 ISSN - 2250-1991 | IF : 5.215 | IC Value : 77.65

Research Paper Commerce

Dynamics of The Relationship Between Trading Volume, Return And Volatility in African Stock Markets

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ABSTRACT

This paper examines the relationship between trading volume, return and volatility in eight African stock markets by using daily data of the trading volume and return of stock indices of these markets during the period from February 2004 to November 2012. The results reveal a positive contemporaneous relationship between trading volume and return for the stock markets of Morocco, Egypt and Kenya; which gives support, for these stock markets, to the mixture of distributions hypothesis (MDH). However, the inclusion of volume in the conditional variance equation does not eliminate the GARCH effect, meaning that volume is not a good proxy for the arrival of information into these markets – thus challenging MDH. Consideration of skewness by estimating the exponential GARCH model (EGARCH) shows that there is presence of leverage effect for the stock markets of Morocco, Egypt and South Africa; by contrast, for the stock markets of Kenya, Mauritius and Botswana, there is no leverage effect. With regard to the stock markets of Nigeria and WAEMU (West African Economic and Monetary Union) the leverage ratio is negative but non-significant. Furthermore, the dynamic analysis revealed a bidirectional causality between return and trading volume in all eight markets with the exception of South Africa which showed a unidirectional causality from returns to trading volumes. These results support the sequential information arrival hypothesis (SIAH) in these markets.

KEYWORDS contemporaneous relationship, volatility clustering, leverage effect.

Introduction

The study of the relationship between trading volume, stock return and volatility has been the focus of much research in the financial literature since the 1950s. Indeed, price being a fundamental determinant of return, it reflects the average change in investors' beliefs depending on the arrival of new information into the market. Return can therefore be interpreted as the assessment of new information by investors. On the other hand, volume highlights investors' feedback following new information flow into the market. It can thus be interpreted as an indicator of investors' reaction on new information. In this respect, trading volume appears to be an important complement to the analysis of the behavior of prices and thus of returns. As for volatility, it is a parameter that helps to quantify the risk level of returns and prices. As such, it serves as investment risk indicator for investors and determines their beliefs as well as their reaction. More information can therefore be obtained on the market through the dynamic analysis of the trading volume, returns and volatility.

In total, the general consensus to date in the trading volume-return- and volatility literature is that there is a strong link, on the one hand, between current trading volume and current return and, on the other hand, between current volume and current return volatility. Since understanding this link could help to distinguish the different assumptions on the structure of the market and possibly lead to a better forecasting of volatility, further exploration of this relationship is worth pursuing, especially when it deals with emerging and less developed African stock markets.

The objective of this paper is to report additional evidence from developing markets, particularly those of Africa, on the relationship between trading volume, return and volatility. Specifically, the research aims to provide evidence of the validity of certain competing theories put forward in the literature to explain the presence of GARCH effects in the return volatility of stock indices. To do this, it would be necessary to: verify the existence of a positive contemporaneous relationship between, on the one hand, volume and return and, on the other hand, between volume and volatility (i), verify if trading volume is a good indicator of information flow into market (ii) ensure that certain features of financial time series do exist, namely persistence, volatility clustering and leverage effect.

The paper is structured around three key points: literature review, methodology and analysis of the main results of the study.

1. Literature Review

The financial literature has documented, in different versions, the relationship between trading volume, return and volatility. Girard and Biswas (2007) discuss two basic approaches to explain the dynamics of this relationship. The first approach suggests that differences in investor viewpoints and expectations are behind changes in trading volume, return and volatility. The second approach suggests that the way in which information arrives at the market determines the relationship between trading volume, return and volatility. This second approach based on the flow of information on the market is the most widespread. According to this approach, the return series is not the result of a unique probability distribution, but rather a mixture of conditional distributions with varying degrees of efficiency in the process of generating the expected returns. Thus, the autoregressive mixing variable, regarded as the rate at which information arrives at the market, explains the presence of GARCH effects in stock price movements. For this purpose, trading volume is considered the standard proxy for this mixing variable. This approach has a number of assumptions, the two most important of which include the Mixture of Distributions Hypothesis (MDH) and the Sequential Information Arrival Hypothesis (SIAH).

MDH was developed by Clark (1973), and was also addressed by other authors, such as Epps and Epps (1976), Tauchen and Pitts (1983), Harris (1986), Lamoureux and Lastrapes (1990) and Andersen (1996). This hypothesis suggests the existence of a positive contemporaneous relationship between trading volume, return and volatility. This means that the advent of information flow into the market causes a simultaneous variation in trading volume, return and volatility. The dissemination of information is therefore simultaneous at the level of investors, so that transition to the market equilibrium is immediate. Under this hypothesis, it should have no information contained in the trading volume that can be used to respectively predict current values of returns and of volatility, and vice versa, as these variables simultaneously change, in response to the arrival of new information (Mahajan and Singh, 2009). Empirical data on this relationship are abundant. Lamoureux and Lastrapes (1990), Anderson (1996), Sharma, Mougoue and Kamath (1996), Gallo and Pacini (2000) argue this relationship in US stock markets. This relationship is also supported in UK stock markets by Omran and McKenzie (2000) and in Spanish stock markets by Zarraga (2003). Regarding the less developed markets, Pyun, Lee and Nam (2000) provide evidence of positive contemporaneous relationship from the Korean stock market, Bohl and Henke (2003) from the Polish stock market, Kamath (2007) from Istanbul stock market, Khan and Ruizwan (2008) from Pakistan stock market, Kamath (2008) from the stock market of Santiago in Chile while Lucey (2005) found mixed evidence on the Irish Stock market as well as Floros and Vougas (2007) on the Greek stock market. In Africa, evidence of the positive contemporaneous relationship between trading volume, return and volatility was provided by El-Ansary and Atuea (2012) from the Egyptian stock market.

Another hypothesis suggested by the information model to explain the relationship between trading volume, return and volatility, is the Sequential Information Hypothesis (SIAH). This model, successively developed by Copeland (1976) and Jennings and al., (1981), states that the dissemination of information is asymmetrical in the market. It suggests a gradual dissemination of information at the level of investors, which implies that a series of intermediate balances take place first before the completion of the final balance. In other words, new information is disseminated sequentially to traders, depending on their level of information. Thus, informed traders take positions and adjust their portfolios accordingly, before uninformed traders, in turn, make necessary adjustments to balance their assets. Once all investors reacted to this new information, a final equilibrium is attained. This successive reaction of traders to new information indicates that lagged values of trading volume can help predict current values of returns and volatility, and vice versa.

For Girard and Biswas (2007), this dissemination of sequential information from trader to trader is correlated with the number of transactions. Therefore, the arrival of new information to the market is attributable not only to price movements but also to a rise in trading volume. This means that an increase of information shocks generates an increase in both trading volume and price movements and volatility. It follows that past trading volume may provide information on volatility and current returns. Similarly, volatility and past returns may also contain information relating to the current volume. In this way, the sequential arrival of information model may reflect a causal relationship between trading volume and return on the one hand, and between trading volume and volatility, on the other hand.

In general, MDH and SIAH support the existence of a positive contemporaneous relationship between trading volume, return and volatility. However, when MDH does not imply that the relationship is a positive contemporaneous one, then SIAH suggests a dynamic relationship where lagged values of returns and volatility may have the ability to predict the ongoing trading volume, and vice versa (Darrat and al., 2003). Unlike contemporaneous relationship, an analysis of the dynamic causal relationship between volume, return and volatility, raises questions concerning the informational efficiency of the market.

Using data from the London Stock Exchange, Ané and Ureche-Rangau (2008) revealed that the inclusion of trading volume as a latent variable in the specification of the conditional variance of equity returns do not capture the GARCH effect, and therefore, it does not explain the behavior of equity returns for the selected large values. Mahajan and Singh (2009), examined the dynamic empirical relationship between return, volume and the volatility of returns on the Indian stock market, using daily data of the SENSEX index. Empirical analysis of these data provides a positive and significant correlation between volume, return and return volatility, which is indicative of both MDH and SIAH. In reviewing the findings of Lamoureux and Lastrapes (1990), the study documents a slight decrease in time in the variance persistence with the inclusion of trading volume as proxy for the arrival of information in the variance equation; this is inconsistent with the findings of Lamoureux and Lastrapes (1990). ARCH and GARCH effects are therefore significant as observed in Daniel and Liam (2005); which highlights the inefficiency of the Bombay stock market. For Mahajan and Singh (2009), such finding leaves the possibility to think that there could be other variables, apart from volume, that would contribute to returns' heteroscedasticity in this market. Thus, this result was attributed to the low depth of the Indian market. Then, in the light of the asymmetry found, the study indicates the presence of leverage effect and the positive impact of volume on volatility. Finally, these authors find a unidirectional causal relationship from the volatility of returns to trading volume; which contradicts MDH and supports SIAH. Darwish (2012) also examined the dynamic relationship between return and trading volume, using weekly data from the Palestinian stock market. His findings reported evidence of the existence of a positive contemporaneous relationship between return and trading volume. He also revealed the existence of a bidirectional causality between return and trading volume.

Finally, El-Ansary and Atuea (2012) examined the relationship between trading volume and return in the Egyptian stock market. The objective of his study is not only to help explain the impact of trading volume on the variation of returns, but also to shed light on the efficiency of the Egyptian stock market. The findings showed that there is a positive contemporaneous relationship between trading volume and return, and a bidirectional causality between the two variables which is more obvious with five-day period late.

2. Data and Research Methodology

2.1 Data from the study and descriptive statistics

Data from the study are related to trading volumes and daily stock indices from eight African stock markets including: South Africa, Egypt, Morocco, Nigeria, Kenya, Botswana, Mauritius and WAEMU. The data used in this study were collected from the Bloomberg database and cover the period from 2 February 2004 to 16 November 2012. Volatility has been determined to be the absolute return, that is to say, the square of stock returns calculated:

Volatility $= (R_t)^2$

Variations in the trading volume V_t were calculated using the following equation:

$$V_t = \ln (V_t / V_{t-1}) \quad (1)$$

Table 1 shows the basic descriptive statistics on the different series of the study. This statistics shows that the sample averages of returns and volatility are all positive; which means that these variables have increased on average during our study period.

Table 1**: Descriptive statistics data**

Variables	Mean	Minimum	Maximum	Std. Dev	variance	Skewness	Kurtosis	Jarque-Bera
Rt Morocco	0.000256	-0.05885	0.050111	0.010308	0.000106	-0.27992	6.71869	1297.85***
Morocco	0.000104	0.00000	0.003266	0.000245	6.e-07	5.716439	49.44512	218776.6
Vt Morocco	0.000383	-8.8688	5.3081	0.920966	0.848178	-0.38881	8.845388	2972.26***
Rt Egypt	0.000425	-0.17992	0.10601	0.018193	0.000331	-0.83573	11.90019	7636.5***
Egypt	0.000334	0.00000	0.027113	0.001030	0.000330	11.38020	22.82850	4902823***

Vt Egypt	0.003862	-2.1375	2.1785	0.307749	0.094709	0.081871	10.97719	5904.24***
Rt S. Africa	0.000504	-0.07580	0.068340	0.013041	0.000170	-0.15037	6.76561	1374.61***
S. Africa	0.000169	0.00000	0.005330	0.000404	1.6e-06	6.419678	59.30945	318967.1***
Vt S. Africa	-0.00131	-1.6010	1.6788	0.290123	0.084171	5.988959	2689239	848.412***
Rt Nigeria	0.00002	-0.09475	0.11758	0.010889	0.000118	0.457825	15.5733	15598***
Nigeria	0.00012	0.00000	0.015569	0.000491	2.4e-06	18.81700	49.96981	2372698***
Vt Nigeria	0.00014	-3.8167	3.2052	0.465219	0.216429	-0.13615	11.33479	6465.64***
Rt Kenya	0.00010	-0.10340	0.12135	0.009913	0.000098	0.14491	29.64603	74106.2***
Kenya	0.00010	0.00000	0.016647	0.000570	3.2e-06	19.3115	46.03199	2014179***
Vt Kenya	0.00078	-2.7214	3.35557	0.562462	0.316363	5.69606	83.19013	862.705***
Rt Botsw	0.000486	-0.07955	0.12980	0.006401	0.000042	5.06545	126.746	1.43e+06***
Botsw	4.16e-05	0.00000	0.019209	0.000495	2.4e-06	30.90453	109.0591	1130000***
Vt Botsw	-0.00822	-5.6904	5.1702	1.048386	1.099114	-0.07286	7.486049	1892.93***
Rt Mauritius	0.000445	-0.20753	0.19684	0.010291	0.000105	-0.51261	147.5815	1.9e+006***
Mauritius	0.000104	0.00000	0.003266	0.000245	7.0e-07	5.71644	49.44512	218776.6***
Vt Mauritius	-0.00211	-6.2370	6.8471	0.771239	0.594809	-0.01089	10.98049	5770.56***
Rt WAEMU	0.000197	-0.11033	0.081387	0.010362	0.000107	-0.54598	17.52234	20515.4***
Vt WAEMU	-0.02981	-10.517	12.265	2.390032	5.712253	-0.06462	4.72112	266.807***
WAEMU	0.000110	0.00000	0.010913	0.000439	1.9e-06	12.15807	22.33451	4699323***

*Rt = return, Vt = trading volume, WAEMU = West African Economic Monetary Union. = volatility, *, **, *** refer to 10, 5, and 1 percent statistical significance levels respectively.*

The observation of Table 1 shows that the asymmetry coefficients of the series of the study are all strictly different from zero; which means that the series are asymmetric. The study also shows that the flattening coefficients or kurtosis are strictly greater than three (3), which means that the distributions of the series of the study are leptokurtic with sharper peaks than those of the normal distribution. Both findings support that the three series are not normally distributed. This is confirmed by the Jarque-Bera test which rejects the null hypothesis of normality at the confidence level of 1%. We can therefore conclude that the series of the study are not normally distributed, they are asymmetric with a leptokurtic distribution and fat tails. This reflects a high probability of extremes.

2.2 Study Methodology

The methodology adopted in this paper is based on the Generalized Autoregressive Conditional Heteroscedasticity model (GARCH) by Bollerslev (1986). Following the work of Sharma et al., (1996), we study the GARCH effects in the observed data and examine the effect of trading volume on returns and volatility using the GARCH (1,1) model. This model is estimated, using the maximum likelihood method, under the Generalized Error Distribution (GED) which is the distribution likely to take into account the asymmetrical and leptokurtic characteristics of financial series (Arago and Nieto, 2005). GARCH model specification allows the current conditional variance to be a function of past conditional variances, leading volatility shocks to persist in time (Huson et al., 2005). To test, in particular, whether the positive contemporaneous relationship between trading volume, returns and volatility exists, the following GARCH (1,1) model is estimated, where volume is included in the mean equation.

$$R_t = \alpha_1 + \beta_1 R_{t-1} + b_1 Vt + \varepsilon_t \qquad (2)$$

$$\varepsilon_t^2 / (\varepsilon_{t-1}^2, \varepsilon_{t-2}^2, \ldots) \approx N(0, h_t)$$

$$h_t = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 h_{t-1} \qquad (3)$$

Where

Where

h_t represents the term for the conditional variance at time t,

ω_1 represents the new information coefficient for ARCH term and, ω_2 represents the volatility persistence coefficient related to GARCH term.

The ω_1 and ω_2 parameters must be greater than 0 and ω_0 should be positive in order to ensure that the conditional variance h_t is not negative. The sum of $(\omega_1 + \omega_2)$ parameters is a measure of the persistence of the conditional variance of returns taking values between 0 and 1. The higher this sum approaches unity, the more persistent is the volatility shock; this phenomenon is known as volatility clustering or hysteresis.

This GARCH model methodology also plays a role in supporting or rejecting the mixture of distributions hypothesis (Mahajan and Singh, 2009). According to this hypothesis, an autocorrelated mixing variable measures the rate at which information arrives at the market; which explains the GARCH effect in the returns. This relationship has been documented in the US stock market by Lamoureux and Lastrapes (1990). In general, most empirical studies found evidence that the inclusion of trading volume in the conditional variance equation leads to a substantial reduction in the estimated persistence or even completely eliminate the volatility persistence. This indicates that volume is a good proxy for information arrival to the market and this, is generally interpreted as empirical evidence in favor of the Mixture of Distributions Hypothesis (Sharma, Mougoue and Kamath (1996) and Brailsford (1996)). Thus, to determine whether trading volume explains the GARCH effects on returns, the GARCH (1,1) model with a volume parameter in the conditional variance equation is estimated and the results are shown in Table 4 .

$$h_t = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 h_{t-1} + \gamma V_t \qquad (4)$$

Overall, GARCH models are based on a symmetric process. Therefore, the positive and negative shocks of the same size are assumed to have the same impact on the conditional variance. But in reality, the asymmetric effect of return shocks on volatility is very common for financial series. Therefore, the results based on the GARCH model may be questionable because they do not take into account the asymmetry and non-linearity of the conditional variance. To overcome these shortcomings, it appears more appropriate to resort to asymmetric GARCH models including the Exponential GARCH (EGARCH) model characterized by an asymmetric specification of disturbances that help to take into account the asymmetric shocks of return volatility. Thus, we estimate the EGARCH (1,1) model or exponential GARCH (1,1), which was proposed by Nelson (1991), according to the following formulation:

$$Ln\sigma^2 = \omega + \beta \ln \sigma_{t-1}^2 + \alpha \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + b_1 V_t \qquad (5)$$

β is the volatility persistence parameter, if it is positive it implies that positive changes in stock indices are associated with other positive changes and vice versa. The β coefficient measures the amplitude of past error term, that is to say, the effect of information on the volatility of the previous period on the current volatility. is the variance of the previous period. Unlike the GARCH model, the EGARCH model takes into account the leverage effect. The β coefficient captures the sign of the error term. Ideally, β should be negative; which means that bad news have a greater impact on volatility than good news of the same order of magnitude. If β is negative, leverage effect holds. In other words, the unexpected decrease in prices (bad news) induces a more than proportionate increase in the expected volatility compared to an unexpected increase in prices (good news) of the same order of magnitude (Black, 1976; Christie, 1982). The b_1 parameter measures the impact of trading volume on volatility. As mentioned before, the (1,1) specifications used in the GARCH/EGARCH processes are motivated by concern for harmonization with literature for a better comparison of the findings of the study with previous work. The results are shown in Tables 4 and 5.

3. Empirical results and analysis

Table 3 presents the results of the correlation between trading volume, return and volatility. It shows that volume and volatility are positively correlated for the emerging markets of Morocco, Egypt, and South Africa. The same holds true for less developed markets like the Botswana stock market. This is the first indication that there may be a causal link between trading volume and volatility, because of a latent exogenous variable which is represented by the rate of information arrival to the market, and which may affect both volume and the return variance of stock indices, resulting in simultaneous movements. Regarding volume and return, Table 3 shows a positive correlation only for the Egyptian stock market for emerging markets and a negative correlation for the WAEMU stock market with respect to less developed markets. For Egypt, it may mean a simultaneous relationship exists between the two variables; on the other hand, for the WAEMU stock market, both variables seem to be moving in reverse. As for the other less developed markets, no correlation seems to exist between return and volume.

Table 3: **Correlation between return-volume and volatility-volume**

Correlation	Morocco	Egypt	South Africa	Nigeria	Kenya	Botswana	Mauritius	WAEMU
R_t - V_t	0.0246 (0.2532)	0.1244*** (0.0000)	-0.0187 (0.3864)	0.0355* (0.0994)	0.0318 (0.1405)	0.0289 (0.1801)	0.0310 (0.1511)	-0.046** (0.0314)
- Vt	0.0626*** (0.0037)	0.0907*** (0.0000)	0.0820*** (0.0001)	-0.0195 (0.3653)	0.0242 (0.2616)	0.0439** (0.0418)	0.0165 (0.4451)	0.0385* (0.0740)

*; **; *** *refer to 10, 5, and 1 percent statistical significance levels respectively.*

To complete our study about the contemporaneous relationship between trading volume, return and volatility, we estimate the GARCH (1,1) model under the Generalized Error Distribution (GED) hypothesis. Part A of Table 4 presents the results of the application of GARCH (1,1) model on the eight African stock markets, when volume is included in the mean equation. Let's note that the GARCH (1,1) model does not converge for the markets of Mauritius and WAEMU because the sum of GARCH parameters for these two markets is not strictly lower than 1. With respect to return, the results suggest that the b_1 volume coefficients are positive and statistically significant at the 5% confidence level only for two stock markets (Morocco and Egypt) out of the three emerging markets. For these two markets, this indicates that there is a positive contemporaneous relationship between trading volume and return. This means that return and volume change simultaneously in response to the arrival of new information to the market. This result is consistent with the recent findings by El-Ansary and Atuea (2012) in the Egyptian stock market; supporting therefore MDH and SIAH in both markets. These results also give support to the idea that bull markets are accompanied by an increase in trading volume while bear markets are accompanied by a decline in trading volume. This is not the case for the emerging market of South Africa. By contrast, for the five other less developed markets i.e. Nigeria, Botswana, Kenya, Mauritius and WAEMU the results suggest that the trading volume parameters are statistically insignificant; meaning that there is no positive contemporaneous relationship between trading volume and return for these markets, and this indicates that the two variables do not vary simultaneously.

Regarding volatility, the GARCH model parameters, ω_1 and ω_2, are all positive and statistically significant at the 1% confidence level for all stock markets; which means that the GARCH model is a good representation of the behavior of daily stock returns for it manages to successfully capture the temporal dependence of the return volatility of stock indices. In addition, the sum of the GARCH parameters ($\omega_1+\omega_2$) for all of these markets is on average equal to 0.90 (with the exception of the Mauritius and WAEMU stock markets); that means there is volatility persistence and clustering, thus indicating support for the inefficiency of these markets.

Table 4: GARCH (1,1) Result, Volume-Return-volatility

Indices	Part A : $R_t = \alpha_1 + \beta_1 R_{t-1} + b_1 Vt + \alpha_t$; $h_t = \omega_0 + \omega_1 + \omega_2 h_{t-1}$					Part B : $h_t = \omega_0 + \omega_1 + \omega_2 h_{t-1} + b_1 Vt$				
	b_1	ω_1	ω_2	$\omega_1 + \omega_2$	$Q^2(12)$	ω_1	ω_2	b_1	$\omega_1+\omega_1$	$Q^2(12)$
Morocco	0.0005*** (0.0001)	0.166*** (0.0000)	0.789*** (0.0000)	0.962 ---	12.075 (0.440)	0.161*** (0.0000)	0.5724*** (0.0000)	6.5e-06*** (0.0000)	0.7342 ---	10.614 (0.319)
Egypt	0.0089*** (0.0000)	0.154*** (0.0000)	0.706*** (0.0000)	0.860 ---	10.177 (0.600)	0.144*** (0.0000)	0.5812*** (0.0000)	6.6e-05*** (0.0000)	0.7261 ---	15.543 (0.213)
South Africa	-4.64e-05 (0.9419)	0.095*** (0.0000)	0.892*** (0.0000)	0.987 ----	15.026 (0.240)	0.087*** (0.0000)	0.8957*** (0.0000)	2.3e-05*** (0.0000)	0.9829 ---	17.557 (0.130)
Nigeria	0.0004* (0.0800)	0.252*** (0.0000)	0.698*** (0.0000)	0.951 ---	6.9601 (0.860)	0.258*** (0.0000)	0.6960*** (0.0000)	-1.9e-06 (0.7149)	0.9544 ---	0.855 (0.
Kenya	0.00017 (0.2848)	0.307*** (0.0000)	0.573*** (0.0000)	0.881 ---	2.8157 (0.997)	0.301*** (0.0000)	0.5775*** (0.0000)	3.3e-06 (0.2183)	0.8785 ---	2.6430 (0.998)
Botswana	-4.95e-07 (0.9831)	0.275*** (0.0000)	0.475*** (0.0000)	0.750 ---	0.1870 (0.999)	0.318*** (0.0000)	0.4523*** (0.0000)	4.0e-07*** (0.0000)	0.7704 ---	0.7277 (0.999)
Mauritius	5.44e-05 (0.4440)	0.375*** (0.0000)	0.635*** (0.0000)	-	Do not converge					
WAEMU	-9.9e-08 (0.9850)	0.316*** (0.0000)	0.720*** (0.0000)	-	Do not converge					
Average				0.90					0.841	

*, **, ***, *refer to 10, 5, and 1 percent statistical significance levels respectively*

Furthermore, to verify the relationship between trading volume and return volatility, the GARCH (1,1) model with a volume parameter in the variance equation is estimated and the results are presented in Part B of Table 4. The study found that the parameters of the GARCH model, ω_1 and ω_2, are all positive and statistically significant. The b_1 volume coefficient is positive and statistically significant for all three emerging markets (South Africa, Morocco and Egypt) and for the Botswana stock market, indicating a positive impact of volume on volatility; which means that there is a positive contemporaneous relationship between volume and volatility in these markets. However, for the markets of Nigeria and Kenya, the volume parameter is not significant. We ignored the markets of WAEMU and Mauritius for failure to comply with the stationarity constraint previously found in these markets.

In addition, the study shows a reduction in the volatility persistence when trading volume is included in the variance equation, since the sum ($\omega_1+\omega_2$) of the GARCH parameters becomes on average 0.84 in Table 4 (Part B) compared to the average value which was 0.90 in the same Table 4 (Part A) when volume was not included in the variance equation. Although these parameters are more or less reduced they are still statistically significant; which implies that the GARCH effect is not eliminated. Taken together, these results indicate that the introduction of volume as an explanatory variable in the conditional variance equation dampens but does not eliminate the GARCH effects. This contradicts the findings of Lamoureux and Lastrapes (1990), who argue that GARCH effects disappear with the inclusion of volume in the conditional variance equation. We can therefore deduct that, for these markets, trading volume is not playing its role of information catalyst by analogy to developed markets. Other factors other than the volume may be the source of the change in returns and their volatility.

To take into account the asymmetrical features previously found in the series of our study and make the results of the study more reliable, we estimated the asymmetrical EGARCH model that makes no restrictions on the model parameters and no positivity constraint on the conditional variance. The results are shown in Table 5. Part A of this table shows the results with volume included in the mean equation. These results suggest that the b_1 volume parameters are positive and significant only for the emerging markets of Morocco and Egypt. Nevertheless, for the other less developed markets, including the emerging market of South Africa, the volume parameters are all non-significant. This means that, for the markets of Morocco and Egypt, there is a positive contemporaneous relationship between trading volume and return; which is not the case for the other markets. These results are consistent with those previously obtained with the GARCH model (1,1), regarding the relationship between volume and return. With respect to volatility, the inclusion of volume in the variance equation (Part B) shows that the volume parameters are all positive and significant, except for the markets of Nigeria and Mauritius. This means that there is a positive contemporaneous relationship between volume and volatility for the three emerging markets as well as for the less developed markets of Kenya, Botswana and WAEMU. Such finding supports both MDH and SIAH. This is not the case for the less developed markets of Nigeria and Mauritius.
Moreover, the study also shows that for the three emerging stock markets of South Africa, Morocco and Egypt, the asymmetry coefficients γ are negative and significant, which means that there is presence of leverage effect and implies that for these markets, each price change responds asymmetrically to positive and negative information. This means bad news (lower returns) have a greater impact on the conditional variance than good news (higher returns) of the same order of magnitude. This result is consistent with those obtained by Markhwiting et al. (2011) for the South African market and, Abdalla and Winker (2012) for the Egyptian market. By contrast, for the less developed markets, the asymmetry coefficients are not significant, with the exception of the Botswana market where a significant negative asymmetry was noted. There is therefore presence of leverage effect for the Botswana market, unlike the other four less developed markets (Nigeria, Kenya, Mauritius and WAEMU).

Table 5**: Summary of the EGARCH model (1,1) on the volume-volatility-return relationship**

Indices	Part A : $Ln\sigma^2 = \omega + \; + \; +$					Partie : $Ln\sigma^2 = \omega + \; + \; + \; + b1V_t$				
	b_1	σ	σ	σ	$Q^2(12)$	σ	γ	σ	b_1	$Q^2(12)$
Morocco	0.0005*** (0.0000)	0.304*** (0.0000)	-0.040*** (0.0472)	0.929*** (0.0000)	11.684 (0.471)	0.23*** (0.0000)	-0.036*** (0.0000)	0.966*** (0.0000)	0.441*** (0.0000)	10.478 (0.574)
Egypt	0.0096*** (0.0000)	0.741** (0.0180)	-0.332*** (0.0000)	0.902** (0.0219)	8.819 (0.718)	0.374*** (0.0049)	-0.172*** (0.0084)	0.946*** (0.0000)	0.936*** (0.0000)	2.5181 (0997)
South Africa	-9.04e-05 (0.8806)	0.125*** (0.0000)	-0.094*** (0.0000)	0.984*** (0.0000)	39.765 (0.306)	0.101*** (0.0000)	-0.080*** (0.0000)	0.987*** (0.0000)	1.040*** (0.0000)	40.812 (0.267)
Nigeria	0.00037* (0.0784)	0.360*** (0.0000)	-0.010 (0.6698)	0.921*** (0.000)	6.1909 (0.906)	0.347*** (0.0000)	-0.0118 (0.6152)	0.919*** (0.0000)	0.0651 (0.5294)	6.126 (0.910)
Kenya	0.00024 (0.1394)	0.436*** (0.0000)	-0.025 (0.3544)	0.851*** (0.0000)	1.6531 (0.999)	0.381*** (0.0000)	-0.0329 (0.1717)	0.877*** (0.0000)	0.221*** (0.0025)	1.5400 (0.999)
Botswana	4.00e-10 (0.9342)	0.472*** (0.0000)	-0.153*** (0.0018)	0.746*** (0.0000)	1.5197 (0.999)	0.426*** (0.0000)	-0.167*** (0.0047)	0.645*** (0.0000)	0.366*** (0.0000)	7.407 (0.830)
Mauritius	6.84e-05 (0.3331)	0.429*** (0.0000)	0.01504 (0.4703)	0.940*** (0.0000)	2.3304 (0.999)	0.428*** (0.0000)	0.015 (0.4515)	0.941*** (0.0000)	0.125* (0.0512)	1.7482 (0.999)
WAEMU	5.02e-09 (0.9099)	0.483*** (0.0000)	-0.0139 (0.7397)	0.862*** (0.0000)	0.8287 (1.000)	0.395*** (0.0000)	-0.0167 (0.5813)	0.842*** (0.0000)	0.104*** (0.0000)	1.8113 (1.000)
Average				0.901				0.890		

*, **, *** *refer to 10, 5, and 1 percent statistical significance levels respectively*; WAEMU: West African Economic Monetary Union

Besides, the study also shows that the coefficients of the β volatility parameter are all positive and significant for all markets; which means that there is volatility persistence and clustering, considering the average value of this parameter (0.90) which tends to 1. This gives support to the argument that these markets are informationally inefficient. The average value of the coefficients of the volatility persistence parameter has remained more or less stable despite the introduction of trading volume in the variance equation. This result does not support MDH but SIAH for the markets of Morocco and Egypt. This result is not also consistent with the findings of Lamoureux and Lastrapes (1990), which would like the GARCH effects to disappear with the introduction of the trading volume in the variance equation, thus confirming that the trading volume is not playing its role of information catalyst by analogy to developed markets.

The results of the diagnostic tests, relating to the autocorrelation of return residuals, are consistent with the null hypothesis that the squared residuals are no longer autocorrelated; which indicates that the normalized residuals are not affected by the ARCH effect. This shows that these models are well suited to estimate the series of our study.

Conclusion
This study examined the empirical relationship between stock returns, trading volume and return volatility in eight emerging and less developed African stock markets using daily data of the trading volumes, returns and volatility (squared returns) of stock indices of these markets.

The results of this study suggest, firstly, for emerging markets (South Africa, Egypt and Morocco) that there is a positive contemporaneous relationship between trading volume and return for the stock markets of Egypt and Morocco. This gives support to MDH and SIAH in both markets; which is not the case for the market of South Africa. Regarding the relationship between volume and volatility, a positive contemporaneous relationship was found for all three emerging markets of South Africa, Egypt and Morocco. Furthermore, for the less developed markets of Nigeria, Kenya, Botswana, Mauritius and WAEMU, no positive contemporaneous relationship was observed between volume and return. On the other hand, regarding the relationship between volume and volatility, a positive contemporaneous relationship was found for the markets of Kenya, Botswana and WAEMU; which is not the case for the markets of Nigeria and Mauritius.

The study also shows that for every eight emerging and less developed markets, the GARCH effect does not disappear when trading volume is included in the conditional variance equation as proxy for the arrival of information flow into the market; contradicting the findings of Lamoureux and Lastrapes (1990) who argue that the GARCH effects disappear when volume is included in the conditional variance equation. This indicates that trading volume does not serve as vehicle of information by analogy to developed markets. Other factors other than volume, could be the source of change in returns and volatility. This brings little support to MDH and SIAH, especially for markets that have demonstrated a positive contemporaneous relationship.

Moreover, taking into account skewness by estimating the EGARCH model shows that there is presence of leverage effect for the three emerging markets of South Africa, Morocco, and Egypt. As a result, bad news have a greater impact on conditional volatility, for these markets, than good news of the same order of magnitude. However, for the less developed markets, only the Botswana market has a negative and significant asymmetry, indicating the presence of leverage effect. For the other markets, the asymmetry parameter is certainly negative but non-significant. So, there is no leverage effect.

Taking the above ideas into consideration, emerging African stock markets (South Africa, Egypt and Morocco) more or less behaved like other emerging and developed markets regarding the relationships existing between volume, return and volatility. Nevertheless, for the other less developed stock markets (Botswana, Mauritius, Nigeria, Kenya and WAEMU), the impact of volume on return and volatility is less noticeable. In that no correlation was found between volume and return. This absence of relationship between trading volume and return on these less developed African stock markets could be attributed to the absence or weakness of speculative transactions. As far as the relationship between volume and volatility is concerned, a positive contemporaneous relationship was found, at least for one market in two. This could be justified by the low trading volume and the low liquidity that characterize these markets. Similarly the leverage effect was systematically found in the three emerging markets, whereas this is not the case in the less developed markets, except for Botswana.

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