DBA AFRICA MANAGEMENT REVIEW

VOLUME 10 NO 4

2020

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A Quarterly publication of the Department of Business Administration,
School of Business,
University of Nairobi

ISSN NO: 2224-2023

http://journals.uonbi.ac.ke/damr
September 2020 Vol 10 No 4 Pgs 1-19

ISSN - 2224-2023

DBA Africa Management Review

Received Date
18/08/2020
Accepted Date
14/09/2020

EFFECT OF VOLATILITY OF THE UNDERLYING SPOT MARKET ON DEPTH OF THE NASCENT KENYAN DERIVATIVES MARKET

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Abstract

Derivatives market in Kenya is at its nascent stage which raises doubt on its depth in both the short term and long term. NSE kicked off futures trading on 4th July 2019 which is characterized by very low volumes, a clear indication of shallow market which is at its nascent stage. The study identified single stock futures and equity index futures as the instruments traded in derivatives market in Kenya. The study explored the effect of volatility of the underlying spot market on the depth of the nascent derivative market in Kenya. The study used Nairobi Security Exchange price list and contracts data ranging from 4th July 2018 to 31st January 2020. The study employed descriptive statistics and inferential statistics namely granger causality tests, Johansen Cointegration and Autoregressive distributed lags using Stata version 16. The results revealed that volatility of the underlying spot market has a negative but statistically insignificant effect on single stock futures market depth. However, volatility of the underlying spot market has a positive but statistically insignificant effect on equity index futures market depth. The study concluded that at nascent stage, volatility does not affect the derivatives market depth. Therefore, Capital Markets Authority and Nairobi Security Exchange should focus on other factors that can accelerate the derivatives market depth such as introduction of new derivatives products.

Keywords: volatility, spot market, derivatives market depth, Kenya

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1.1 Background of the Study

In developed countries benefits of derivatives market have been realized through various innovations and improvements in the industry. According to Adelegan (2019), protection against volatility of capital flows would be the main benefit of derivatives for Sub Saharan Africa countries. For instance, the South African derivatives market has developed exponentially in the recent years hence protecting the market participants against the price volatility by helping them transfer and unbundle risks as facilitating capital inflows in the country (Munda, 2018). At nascent stage, Johannesburg introduced new derivatives products and automated the derivatives market which led to increased market activity and success of derivatives market depth (Rashid, 2010).

Kenya has been putting effort toward establishment of a derivatives market which has not been very successful (Munda, 2018). Gachiri (2011), documents the journey that began in 2011 with a proposal for commodity market. Eight years later, commodities exchange in Kenya has not started broadly due to low volumes and infrastructure development (Kariuki, 2019). Other countries such as Zimbabwe and Zambia failed in establishing a commodity exchange mainly due to lack government support; a factor that Ethiopia leveraged on and succeeded (Mezui et al., 2013). This study was motivated by the fact that Kenya Agricultural and Commodity Exchange (KACE) failed to accelerate from nascent stage which could have been attributed to low price variability or high price variability. This study therefore sought to determine the influence of volatility of the underlying spot market on derivatives market depth in Kenya.

Kenya launched its derivatives market in 4th July 2019. The products traded included equity index futures which underlying spot market consist of the stocks that form NSE 25 index and single stock futures which underlying spot market include the top five stocks in terms of market capitalization namely the Safaricom Plc, KCB Group, Equity Group, East African Brewaries Limited (EABL) and British American Tobacco Kenya (BATK). Single Stock Futures and Equity Index Futures are the only derivatives products traded in Kenya.

As stipulated in the Capital Markets Act and the capital markets derivatives market regulation, 2015 the main reason for establishing derivatives market in Kenya was to manage risk due to uncertainty in the stock and commodity prices, increase the liquidity in the financial markets, and improve the price discovery in Kenya financial markets which will allow individuals with better information and judgment on the market movement to take positions in the market (Maina, 2018).

In derivatives trading, understanding of volatility is important because volatility is a reliable measure of future (Cornell, 1981). Volatility is the measure of the risk or security stability proxied by standard

deviation of a compounded return over time. Investors are often more focused on understanding the volatility of a market to predict its future prices (Kawaller, Koch & Peterson, 2011). One of the key factors also in option pricing is the volatility of the underlying asset (Bakshi, Cao & Chen, 1997).

Black (1986) who used annualized standard deviation of prices noted that the price variability of the underlying cash market is a significant determinant for depth of the derivatives market. The contracts written on volatile cash markets are more likely to accelerate the depth of the derivatives market. Kawaller, Koch and Peterson (2011) also used annualized standard deviation to investigate the causality between the rate of trading and market volatility and found "solid support for the theory that derivatives market depth reflects a reaction to market volatility changes rather than a cause. While Corkish, Holland and Vila (1997) weakly supported that volatile spot market as a necessary condition of acceleration of depth of the derivatives markets, Cornell (1981) established that “new contracts should be written on commodities with sufficient price variability.

The market depth of derivatives shows the number of open interest, which are the number of traded contracts at different prices (Kempf, 2000). The higher the number of contracts purchased and sold at each date, the greater the market depth. Various studies have affirmed that derivative markets with deeper market depth are those that have contracts with high trading volumes while shallow derivative market has a few numbers of contracts which have low trading volumes (Kim & Waweru, 2013). Kim and Waweru (2015) used the trading volume as a measure of derivatives market depth. However, Crotty (2009) employed open interest as a measure of derivatives market depth to investigate the depth of Canada derivatives markets.

This study hypothesized that volatility of spots market of both single stock futures and equity index future markets has a significant effect on the derivatives market depth in both single stock futures and equity index futures. The study used weekly standard deviation as a measure of weekly price variance of the underlying spot market. The study also employed open interest to measure the derivatives market depth that is single stock futures and equity index futures.

1.2 Study Objective

This study sought to determine the effect of the volatility of underlying spot market on the derivatives market depth in Kenya, for which the following objective was formulated:

H_{O1}: Volatility of the underlying spot market has no significant effect on the derivatives market depth in Kenya.

2.1 Volatility Literature

Various authors have examined the influence of volatility on derivatives market depth. Darrat and Rahman's (2015) analyzed the impact of future indices on the Hong Kong sector and argues that the volatility of the HIS index did not have a significant impact on future indices. Darrat and Rahman (2015)

used a probit model to estimate how much volatility of the underlying spot market would affect the futures market. The study concluded that the price variability of the spot market has no significant effect to the success of the futures contracts. However, the study was conducted in Hong Kong hence significant contextual difference to the focus of this study.

In Asia's emerging markets, a report by Kim and Waweru (2015) empirically explored how volatility of the underlying spot market influenced the depth of derivatives products. The study employed panel regression methods to assess the effects of explanatory variable on the explained variables. The study's empirical results revealed that the volume of trading, which was the proxy for depth, was positively correlated with the volatility of the cash market prices. The study found that the larger the volatility of the spot market demand, the greater the chances of the length of the deal. The results support the current study hypothesis that cash market price volatility is positively linked to the derivatives market depth, but since the study was conducted on the Asian derivatives market, the findings may not be relevant in the Kenyan derivative market due which has different economic environment.

Hung, Lin, Huang, and Chou, (2011) conducted a study analysing derivative contract accelerators. The study discussed the key factors deciding whether the futures listed on the exchange can prosper or fail. The study used GARCH and ARCH time series methods to analyze various futures in Asian economies. The study showed that one of the key determinants was the price variability of the underlying cash market which attracted hedgers, arbitragers and speculators to act as catalyst for futures depth. The study was conducted in developed financial markets while the current study sought to examine a developing financial market.

Tokat and Tokat (2010) study studied the transmission of shock and volatility from Turkish Markets in future and spot markets. The research was motivated by one of the main financial-market issues as to how the implementation of financial derivatives would stable or destabilize the underlying asset markets. The study focused on determining to what extent there is interrelationship between the two markets.

The empirical results of the study by Tokat and Tokat (2010) market showed that reports and surprises from both futures and spot markets directly affect the futures market. Additionally, the analysis calculated cross-error coefficient is also important for both economies, indicating an indirect impact of fluctuations on one market on the other. The results show that its future price volatility directly affects the volatility of the USD/TRY futures market. However, the findings of Tokat and Tokat (2010) did not link the underlying volatility in the cash market to the deepness of the derivatives products.

Additionally, Pericli and Koutmos (2005) analyzed the conditional price variance following the launch of futures and options for the New York Stock Exchange index. To

explicitly account for stock return volatility asymmetry, the study used a non-linear GARCH regression model. The findings reported a drop in the S&P 500 index volatility after it introduced futures contracts. The study was able to show the influence of introduction of futures market on the volatility of the underlying spot market but it was not to show whether the underlying spot market volatility has any significant influence on the derivatives market depth.

3.1 Research Methodology

3.1.1 Research Philosophy and Design

The study used both qualitative and quantitative data in a single study with a principle that utilization of both quantitative and qualitative approaches provides better understanding of study problems (Curtis, 2011). The quantitative data was a time series covering the entire period of study between July 4th 2019 and 31st January 2020. The qualitative data collected from derivatives experts to validate the quantitative results.

3.1.2 Accessible Population

The study obtained data from both secondary and primary sources. The secondary data relate to transactions on derivatives contracts in single1stock1futures and equity1index1futures. The secondary data was obtained from derivatives and equity price lists starting 4th July 2019 to 31st January 2020. The target population that provided primary data is shown in Table 1.

Table 1: Target Population Distribution Table

Category	Population
Staff working at the CMA dealing with derivatives	7
Staff working at the NSE dealing with derivatives	6
Experts of the 2 clearing members (Co-operative and Stanbic Bank)	5
Experts of the 7 trading members	14
Total	**32**

Source: CMA (2020)

As shown in Table 1, the primary data target population included key informants from derivatives market at the NSE, staff working with derivatives at CMA, clearing members and trading members. These individuals possess specific knowledge relating to derivatives trading globally, in the region and in Kenya. Kothari (2014) explains that if target population is small, census survey is the most appropriate. The study chose census technique over various sampling techniques since the population of this study was small. The sample size for the collection of secondary data was 30 trading weeks derived from traded days starting from 4th July 2019 to 31st January 2020. The study obtained the transactions done during the study period from 4th July 2019 to 31st January 2020.

3.1.3 Data Collection Methods

Secondary data was collected for the two variables volatility of the underlying spot market and the derivatives market depth. This data was collected from the NSE Derivatives and Equity daily price list since the commencement of trading on 4th July 2019 to 31st January 2020. The total observations was 30 weeks. Data was collected for both single stock futures and equity index futures.

Weekly standard deviation of returns in spot market was used as a proxy measure volatility of the underlying spot market. For the dependent variable, the study employed open interests as the proxy measure of the market depth.

The study collected primary data from the 32 derivatives experts who dealt directly with derivatives market identified from sample frame to validate the findings of the secondary data in this study. The use of interview to collect data from the derivatives experts who interact directly with the derivatives market was appropriate since they are aware of the specific information about the functioning of the derivatives market in Kenya.

3.1.4 Statistical Techniques

The study employed both descriptive and inferential statistics. Under descriptive the study reported the mean, minimum, maximum, mode, median and the standard deviation of the data set. Under inferential statistics the study tested for stationarity of the data series using Augmented Dickey Fuller (ADF) test. It then employed Granger Causality test to establish whether volatility of the underlying spot market is useful causation of derivatives market depth. The following equations guided the granger causality test between independent variables and the derivatives market depth.

$$X1_t = \beta_1 X1_{t-i} + \beta Y_{t-j} + \varepsilon 1_t \quad (1)$$

$$Y_t = \beta_1 Y_{t-j} + \beta_1 X1_{t-i} + \varepsilon 2_t \quad (2)$$

$$Y2_t = \beta_2 Y_{t-j} + \beta_2 X2_{t-i} + \varepsilon 3_t \quad (3)$$

$$X2_t = \beta_2 X2_{t-i} + \beta_2 Y2_{t-j} + \varepsilon 4_t \quad (4)$$

Where X is the volatility of the underlying cash market of single stock futures, X2 is the size of the underlying cash market of equity index futures, Y is the open interest of single stock futures Y2 is the open interest of equity index futures, $\varepsilon 1_t, \varepsilon 2_t, \varepsilon 3_t \; and \; \varepsilon 3_t$ are the error terms and $\beta_1 \; and \; \beta_2$ is the beta coefficient. The study also utilized the Johansen test of cointegration to establish whether there exist long run linear relationship between volatility of the underlying spot market and the market depth of both single stock futures and equity index futures. To this end, the study used trace statistics to establish whether there are cointegrating equations. To test the study hypothesis, The study employed autoregressive distributed lags (ARDL). Unlike other methods, ARDL's cointegration technique requires no pre-testing of unit roots. Thus, when dealing with variables of different order I(0) or I(1) or combination, the ARDL model is advantageous and reliable when the underlying variables are related in long term and have limited sample size (Gujarati, 2009). The equations below guided the ARDL analysis.

$$Y_t = \alpha Y_{t-i} + \beta_i X1_t + \varepsilon \quad (5a)$$

$$Y2_t = \alpha Y_{t-i} + \beta_i X2_t + \varepsilon \quad (6a)$$

Where Y_t and $Y2_t$ are open interests of single stock futures and equity index futures respectively.
Y_{t-i} is the first lag of open interest, $X1_t$ and $X2_t$ represent the volatility of the underlying spots market in single stock futures and equity index futures respectively α and β_i are coefficients of determination.

Primary data from interview sessions was analysed thematically. We transcribed the recorded audios and listen for the reccurring themes and presented the information in narratives. This information was used to validate the findings from secondary data analysis in the discussion section.

4.1 Research Findings

4.1.1 Descriptive Results

Volatility of the underlying spot market was measured using weekly standard deviation. The total number of observations was 30 weeks over the study period and the summary of data series is as shown in Table 1.

Table 1. Volatility of the underlying Spot Market Stocks of Single Stock Futures

Stock	Number of weeks	Average
SCOM	30	2.63%
EQTY	30	3.88%
KCBG	30	3.88%
EABL	30	3.76%
BATK	30	2.30%

Source: Data processed

As shown in Table 1 the average volatility of the underlying stock in single stock futures was 2.63%, 3.88%, 3.88, 3.76% and 2.3% for Safaricom (SCOM), Equity Group (EQTY), Kenya Commercial Bank Group, East African Breweries Limited (EABL) and British African Tobacco Kenya (BATK) respectively. The banking sector stocks (EQTY and KCBG) were most volatile during the period of study which could be attributed to the scrapping of interest rate capping hence improving financial transaction which translates to more activity in spot market.

The study used weighted averages to obtain a volatility index for the five stock. The summary statistics for the volatility of underlying spot market of single stock futures is as shown in Table 2.

Table 2.Summary Statistics of the Volatility of the Underlying Spot Market of Single Stock Futures

Variable	Volatility
Number 2of 2weeks	30
Mean	4.46%
Std. 2Dev.	4.78
Min	0.92%
Max	24.44%
Mode	No 2Mode
Median	2.92%

Source: Data processed

As shown in Table 2, on average underlying spot market is 4.46% volatile on weekly basis. This weekly data deviated from the mean by a standard deviation of 4.78. The minimum volatility of the underlying spot market was 0.92%. The maximum volatility of the underlying spot market was 4.44% which was in week 14 (7th October to 11th October 019). The series had no mode but the median was 2.92. Table 3 shows the volatility of the underlying spot market of Equity Index Futures.

Table 3. Volatility of the Underlying Spot Market of Equity Index Futures

Variable	Volatility
Number 2of 2weeks	30
Mean	1.67%
Std. 2Dev.	1.65
Min	0.44%
Max	8.13%
Mode	1.02%
Median	1.11%

Source: Data processed

As shown in Table 3, on average the NSE 25 share index is 1.67% volatile on weekly basis with a standard deviation of 1.65. The minimum volatility of the NSE 25 share index was 0.44% which was in week 0 (18^{th} November to 2^{nd} November 2019).

The maximum volatility of NSE 25 share index was 8.13%. The series had a mode

of 1.0 % and the median of the study was 1.11%. Open interest was used as a proxy measure for derivatives market depth. Table 4 shows the summary statistics for single stock futures open interest.

Table 4. Single Stock Futures Open Interest

Variable	Y1
Number 2of 2weeks	30
Mean	206
Std. 2Dev.	1.28
Min	9
Max	451
Mode	131, 2239
Median 2	210

Source: Data Processed

As shown in Table 4, on average 206 contracts are traded weekly in single stock futures derivatives market with a standard deviation of 1.28. The minimum number of contracts traded in a week was 9 while the maximum number of contracts traded was 451 traded. The series was bi-modal with two modes of 131 and 39. Table 5 shows the summary statistics for equity index futures open interest.

Table 5. Summary Statistics for Equity Index Futures Open Interests

Variable	Y2
Number 2of 2weeks	30
Total	58
Mean	2
Std. 2Dev.	2.26
Min	0
Max	5
Mode	0
Median 2	3
Weeks 2with 2no 2activity	15
Percentage 2of 2weeks 2of 2no 2activity	50%

Source: Data Processed

As shown in Table 5, on average equity index future 2 contracts were traded weekly with a standard deviation of 2.26. The minimum number of contracts traded

weekly was 0 and the maximum number of contracts traded was 5. The mode of the 30-week series was 0 and the median was 3. There were 15 weeks (50% of the trading days) when there was no activity in equity index futures.

4.1.2 Granger Causality Test between Volatility of the Underlying Spot Market and Single Stock Futures Market Depth.

Prior to granger causality tests the study conducted stationarity test and established that the variables were not stationary at level. The data was made stationary, by first differencing and established that the first difference of the two set of time series was stationary. The action of differencing reduced the number of observations from 30 to 29 in the in the subsequent granger causality test. Table 6 shows the test statistics of differenced variables is greater than that of 5% critical value. Additionally, the p.value of the two variables is less than 0.05 which implies that the volatility and the first difference of open interest is stationary. In this case, D.Y is the first difference of single stock futures open interest series which was the proxy measure of market depth and D.X1 is the first difference of weekly standard deviation which was the proxy measure of the volatility of the underlying spot market in single stock futures.

Table 6. Unit Root Test

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	Z(t) P.value
D.Y	-2.202	-2.518	-1.721	-1.323	0.0195
D.X1	-4.106	-2.518	-1.721	-1.321	0.0003

Source: Data Processed

The study conducted granger causality test between volatility of the underlying spot market measured by weekly standard deviation of returns and open interest which was used as a proxy measure for market depth. Table 7 shows the granger causality results in single stock futures.

Table 7. Granger Causality Test between Volatility of the Underlying Spot Market and Derivatives Market Depth (Single Stock Futures)

Equation	Excluded	F	df	Prob>F
D.Y	X2	0.6756	2	0.7089
D.Y	ALL	0.6756	2	0.7089
D.X1	Y	1.5011	2	0.4566
D.X1	ALL	1.5011	2	0.4566

Source: Data Processed

Table 7 revealed that no variable granger causes each other. According to the test results, the probability of the F statistics was (p= 0.7089) when testing whether single stock futures market depth granger causes volatility of the underlying spot, which is greater than 0.05. This implies that single stock futures market depth does not granger cause volatility in its underlying spot market. Additionally, volatility of the underlying spot market does not granger cause open interest as revealed by prob > F (p=0.457). The results imply that fluctuations of prices in the underlying spot market do not necessary lead to change in single stock futures market depth.

According to the derivatives market experts interviewed, spot market and derivatives market (single stock futures) are two independent markets hence they do not necessary influence each other. As such, high price variability may not lead to changes in number of contracts (open interest) traded in single stock futures.

4.1.3 Granger Causality test between Volatility of the NSE 25-Share Index and Equity Index Futures Market Depth

Prior to granger causality test between the volatility of the underlying spot market (NSE 25 share index) and equity index futures market depth, the study conducted stationarity test and established that the variables were not stationary at level.

The study made data stationary, by first differencing. Stationarity test on first difference established that the data was stationary. This therefore implied that the number of observations reduced from 30 to 29 in the subsequent granger causality test. Table 8 shows the stationarity test results after first differencing.

Table 8. Stationarity Test

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	Z(t) P.value
D.Y2	-1.880	-2.479	-1.706	-1.315	0.0357
D.X2	-4.748	-2.473	-1.703	-1.314	0.000

Source: Data Processed

Where D.Y2 is the first difference of equity index futures open interest which is a measure of equity index futures market depth and D.X2 is the first difference of weekly standard deviation of returns which is the measure of volatility of the underlying spot market of equity index futures. In this case, the underlying spot market of equity index futures is the NSE 25 share index. As shown in Table 8, the variables are stationary (D.Y2 and D.X2 have a p-value of 0.00357 and 0.000 respectively). The P-value is less than 0.005 hence the variables are stationary. Table 9 shows the granger causality test between volatility of the NSE 25 share index and Equity Index Futures Depth.

Table 9. Granger Causality between Volatility of the NSE 25-share index and Equity Index Futures Depth

Equation	Excluded	F	df	Prob>F
D.Y2	D.X2	5.3687	2	0.373
D.Y2	ALL	5.3687	2	0.373
D.X2	DY2	10.692	2	0.058
D.X2	ALL	10.692	2	0.058

Source: Data Processed

As shown in Table 9, the probability of the F statistics was (p= 0.373) when testing whether the open interest granger causes volatility of the NSE 25-share index (volatility of the underlying spot market) is greater than 0.05. This implies that the equity index futures market depth does not granger cause any changes in volatility of the NSE 25-share index. Additionally, the test reveals that prob > F (p=0.058) is greater than 0.05 hence volatility of NSE 25-share index does not granger cause any change in equity index futures market depth.

According to the derivatives market experts, the equity index futures have not garnered attention from the traders due to unfamiliarity. This is also supported by the summary statistics which revealed that on average, there are two open interests in equity index futures weekly is a proof poor market knowledge or familiarity. The equity index futures unfamiliarity could be the reason that the two variables (volatility of the NSE 25 share index and equity index futures market depth) do not granger cause each other.

4.1.4 Cointegration Test between Volatility of the Underlying Spot Market and Single Stock Futures Market Depth

The study conducted Johansen cointegration test to investigate whether volatility of the underlying spot market has a long run linear relationship with single stock futures market depth.

Table 6*:* Johansen Cointegration Results on Volatility of the Underlying Spot Market and Single Stock Futures Market Depth

Maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	6	-35.332882	0	14.7342	14.07
1	9	-29.965805	0.31843	2.0283	3.76
2	10	-28.951658	0.06988		

Source: Data Processed

Table 9 shows that there is one cointegrating equation. The max statistics at rank 0 is greater than the 5% critical value (14.7342 > 14.07) therefore, the null hypothesis that there exist no cointegration is rejected. Additionally, the max statistic at rank 1 is less than 5% critical value (2.0283 > 3.76) hence the study fails to reject the null hypothesis that there exists no cointegration. This implies that there is long-run linear relationship between volatility of the underlying spot market and single stock futures market depth.

4.1.5 Cointegration Test between Volatility of NSE 25 share index and Equity Index Futures Market Depth

The study conducted Johansen Cointegration test to investigate whether volatility of the NSE 25 share index has a long run relationship with open interests in Equity index futures.

Table 10. Johansen Cointegration Results on Volatility and Open interests (Equity Index Futures)

Maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	6	79.113235	0	16.3673	14.07
1	9	87.296888	0.44264	3.8095	3.76
2	10	89.201645	0.12720		

Source: Data Processed

Table 10 shows that there are a maximum of two cointegrating equation. The max statistics at rank 0 is greater than the 5% critical value (16.3673 > 14.07) therefore, the null hypothesis that there exist no cointegration equation is rejected. Additionally, the max statistic at rank 1 is greater than 5% critical value (3.8095 > 3.76) hence the study rejects the null hypothesis that there exist no cointegration equation. This implies that there exists a long-run linear relationship between volatility of NSE 25 share index and equity index futures market depth.

The derivatives experts agreed with the cointegration results. They explained that if the volatility is high in the cash market, traders holding spot market stocks will likely have fears. The traders will then find impetus to hedge in derivatives market until prices are somehow stable. Additionally, the traders are more likely to trade in derivatives market and in spot market to take advantage of the volatile prices and generate profits.

4.1.7 ARDL Results between Volatility of the Underlying Spot Market and Single Stock Futures Market Depth.

The Johansen Cointegration results showed cointegrating vectors, therefore ARDL model was suitable to model the relationship between volatility of the underlying spot market and derivatives market depth. The following model guided the study in establishing whether volatility of the underlying cash market has any significant effect on the derivatives market depth.

$$Y_t = \alpha Y_{t-i} + \beta_i X2_t + \varepsilon \qquad (5b)$$

Table 11. ARDL Results on Volatility against Single Stock Futures Market Depth

Statistic			Value			
Number of Observations			29			
F(2,26)			134.69			
Prob > F			0.0000			
R-squared			0.9120			
Adj R-squared			0.9052			
Y1	**Coef.**	**Std. Err**	**T**	**P>t**	**[95% Conf. Interval]**	
Y1.L1	0.962	0.0586	16.41	0.000	0.8413	1.082
X2	-1.51	1.747	-0.87	0.395	-5.1056	2.0792
Cons	0.254	0.3128	0.81	0.424	-0.3887	0.897

Source: Data Processed

The ARDL results are shown in Table 11, where Y1 is the single stock futures market depth, X2 is the volatility of the underlying spot market measured by weekly standard deviation of returns. Y1.LI is the first lag of single stock futures market depth measured by open interest.

Table 11 established that the model was significant (Prob> F = 0.000). The results reveal that a percentage change of first lag of open interest in single stock futures is associated with 0.96 percentage change in the open interest of single stock. This relationship is significant at probability value of 0.0001.

It implied that an increase in past values of open interest positively affects the future values. Additionally, the results reveal that an increase in volatility of the underlying stock market leads to decline in single stock futures market depth, however, this relationship is insignificant (β = -1.51, p=0.395).

4.1.8 Post Estimation Test

The study conducted post estimation test to check for the suitability of the model. These include autocorrelation test which was tested using Durbin-Watson Statistic and heteroscedasticity which was tested using white tests.

The null hypothesis of the Durbin-Watson statistic is that there is no serial autocorrelation. There was no serial autocorrelation since the p-value is greater than 0.05 (Durbin-Watson d-statistic (3, 29) = 0.400).

Additionally, the null hypotheses of white test reveal that there is homoscedasticity (no heteroscedasticity). The results revealed that there was no heteroscedasticity (chi2 (9) = 7.99, Prob > chi2= 0.1567). This implies that2the2model2does not suffer the problem of heteroscedasticity or autocorrelation.

4.1.9 Hypothesis Test

The study sought to test the hypotheses **H_{O1}: Volatility of the2underlying2spot2market has no significant effect on the single stock futures market depth.** According to the ARDL results, the volatility of the underlying cash market had a negative but insignificant influence on the single stock futures market depth. The p-value of the regression coefficient was 0.395 which was greater than 0.05 hence the study failed to reject the null hypotheses and concluded that there is no significant effect of the volatility of the underlying cash market on the market depth of single stock futures in Kenya.

The derivatives experts attributed the statistical insignificant relationship between volatility of the spot market and single stock futures market depth to nascent stage of the Kenyan derivatives market.

4.1.10 ARDL Results between the Volatility of NSE 25-Share and Equity Index Futures Market Depth

To establish whether volatility of the NSE 25 share index has any significant effect on the derivatives market depth of Equity index futures, ARDL model was conducted. The following model guided the analysis and

$$Y2_t = \alpha Y2_{t-i} + \beta_i X5_t + \varepsilon \qquad (6b)$$

Table 12 shows the summary of results where Y2 is the equity index futures market depth measured by open interest. Y2.L1 is the first lag of equity index futures market depth. X5 is the volatility of NSE 25 share index measured by weekly standard deviation of NSE 25 share index returns.

Table 12. ARDL Model Results of Volatility against Open Interest of Equity Index Futures

Statistic			Value			
Number of Observations			29			
F(2,26)			147.25			
Prob > F			0.0000			
R-squared			0.9189			
Adj R-squared			0.9126			
Y2	**Coef.**	**Std. Err**	**T**	**P>t**	**[95% Conf.**	**Interval]**
Y2.L1	1.008	0.0620	16.25	0.000	0.8804	1.135
X5	5.763	6.423	0.90	0.378	-7.44	18.996
Cons	0.392	0.228	0.17	0.865	-0.4299	0.508

Source: Data Processed

Table 12 revealed that the model was significant (Prob> F = 0.000).2The results reveal that a percentage change of first lag of open interest in equity index futures is associated with 1.01 percentage change in the open interest of equity index futures. This relationship is significant at probability value of 0.0001.This implies that an increase in past values of open interest positively affects the future open interests of Equity index futures.

Additionally, the results reveal that an increase in volatility of the NSE 25 share index leads to an increase in equity index futures market depth. However, that association is insignificant as shown by the p.value ($\beta = 5.763$, $p = 0.378$).

4.1.11 Post Estimation Test

Post estimation tests2were2conducted2to check for the suitability of the model. These include autocorrelation test which was tested using Durbin-Watson Statistic and heteroscedasticity which was tested using white tests.

The null hypotheses of the Durbin-Watson statistic is that there is no serial autocorrelation. There was no serial autocorrelation since the p-value is greater than 0.05 (Durbin-Watson d-statistic (3, 29) $p = 0.5296$).

Additionally, the null hypotheses of white test states that there is homoscedasticity (no heteroscedasticity). The results revealed that there was no heteroscedasticity (chi2(9) = 15.94, Prob > chi^2 = 0.07). This implied that the model does not suffer the problem of heteroscedasticity or autocorrelation. 4.1.12 Hypothesis Test

The study sought to test the hypotheses **H_{O2}: Volatility of the NSE 25 Share index has no significant effect on the equity index futures market depth.** According to the ARDL results, volatility had a positive and insignificant influence on equity index futures market depth. The p-value of the regression coefficient was 0.378 which was less than 0.05 hence the study fails to reject the null hypotheses and conclude that there is no significant effect of the volatility of the NSE 25 share index on the Equity index futures market depth in Kenya. The derivatives attributed this insignificance to the fact that spot market and derivatives market are two independent market and therefore what happens in spot market does not necessarily be reflected in derivatives market.

5.1 Discussion

According to granger causality results the fluctuations of prices in the underlying spot market (volatility) do not necessary lead to change in number of contracts traded (open interests) in single stock futures and in equity index futures. Additionally, the ARDL results showed no significant influence of volatility of the underlying spot market on the market depth of single stock futures. The ARDL findings also showed that the volatility of the NSE 25 share index has no significant influence on the single stock futures market depth. The findings were inconsistent with that of Black (1986) and

Kim and Waweru (2015) who found that cash market price volatility was highly influential on the trading volume of the index future contract.

A number of reasons could attribute to insignificant relationship between volatility of the underlying spot market and derivatives market depth in Kenya. Firstly, the derivatives market in Kenya is in nascent stage and it was characterized by low liquidity in derivatives market counters which was reflected in low number of open interests. Secondly, according to the derivatives experts spot market and derivatives market are two independent markets hence what happen in one market may not be reflected on the other market.

5.1.1 Conclusion

The study concludes that at nascent stage volatility of the underlying spot market does not necessarily affect the derivatives market depth at nascent stage. Changes in volatility of the underlying spot market does not result to changes in market activity at the derivatives counters and therefore, Capital Markets Authority and Nairobi Stock Exchange may not base their policies to accelerate the derivatives market which is at developing stages on volatility of the underlying spot market. They should therefore focus on other strategies such introduction of new derivatives products such as currency and commodities futures to increase market participants.

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