Testing for Volatility Persistence in Wheat Prices: Is Idiosyncratic Source Matters?

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Abstract

The paper investigates the best fit estimation technique for modeling volatility persistence in price of wheat. It further evaluates the source of rising volatility. It provides two main innovations: first, it analyzes wheat returns volatility types namely idiosyncratic and systematic volatility types and provides evidence of structural shifts in the price of wheat using the Narayan and Popp (2010) test and further modified the estimations to include both symmetric and asymmetric volatility models. Second, it uses several GARCH specifications to ascertain which of the sources of volatility generate more volatility. The paper finds two structural breaks that occur in 2015/2016 and 2018. It notices the existence of persistence and leverage effects in the returns volatility of wheat and that rising volatility regardless of types, necessitates demand for higher returns by investors to hold the investment. Conclusively, it recommends that, when modeling wheat return volatility, issues of asymmetric effects, structural shifts, and volatility persistence are very pertinent and that investors should structure investment portfolio with the knowledge that the idiosyncratic source heralds more persistence in volatility and therefore, necessitates utmost concentration.

Index terms— wheat price volatility, volatility persistence, EGARCH, and structural shifts.

1 Introduction

n understanding of the persistence of volatility risk in grain prices most importantly, the price of wheat is crucial to help design a sustainable strategy to hedge against the attendance effects. Studies have documented several factors that could be accountable for price increases; these include: ban of export of major grain such as corn, supply shortages, reduced stock-to-use ratios and panic buying by some major importers (Gilbert, 2010;and Minot, 2014). The long shift (decline) in the prices of wheat between 2017 and 2019 with increased volatilities (see Figure 1) have generated immense concerned for investors to search for which of the volatility sources generate the highest persistence of volatility risk. Having a better comprehension of effective modeling of price returns and volatility becomes imperative considering seasonal shifts in prtrends.

It is clear that this is not the first time that there is going to be a shift in commodity prices, specifically prices of grains. For instance, commodity prices rose rapidly between 2010 and 2011; and since 2007, global grain markets have witnessed an upward shift in price volatility. This is evident in the submission of Minot (2014), which provide analyses of pre-during-post of the global crises. The study shows that for these periods, the unconditional volatility of grain prices rose by 52% for corn, 87% for rice and 102% for wheat, respectfully. This indicates that price of wheat produces increased upward volatility risk to investors when compared to other grains.

The paper, therefore contributes to the existing studies on commodity price volatility modeling in three folds: first, it uses the recent Narayan and Popp (2010) to model the wheat return volatility. The approach allows for structural breaks in data series. Second, the wheat return volatility analysis was performed using the volatility sources. This is an improvement to existing studies on emerging markets that had concentrated on a single source of volatility. Third, the paper considers both systematic and idiosyncratic volatility risks models. The main thrust of the paper is to identify structural breaks that occur in wheat returns; and consequently, show how intense is the volatility risk in wheat price in the international market. Our results also lend support for the consideration of the source that generates more persistence in the wheat return volatility.

Comparatively, the idiosyncratic volatility models seem more appropriate in modeling wheat return volatility than the systematic ones, as it produces more persistence in volatility risk. Most importantly, the Exponential GARCH (EGARCH) model gives the best fit and therefore, propose that when modeling wheat return volatility, the EGARCH model should be considered. The implication therefore, is that investors in wheat should expect higher returns during rising volatility regardless of types and otherwise. The rest of the paper is structured as follows. Section two presents data and methods. Section three describes the analysis of empirical results and section four concludes the paper.

2 Data and Methods

The weekly wheat price data used in this study were garnered from the Bloomberg terminal throughout January 2014 and April 2019. The pre-estimation analysis is performed in two folds: the first provides descriptive statistics for wheat returns volatility considering the two types of volatilities generatedsystematic and idiosyncratic volatilities; the second shows the unit root test using the NP unit root test with structural breaks. The wheat returns is computed with the formula i t i t i t r r ? ? ? + + = ?1 1 0

. Table 1 presents the descriptive results on wheat return volatility for both systematic and idiosyncratic volatilities. It seems evidence from the results that there are significant variations in the trends of the two volatilities. Comparatively, following the standard deviation result, the trend of the idiosyncratic volatility appears more volatile than the systematic volatility. The statistical distribution of the series, indicates that both idiosyncratic and systematic volatilities are negatively skewed which shows that there exist extreme right tails in both series. Other descriptive statistics show that wheat return volatility series are leptokurtic (both possess fat tails than the normal distribution); the Jarque Bera statistic reveals evidence of non-normality for both systematic and idiosyncratic volatilities. Since the descriptive results show that wheat return volatilities are negatively skewed and not normally distributed, therefore, the inferential statistics that is most appropriate must follow non-normal distributions (see Wilhelmsson, 2006). The alternatives available consist of the generalized error distribution (GED), the Student-t distribution, the Student-t distribution with fixed degree of freedom and GED with fixed parameter. All these non-normality procedures are conducted for each of the volatility models and the model selection criteria are used to determine the most appropriate models. Only results that are best fit in each of the techniques is reported in the report. Results of the unit root test are presented in Table 2. The estimations follow the NP test that allows for the inclusion of two structural breaks in the series. The NP test is based on two assumptions on the deterministic components. The first allows for the two breaks in the intercept of the data series, which we tagged model 1 (M1). The second allows for two structural breaks both in levels and in slope of trend of the series. It is named model 2 (M2). Therefore, the two models are specified differently to consider for the deterministic component. The models are specified as follows: is the polynomial lag operator that allows breaks to occur slowly over time (see Narayan et al., 2010). The procedure follows the innovative outlier framework and it allows for changes to the trend to occur gradually rather than been instantaneous. The assumption behind the framework is that the series reacts to shocks from the innovation process (i.e. a Moving Average representation of the shocks).( )[ ] ( ) 1 * , 2 2 , 1 1 2 1 1 t t M t U D U D L t d ? + ? + + = ? ? ? ? ? ( )[ ] ( ) 2 * , 2 2 , 1 1 , 2 2 , 1 1 2 1 2 t t t t M t T D T D U D U D L t d ? + ? + ? + ? + + = ? ? ? ? ? ? ? Where ( ) ( )( ) . 2 , 1 ; 1 ; 1 , , , , , = ? ? ? = ? ? = ? i T t T t T D T t U D i g i g t i i g t i ? ? Also,

Following the assumption on the deterministic component ( )t d and stochastic component ( ) t ? of Ri t ( ) ( ) ( ) ( ) 3 * * 1 1 , 2 2 1 , 1 1 , 2 2 , 1 1 2 1 1 1 t R j t m j j t t t B t B R t M R t U D U D T D T D t ? ? ? ? ? ? ? ? ? ?? ? + ? + ? + ? + ? + ? + + + = ? = ? ? ? ? ( ) ( ) ( ) ( ) 4 * * * * * * * 1 1 , 2 2 1 , 1 1 1 , 2 2 1 , 1 1 , 2 2 , 1 1 2 1 1 2 t R j t m j j t t t t t B t B R t M R t T D T D U D U D T D T D t ? ? ? ? ? ? ? ? ? ? ? ?? ? + ? + ? + ? + ? + ? + ? + ? + + + = ? = ? ? ? ? ? ? Where ( ) ( ) . 2 , 1 ; 1 1 , . = + ? = = ? i T t T D i B t i B

In this case, to test the unit root of null hypothesis of1 = ? against the alternative hypothesis of . 1 ? ?

The NP test suggests the use of t-statistics of ? ?obtained after equations (**??**) and (**??**) have been estimated. The break dates are selected using the sequential procedure proposed by the NP test and appropriate critical values as indicated in the work of Narayan et al (2010). In Table 2, the unit root test results are presented with the optimal break point dates for both volatility types. As presented in Table 2, the two types of return volatility series are non-stationary after accounting for structural breaks and thus, adequate cognizance should be taken to recognize these breaks when dealing with wheat returns volatility modeling. Expectedly, the break dates (TB1 and TB2) for the two volatilities considered are not far apart. The first break was experienced in 2015 for both considered volatility types. Correspondingly, the second break (TB2) appears during the 2018 trading bout. In this period, the wheat market witnessed tremendous negative sentiments, rising speculations and huge divestment and the volatility risks were rising against falling wheat price trajectories.

3 III. Wheat Return Volatility Estimates

In this section, the paper makes use of different plausible models to estimate wheat return volatility. This is conducted by considering both systematic and idiosyncratic volatility sources and consequently, the paper compares the performance of the estimations by bearing in mind varying wheat portfolios, equal and value weighted volatility. Model selection criteria used for the selection of appropriate model of return volatility of wheat are Schwarz Information Criterion (SIC), Akaike Information Criterion (HIC) and HQC. The volatility results also present some post-estimation analyses using ARCH LM test to validate the presence of heteroscedasticity in the selected volatility estimates. The paper estimated the volatility of wheat returns through the symmetric and asymmetric models. The symmetric volatility models consist of the GARCH (1, 1) and GARCH in mean (GARCH-M (1, 1)), while the asymmetric volatility models are Threshold GARCH (TGARCH (1, 1)) and Exponential GARCH (EGARCH (1, 1)). A significant contribution of this paper as far as modeling of corn return volatility is concerned, is that it considers structural breaks. Apart from this, the volatility modeling approach adopted has made it possible to accommodate the time-varying conditional heteroscedasticity of wheat price return and also evaluate the mean-reverting property of the wheat return volatility. The mean and variance equations for the GARCH (1, 1) model are presented as follows: ( ) 5 , 2 2 , 1 1 1 t t t R t R t B B ? ? ? ? µ ? + + + ? + = ?( ) 7 2 2 1 1 1 2 2 1 0 t R t t R t B B ? ? ? ? ? ? ? ? ? ? + + + + + = ?

As said earlier, the asymmetric volatility models considered are TGARCH (1, 1) and EGARCH (1, 1). The two models have their mean equation as shown in equation (**??**) and the variance equations are specified as follows:( ) ( ) ( ) 8 2 1 2 1 2 1 2 1 2 1 2 ? ? ? ? ? ? + + + = t t t t t t In In ? ? ? ? ? ? ? ? ? µ ?

The variance of the EGARCH model is specified in equation (**??**), while the variance of the TGARCH model is expressed as: ( ) 3 and 4 show the results of the several volatility models for both systematic and idiosyncratic volatility forms. The implication of the results is that, the variance process reverts to its mean slowly for all the models and irrespective of the volatility form. This is inferred from the addition of the ARCH and GARCH effects of the variance equations that are close to one, therefore indicating that the variance process reverts slowly although the systematic volatility form reverts quickly than the idiosyncratic one. The slow mean reverting process is an indication of high level of volatility persistence in the price of wheat. In this case, price of wheat with intense idiosyncratic volatility appear more persistent than that with systematic volatility. The findings are consistent with the descriptive statistics presented in Table 1.9 1 2 1 2 1 2 2 1 1 0 2 ? ? ? ? + + + = t t t t t I ?? ? ? ? ? ? ? Where 1 1 = ? t I if 0 1 ? ? t

Comparing the performance of the two volatility forms given the models, the GARCH (1, 1) model appears to produce a better fit over the GARCH in mean (GARCH-M (1, 1)) model for the symmetric volatility models. This is reached with the SIC value. This is not striking as such, as the inclusion of the coefficients on the standard deviation of the wheat price returns in the conditional mean equation, is statistically not significant and therefore, does not provide any useful information as to the volatility models (i.e. systematic and idiosyncratic models). Similarly, the estimates of TGARCH (1, 1) provide an inferior result when compared to the EGARCH (1, 1) for the case of asymmetric. In all, the EGARCH (1, 1) model offers a better fit when compare to the GARCH (1, 1) in the symmetric case.

In addition, the results of the EGARCH model suggest that there are leverage effects in both volatility models -idiosyncratic and systematic volatility forms. This is inferred from the findings, as the variable measuring the leverage effects is negative for both return volatility forms. The implication therefore, is that negative shocks have tendency of reducing volatility more than positive shocks in the wheat market. It also show that investors in the wheat market react more to bad news, as bad news has immense potential of increasing volatility than good news.

In the descriptive statistics, it is evident that there is presence of ARCH effects in the return volatility series (i.e. systematic and idiosyncratic volatility); thus, necessitating the estimation of the post-estimation diagnostic tests to ascertain if the volatility models have accommodated the effects. These is the reason why the ARCH tests is conducted using both F-test and chisquare distributed ( ) 2 nR test. The results show that in all the estimations the acceptance of the null hypothesis of no ARCH effects is appropriate. All the values are statistically not significant. Summarily, the findings show that with structural breaks in volatility series, the exponential GARCH (EGARCH (1, 1)) is superior to other GARCH variants considered in the paper. Hence, more appropriate to model volatility of wheat returns, more specifically in period of structural shifts. IV.

4 Concluding Remarks

Modeling volatility of wheat returns provides crucial information to investors and actors, more particularly; it reveals the level of persistence in volatility risk in the price of wheat. In essence, variability in wheat prices implies significant losses (gains) in investments and therefore, decreases (increases) returns of investors in wheat prices. As a profit maximizing investor, with a risk averse investment interest, the incidence of persistent high volatility will impact on the diversification of investor's portfolio either to a less risky assets or to more volatile asset class. Therefore, testing for persistence in wheat returns volatility has major policy relevance for investors and investors in agricultural produces.

The NP unit root test procedure shows that there are two structural breaks in wheat returns volatility. These occur in 2016 and 2018, respectively. These two seasonal shifts substantially affected wheat prices and consequently its volume of investment. The estimations show that there is persistence in the wheat returns volatility irrespective of volatility types. However, the idiosyncratic volatility type appears more persistent than systematic volatility. The results also show the evidence of leverage effects in both volatility types, and therefore, investors in wheat prices react to news differently. More importantly, the findings show that bad news has the possibility of increasing volatility in the returns of wheat prices than good news. Furthermore, relatively, the asymmetric models seem more appropriate in modeling stock return volatility than the symmetric approach. Particularly, the exponential GARCH (EGARCH) model produces the best fit and therefore, the paper proposes that the EGARCH should be considered when dealing with wheat return volatility modeling. In sum, the paper recommends the consideration of asymmetric effects as well as structural shifts when modeling wheat return volatility. [1]

1

			Panel A: Summary Statistics			
Details	Mean	Median	StdDev	Coef.V	Skewness	JB
SVolew 0.0201		0.0203	0.0112	0.2783	- 0.1045	1.0123
SVolvw 0.0157		0.0184	0.0083	0.3674	- 0.0827	1.0104
IVolew	0.0113	0.0146	0.0078	0.3106	- 0.0549	2.0112
IVolvw	0.0786	0.0073	0.0049	0.2984	- 0.0378	2.0062
			Panel B: Correlation Statistics			
	SVolew	SVolvw	IVolew	IVolvw		
SVolew	1					
SVolvw 0.8016		1				
IVolew	0.8439	0.5533	1			
IVolvw	0.7155	0.7921	0.7309	1		
			Panel C: Autocorrelation Table			
	SVolew	SVolvw	IVolew	IVolvw		
1 ?	0.524	0.457	0.723	0.689		
? 3	0.446	0.343	0.682	0.622		
? 6	0.208	0.198	0.514	0.595		
? 9	0.195	0.124	0.483	0.479		
12 ?	0.183	0.153	0.43	0.374		

[Note: Source: Author's computation and compilation]

Figure 1: Table 1 :

2

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TB i (= Where) 2 , 1 represented the selected breaks (see 1 , = t i B if i TB t ? and zero oth
i

Table 2). Note that t ? i t e and t e is standard
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=

normally distributed with unit variance. The GARCH in

Figure 2: Table 2 :

3

Variable	Asymmetric Models	Symmetric Models		
Value Weighted Estimates	EGARCH (1, 1)	TGARCH (1, 1)	GARCH (1,1)	GARCH-M (1, 1)
Mean Equation				
Alpha	0.0041 (0.8322)	0.0005 (0.5722)	0.0002 (0.4276)	-0.0002 (-0.3081)
Beta	-0.0089 (-1.6149)	-0.0208 (-1.9803)	-0.0112 (-1.2102)	-0.0039 (-1.0527)
Delta	3.29*10^7 (3.2984)**	0.0008 (3.2097)**	0.0001 (2.7812)**	0.0003 (2.8133)**
Theta	0.0003 (0.4282)	0.0003 (0.4435)	0.0003 (0.4219)	0.0004 (0.2172)
Conditional Variance	-	-	-	0.0259 (1.0056)
Variance Equation				
Alpha	-0.2064 (-8.1508)*	4.29*10^5 (3.8923)*	4.98*10^5 (3.2091)*	4.88*10^5 (3.8730)*
Beta	-	0.0592 (6.9831)*	0.0278 (10.5470)*	0.0309 (12.7760)*
Lamda	-	0.8217 (9.0023)*	0.7437 (8.6727)*	0.8014 (10.0598)*
Phile	-	0.0049 (0.7638)	-	-
Rho	0.1472 (10.2086)*	-	-	-
Tau	-0.0142 (-2.6591)**	-	-	-
Sigma	0.7739 (5.4028)*	-	-	-
Diagnostic Statistics				
AIC	-4.9935	-4.9320	-4.9109	-4.9106
SIC	-4.8931	-4.8856	-4.9086	-4.9083
HQC	-4.8826	-4.8811	-4.9101	-4.9078
ARCH LM Test (7)				
F-Test	1.8069	1.5572	1.7209	1.7091
nR^2	1.8609	6.0982	5.8044	7.2206
No of Observation	884	884	884	884
Equal Weighted Estimates	EGARCH (1, 1)	TGARCH (1, 1)	GARCH (1,1)	GARCH-M (1, 1)
Mean Equation				
Alpha	0.0027 (0.7062)	0.0004 (0.2092)	0.0002 (0.4276)	-0.0002 (-0.3081)
Beta	-0.0089 (-1.7140)	-0.0318 (-1.2803)	-0.0112 (-1.2102)	-0.0039 (-1.0527)
Delta	2.42*10^6 (3.5491)**	0.0006 (2.9473)**	0.0001 (2.7812)**	0.0003 (2.8133)**
Theta	0.0002 (0.5009)	0.0008 (0.3851)	0.0003 (0.4219)	0.0004 (0.2172)
CVariance	-	-	-	0.0259

4

Variable	Asymmetric Models	Symmetric Models		
Value Weighted Estimates	EGARCH (1, 1)	TGARCH (1, 1)	GARCH (1,1)	GARCH-M (1, 1)
Mean Equation Alpha Beta Delta Theta Conditional Variance Variance Equation Alpha	-0.0001 (-0.7082) 0.0375 (3.1091)* 0.0007 (2.2004)** 0.0003 (0.5089) –0.2117 (-10.1218)*	-0.0002 (-0.4278) 0.0402 (3.0803)* 0.0005 (2.0192)** 0.0004 (0.7058) -5.28*10^5 (5.2203)*	4.02*10^6 (0.2246) 0.0204 (3.0214)* 0.0007 (2.8503)** 0.0006 (0.6739) -4.58*10^5 (6.6201)*	0.0007 (1.1031) 0.0339 (2.8793)** 0.0014 (2.0103)** 0.0004 (0.6544) -0.0518 (-1.1576) 4.37*10^5 (5.9030)*
Beta Lamda	–	0.0849 (4.1991)* 0.7907 (9.1241)*	0.0583 (12.6220)* 0.8828 (9.8932)*	0.0679 (15.3260)* 0.8812 (12.1438)*
Phile Rho Tau Sigma Diagnostic Statistics AIC SIC HQC ARCH LM Test F-Test nR^2 No of Observation Equal Weighted Estimates	-0.1784 (7.0056)* -0.0125 (-3.6071)* 0.5639 (3.4918)* -4.9735 -4.9383 -4.9306 0.0372 0.0369 884 EGARCH (1, 1)	0.0209 (3.7855)* —-4.9180 -4.8836 -4.8902 0.2682 0.2676 884 TGARCH (1, 1)	—-4.9310 -4.9196 -4.9275 0.2147 0.2134 884 GARCH (1,1)	—-4.9192 -4.9190 -4.9107 0.3421 0.3586 884 GARCH M (1, 1)
Mean Equation				
Alpha	-0.0002 (-0.6983)	-0.0003 (-0.5308)	4.02*10^6 (0.2246)	0.0007 (1.1031)
Beta	0.0328 (3.0119)*	0.0396 (3.0874)*	0.0204 (3.0214)*	0.0339 (2.8793)**
Delta	0.0006 (2.3204)**	0.0004 (2.1196)**	0.0007 (2.8503)**	0.0014 (2.0103)**
Theta	0.0002 (0.6129)	0.0003 (0.8858)	0.0006 (0.6739)	0.0004 (0.6544)

*[Note: Note: *, ** indicate 1% and 5% levels of significance.]*

Figure 4: Table 4 :

[Narayan and Popp ()] ‘A new unit root test with two structural breaks in level and slope at unknown time’. P K Narayan , S Popp . *Journal of Applied Statistics* 2010. 37 (9) p. .

[Bali and Cakici ()] ‘Aggregate idiosyncratic risk and market returns’. T G Bali , N Cakici . *Journal of Investment Management* 2006. 4 (4) .

[Bekaert et al. ()] *Aggregate idiosyncratic volatility*, G Bekaert , R J Hodrick , X &zhang . 2010. Columbia University (Unpublished Working Paper)

[Clayton et al. ()] ‘Are beta, firm size, liquidity and idiosyncratic volatility related to stock returns? Australian Evidence’. L Clayton , M Dempsey , M Veeraraghavan . *Working Paper Series* 2006.

[Nartea and Ward ()] ‘Does idiosyncratic risk matter? Evidence from the Philippine Stock Market’. G V Nartea , B D Ward . *Asian Journal of Business and Accounting* 2009. 2 (1&2) p. .

[Aliyu ()] ‘Does inflation has an impact on stock returns and volatility? Evidence from Nigeria and Ghana’. U R Aliyu . *International Conference on Economics and Finance Research IPEDR* 2011. 2011. IACSIT Press. 4.

[Drew et al. ()] ‘Equity premium: Does it exists? Evidence from Germany and United Kingdom’. M E Drew , M Mallin , T Naughton , M Veeraraghavan . *Studies in Economics and Finance* 2006. 23 (2) p. .

[French et al. ()] ‘Expected stock returns and volatility’. K French , G W Schwert , R Stambaugh . *Journal of Financial Economics* 1987. 19 p. .

[Minot ()] ‘Food price volatility in sub-Saharan Africa: Has it really increased?’. N Minot . *Food Poicy* 2014. 45 p. .

[Wilhelmsson ()] ‘GARCH forecasting performance under different distribution assumptions’. A Wilhelmsson . *Journal of Forecasting* 2006. 25 p. .

[Campbell et al. ()] ‘Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk’. J Y Campbell , M Lettau , B G Malkiel , Y &xu . *Journal of Finance* 2001. 56 p. .

[Gilbert ()] ‘How to understand high food prices’. C L Gilbert . *Journal of Agricultural Economics* 2010. 61 p. .

[Dempsey et al. ()] ‘Idiosyncratic risk and Australian equity returns’. M Dempsey , M E Drew , M Veeraraghavan . *Working Paper series* 2001. Griffin University

[Hamao et al. ()] *Idiosyncratic risk and creative destruction in Japan*, Y Hamao , J Mei , Y Xu . 2003. (Unpublished Working Paper, NBER)

[Malkiel and Xu ()] *Idiosyncratic risk and security returns*, B G Malkiel , Y Xu . 2006. Princeton University & The University of Texas at Dallas

[Goyal and Santa-Clara ()] ‘Idiosyncratic risk matters!’. A Goyal , P Santa-Clara . *Journal of Finance* 2003. 58 p. .

[Gao et al. ()] *Investor sentiment and idiosyncratic risk puzzle*, X Gao , J Yu , Y &yuan . 2010. Hong Kong. University of Hong Kong (Working paper series)

[Brockman et al. ()] *Is idiosyncratic volatility prices? The international evidence*, P Brockman , M G Schutte , W &yu . 2010. Michigan Tech University

[Bekaert et al. ()] *Is there a trend in idiosyncratic volatility? Paper presented at the AFA 2009 San Francisco meetings*, G Bekaert , R J Hodrick , X Zhang . 2009. San Francisco.

[Liu and Narayan ()] R Liu , P K Narayan . *A new structural break unit root test based on a GARCH model*, 2010.

[Kalu ()] *Modelling stock returns volatility in Nigeria using GARCH models*, E O Kalu . 2008. Nigeria. Department of Banking and Finance, University of Nigeria, Enugu Campus, Enugu State

[Mustapha ()] S A Mustapha . *Asset Volatility and Pricing in the Nigerian Stock Market*, (Benin City, Nigeria) 2015. Department of Economics and Statistics, University of Benin (PhD Thesis)

[NSE factbook ()] *NSE factbook*, (Nigerian Stock Exchange) 2012. 2012. (Edition)

[Fu ()] ‘Risk and the cross section of expected stock returns’. F Fu . *Journal of Financial Economics* 2009. 91 p. .

[Mustapha ()] *Stock (Mis) Pricing and Investment Dynamics in Africa” Evidence from African Equities*, S A Mustapha . 2017. Cote D’Ivoire, Abidjan: African Development Bank Headquarters. (African Development Bank Working Paper Series)

[Emenuga ()] *Systematic factors and returns on equities in the Nigerian Securities Market*, C A Emenuga . 1994. Nigeria. Department of Economics, University of Ibadan (Unpublished PhD Thesis)

[Ang et al. ()] ‘The cross section of volatility and expected returns’. A Ang , R J Hodrick , Y Xing , X Zhang . *Journal of Finance* 2006. 61 (1) p. .

[Campbell et al. ()] *The econometrics of financial markets*, J Y Campbell , A W Lo , C A Mackinlay . 1997. Princeton -New Jersey: Princeton University Press.

[Brandt et al. ()] 'The idiosyncratic volatility puzzle: Time trend or speculative episodes?'. M W Brandt , A Brav , J Graham , A Kumar . *Review of Financial Studies* 2009. 23 (2) p. .

[Lundblad ()] 'The risk return tradeoff in the long run'. C Lundblad . *Journal of Financial Economics* 2007. 85 p. .

[Brockman ()] *The time series behavior and pricing of idiosyncratic volatility: Evidence from 1926 to 1962. Working Paper series*, P Brockman , Yan , XS . 2008. University of Missouri -Columbia

[Wei and Zhang ()] 'Why did individual stocks become more volatile?'. S X Wei , C Zhang . *Journal of Business* 2005. 79 (1) p. .