannesburg | 1887 | 388     | JSE          |
|             | A2X Markets                       | Johannesburg | 2017 | 40       | A2X          |
|             | ZAR X                             | Johannesburg | 2016 | 7        | ZARX         |
|             | Equity Express Securities Exchange| Johannesburg | 2017 |          | ESEE         |
|             | Cape Town Stock Exchange          | Cape Town  | 2017    | 9        | CTSE         |
| Sudan       | Khartoum Stock Exchange           | Khartoum   | 1994    | 54       | KSE          |
| Eswatini    | Eswatini Stock Exchange           | Mbabane    | 1990    | 10       | ESE          |
| Tanzania    | Dar es Salaam Stock Exchange      | Dar es Salaam | 1998 | 25       | DSE          |
| Tunisia     | Bourse de Tunis                   | Tunis      | 1969    | 56       | BVMT         |
| Uganda      | Uganda Securities Exchange        | Kampala    | 1997    | 17       | USE          |
|             | ALTX East Africa Exchange         | Kampala    | 2013    | 3        | ALTX         |
| Zambia      | Agricultural Commodities Exchange of Zambia | Lusaka  | 2007    |          | ZAMACE       |
|             | Lusaka Stock Exchange             | Lusaka     | 1994    | 24       | LuSE         |
|             | Africa Digital Stock Exchange     | Zambia     | 2018    | 5        | ADSEL        |
| Zimbabwe    | Zimbabwe Stock Exchange           | Victoria Falls | 1948 | 64       | ZSE          |
|             | Victoria Falls Stock Exchange     | Victoria Falls | 2020 | 2        | VFEX         |
|             | Finsec                            | Harare     | 2019    | 1        | FINSEC       |

**Acknowledgements** The authors are grateful to the editor of the *Journal of Asset Management* and the anonymous referees for their extremely useful suggestions to improve the quality of this article.

**Funding** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Data availability** Data available in a reasonable request.

**References**

Ahmed, A., H Taufiq Hassan, and A. Nasir. 2005. The relationship between trading volume, volatility and stock market returns: A test of mixed distribution hypothesis for a pre- and post-crisis on Kuala Lumpur Stock Exchange. *Investment Management and Financial Innovations* 2 (3): 146–158.

Andersen, T.G. 1996. Return volatility and trading volume: An information flow interpretation of stochastic volatility. *Journal of Finance* 51 (1): 169–204.

Assogbavi, T., J. Schell, and S. Fagnissè. 2007. Equity price-volume relationship on the Russian Stock Exchange. *International Business & Economics Research Journal (IBER)*. https://doi.org/10.19030/iber.v6i9.3411.

Bose, S., and H. Rahman. 2015. Examining the relationship between stock return volatility and trading volume: New evidence from an emerging economy. *Applied Economics* 47 (18): 1899–1908. https://doi.org/10.1080/00036846.2014.1002885.
Dynamic relationship between trading volume, returns and returns volatility: an empirical…

Caginalp, G., and M. Desantis. 2011. Stock price dynamics: Nonlinear trend, volume, volatility, resistance and money supply. *Quantitative Finance* 11 (6): 849–861.

Carroll, R., and C. Kearney. 2012. Do trading volumes explain the persistence of GARCH effects?. *Applied Financial Economics* 22 (23): 1993–2008.

Chen, G., M. Firth, and O.M. Rui. 2001. The dynamic relationship between stock returns, trading volume and volatility. *Financial Review* 36 (3): 153–174.

Christiana, A., E. Setiana, and M. Mamduch. 2016. The empirical relationship between stock return and trading volume based on stock market cycles. *Indonesian Capital Market Review* 8: 46–57.

Chuang, C.C., C.M. Kuan, and H.Y. Lin. 2009. Causality in quantiles and dynamic stock return–volume relations. *Journal of Banking & Finance* 33 (7): 1351–1360.

Chui, C.W., Titman, S., Wei, K.C.J. (2000). Momentum, Legal Systems and Ownership Structure: An Analysis of Asian Stock Markets. *Working Paper, Hong Kong Polytechnic University*.

Clark, P.K. 1973. A subordinated stochastic process model with finite variance for speculative prices. *Econometrica: Journal of the Econometric Society* 41 (1): 135–155.

Copeland, T.E. 1976. A model of asset trading under the assumption of sequential information arrival. *Journal of Finance* 31 (4): 1149–1168.

Cornell, B. 1981. The Relationship between volume and price variability in futures market. *The Journal of Futures Market* 1 (3): 303–316.

Fama, E.F. 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance* 25: 383–417.

Foster, D., and S. Viswanathan. 1995. Can speculative trading explain the volume-volatility relation?. *Journal of Business and Economic Statistics* 13: 379–396.

Gallo, G.M., and B. Pacini. 2000. The effects of trading activity on market volatility. *The European Journal of Finance* 6 (2): 163–175.

Gervais, S., R. Kaniel, and D.H. Mingelgrin. 2001. The high-volume return premium. *The Journal of Finance* 51: 877–919.

Granger, C.W.J. 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica* 37 (4): 424–438.

Hameed, A., and Y. Kusnadi. 2002. Momentum strategies: Evidence from pacific basin stock markets. *Journal of Financial Research* 25 (3): 383–397.

Harris, L., and E. Gurel. 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. *Journal of Finance* 41 (4): 815–829.

Isaortz, D. (2015). Trading Volume Reactions to Earnings Announcements and Future Stock Returns. *Working paper, Interdisciplinary Center Herzliya, Herzliya, Israel*.

Jennings, R., L. Starks, and J. Fellingham. 1981. An equilibrium model of asset trading with sequential information arrival. *Journal of Finance* 36 (1): 143–161.

Jiranyakul, K. 2016a. Dynamic relationship between stock return. *Trading Volume, and Volatility in the Stock Exchange of Thailand: Does the US Subprime Crisis Matter?*. https://doi.org/10.2139/ssrn.2809548.

Jiranyakul, K. (2016b). Causal Linkages between Electricity Consumption and GDP in Thailand: Evidence from the Bounds Test (June 13, 2016b). Available at SSRN: https://ssrn.com/abstract=2538082

Kudryavtsev, A. 2017. The effect of stock return sequences on trading volumes. *International Journal of Financial Studies* 5: 20. https://doi.org/10.3390/ijfs5040020.

Kumar, B., Singh, P., & Pandey, A. (2009). The dynamic relationship between price and trading volume: Evidence from Indian stock market. Retrieved from: http://papers.ssrn.com/sol3/papers.cfm?

Lamoureux, C.G., and W.D. Lastrapes. 1990. Heteroskedasticity in stock return data: Volume versus GARCH effects. *Journal of Finance* 45 (1): 221–229.

Lee, C., and B. Swaminathan. 2000. Price momentum and trading volume. *Journal of Finance* 55: 2017–2069.

Lin, H.-Y. 2013. Dynamic stock return-volume relation: Evidence from emerging Asian markets. *Bulletin of Economic Research* 62 (2): 178–193.

Mahajan, S., and B. Singh. 2000. The empirical investigation of relationship between return, volume and volatility dynamics in Indian stock market. *European Journal of Business and Economics* 2 (4): 113–137.

Mayshar, J. 1983. On divergence of opinion and imperfection in capital markets. *American Economic Review* 73: 114–128.

Miller, E. 1977. Risk, uncertainty, and divergence of opinion. *Journal of Finance* 32: 1151–1168.

Miseman, M. 2019. The dynamic relationship between trading volume, stock return, and volatility-domestic and cross-country: South Asian markets. *Finance, Accounting and Business Analysis* 1 (1): 1–21.

Mpfou, R.T. 2012. The relationship between trading volume and stock returns in the JSE securities exchange in South Africa. *Corporate Ownership & Control* 9 (4–2): 199–207. https://doi.org/10.22495/cocv9i4c2art1.

Naik, P.K., and P. Padhi. 2014. Equity trading volume and its relationship with market volatility: Evidence from Indian equity market. *Journal of Asian Business Strategy* 11: 108–124.

Najand, M., and K. Yung. 1991. A GARCH examination of the relationship between volume and price variability in futures markets. *Journal of Futures Markets* 11 (5): 613–621.

Nelson, Daniel B. 1991. Conditional heteroskedasticity in asset returns: A new approach. *Econometrica* 59 (2): 347–370.

Ong, M.A. 2015. An information theoretic analysis of stock returns, volatility and trading volumes. *Applied Economics* 47 (36): 3891–3806.

Pagan, A.R., and G.W. Schwert. 1990. Alternative models for conditional models for conditional stock volatility. *Journal of Econometrics* 45 (1–2): 267–290.

Pathirawasam, C. 2011. The relationship between trading volume and stock returns. *Journal of Competitiveness* 3: 41–49.

Pishehhaslasi, A., and A. Gunasekarage. 2007. Causal and dynamic relationships among stock returns, return volatility and trading volume: Evidence from emerging markets in South-East Asia. *Asia-Pacific Financial Markets* 14 (4): 277–297.

Remorov, R. 2014. Stock price and trading volume during market crashes. *International Journal of Marketing Studies* 6: 21–30.

Rostani, M., P. Alipour, and A. Behzadim. 2018. Analyzing the causal relations between trading volume and stock returns and between trading volume and return volatility in Tehran Stock Exchange. *Iranian Journal of Finance* 2 (4): 27–40.

Sabri, N. 2008. The impact of trading volume on stock price volatility in the Arab Economy. *Journal of Derivatives & Hedge Funds* 14: 285–298.

Smirlock, M., and L. Starks. 1998. An empirical analysis of stock price-volume relationship. *Journal of Banking and Finance* 12: 31–41.

Statman, M., S. Thorley, and K. Vorkink. 2006. Investor overconfidence and trading volume. *Review of Financial Studies* 19 (4): 1531–1565.

Tran, Quoc T., and Y. Dat Mai. 2015. Stock market reaction to dividend announcements from a special institutional environment of Vietnamese Stock Market. *International Journal of Economics and Finance* 7: 50–58.
Walden, J. 2018. Trading, profits, and volatility in a dynamic Information network model. *Review of Economic Studies* 01: 1–36.
Wang, Z., Y. Qian, and S. Wang. 2018. Dynamic trading volume and stock return relation: Does it hold out of sample?. *International Review of Financial Analysis* 58 (C): 195–210.
Wongchoti, U., T.H. Mcinish, and D.K. Ding. 2008. Behavioral explanations of trading volume and short-horizon price patterns: An investigation of seven Asia-Pacific markets. *Pacific-Basin Finance Journal* 16 (3): 183–203.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

---

Daouda Lawa tan Toe graduated in Finance from the graduate Institute of Finance and Banking of National Cheng Kung University (NCKU) in Taiwan in 2017. He has been a lecturer in Finance at the New Dawn University from 2018 to 2020 and the Director of Business School Department of the same University. He has joined the University Thomas SANKARA (UTS) as a Ph.D. candidate in 2019. He is actually a lecturer and researcher at the Unit of Training and Research of the University Thomas SANKARA (UTS). His research activities are focused on the capital market and corporate finance mainly on African markets.

Salifou Ouedraogo graduated in economics from the University of Ouagadougou. He did his postgraduate studies in the Third Cycle Inter University Program (PTCI) at the Unit of Training and Research in Economics and Management, University of Ouagadougou in Burkina Faso where he earned in 2007 the Diploma of Advance Studies in Economics with a specialization in Monetary and Banking Economics. His pursued a Ph.D. studies within the PTCI framework at Cheikh Anta Diop University in Dakar, Senegal and at Yaoundé II/ SOA University in Cameroon and he earned his Ph.D. degree in 2014. He has been a Full Time Lecturer at the University Ouaga II (currently University Thomas SANKARA) in March 2013, then an assistant professor in June 2014 and he is a senior assistant professor since 2017. His research activities are focused on monetary and financial macroeconomics.