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Effectiveness of Commodity Futures in Curbing Spot Volatility

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Abstract This study examines the impact of introduction of futures trading on the spot price volatility in the commodity market. The paper considers the United States of America, South Africa and Ethiopian economies. Three commodities i.e. coffee, maize and wheat from New York Mercantile Exchange, South African Futures Exchange and Ethiopian Commodity Exchange are analyzed. ARCH LM test is used to check for heteroskedasticity and GARCH and EGARCH are used to check for the behavior of volatility for the pre- and post-futures periods. For all the three economies, the results indicate presence of the ARCH effect in the log returns. For conditional and unconditional variances; spot price volatility for coffee has decreased after futures trading across all the economies and the EGARCH has also shown reduction in persistence of volatility in the post-futures period in the three economies; while that of maize has reduced for the Ethiopian economy but increased in both the US and South African economies. For wheat, the conditional variance has been found to rise in the post-futures period in all the three economies. These results imply that more positive feedback from futures trading is bound to be seen for maize in the less developed economies as opposed to the developed economies as opposed to the other products. This paper has focused on the overlooked factor by earlier researchers, i.e. of economic-gap amongst countries, in looking at the impact of the futures trading on the spot price variation.

Keywords: *derivatives, futures exchange, agricultural commodities, spot price volatility*

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1. Introduction

Background of the Problem

Agriculture is a sector facing particularly large risks mainly from natural factors outside control of the farmers. Resulting variations in farm output with a relatively low price responsiveness of market forces of demand and supply also causes agricultural markets to be volatile. Recent experience with volatility in this sector with major episodes of food price spikes of 2006-08 and 2010-11 has resulted in growing interest in risk management in agriculture. While much research has been done on stabilization-destabilization question, there are problems associated with this work including the fact that most studies relate to developed and emerging economies at the expense of the less developed countries [1] and failure for empirical testing to recognize the relation between information and volatility thus incorrect policy implications; this study will address this issue by focusing on futures trading in a developed, emerging and a less developed economy and employ the GARCH and EGARCH models to capture this relation of information and volatility.

Applicability of Crop Insurance

While agriculture faces a higher level of revenue risk, insurance could be the most suitable solution to manage yield risk from rare and extreme events. Nevertheless, incomplete insurance is a common phenomenon in the developing countries due to the costly nature of the traditional yield insurance products. Nonetheless, recently index-based products have been introduced in these countries like India with no subsidized yield insurance though most schemes have not moved beyond the pilot stage. Absence of government support means further burdens of high costs and thus high premiums over and above the cost of risk as a result of adverse selection, moral hazard, systemic risk and high loss adjustment costs for individual subsistence farmers. Index-based products overcome most of these problems but then their effectiveness is limited to the extent to which the underlying indices on which they are based are correlated with the actual yield experienced on an individual farm.

Risks faced by a farmer

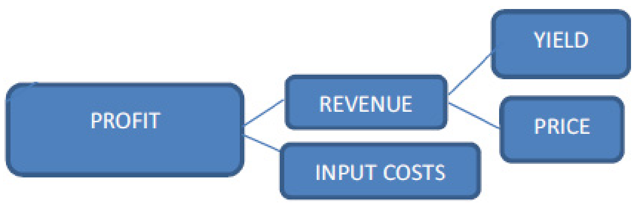

Figure 1.

Claims made against insurance policies frequently add to the insurance costs by increasing the costs of loss adjustment. The insurance costs also needs consideration against the alternative risk management practices e.g. less significant risks could be managed more economically through savings and borrowings. For yield risk, the appropriate strategy would be to insure while for price volatility risk the suitable response would be to employ derivatives.

1.1. Current Futures Trading Issues Globally

With dynamic technologies there has been creation of novel challenges for agency's oversight in matters of monitoring high frequency trading in the futures markets [2].

a) Rise in technology hence High Frequency Trading (HFT)

With rise in technology, HFT in futures market exists and proponents argue that its rise has tended to increase liquidity and narrow bid-ask spreads hence a reduction in transaction costs. One of the issues that have come up is the impact of HFT on market stability e.g. in the afternoon of May 6, 2010, the stock market lost approximately 6% of its value for 5minutes then made up nearly all of the losses. A joint study by Securities and Exchange Commission (SEC) and CFTC attributed this "flash crash" to a single mutual fund's trading algorithm which went on selling after all buying interest had been exhausted. Recently, on August 1, 2012, HFT firm Knight Capital Group Inc. lost about $440 million in less than an hour after a computer malfunction bombarded the stock market with errant orders.

b) Futures trading and spot price volatility

Price volatility which is a measure of the dispersion of returns for a given commodity/security or market index [3] is one of the recent phenomenons in international commodity/security markets. Indeed, volatility is more damaging to the broader economy in countries whose exports are highly concentrated in commodities [3] as is the case for LDCs and OPECs. In 2008 and 2011 it was characterized by drastic rises in oil prices which doubled to more than $145 per barrel then fell by 80% before rising again. Such steep jumps with unexplained price volatility in other range of commodities have fostered the thought that financial speculation in derivatives might be responsible for this volatility [4].

Price risk in agriculture, where most commodities are storable, tends to be of asymmetric nature, with much variation around the trend, characterized by occasional large upward price spikes and less pronounced price troughs. Thus, at the global level the risk of surging food prices to poor consumers in developing countries is more prominent than the risk of declining prices faced by farmers in rich countries. The FAO food price index indicates that food prices grew by 30% (nominal) between June and December, 2010 and 3.4% in January, 2011 in LDCs [4]. The fundamental questions that arise are: how much of this increase can be attributed to volatility as a result of short term factors and how much due to structural factors and with respect to volatility, what is the role of factors such as speculation in the market. Further on, volatility of prices of raw materials has been found to be higher than that of manufactured products [5].

Price volatility is a crucial matter for LDCs since households value price stability and it is the poor (developing countries) who suffer disproportionately from price instability due to the high elasticity of change in their income due to price increases as they can hardly access futures markets for hedging [6]. An example is [7] who notes that in Ethiopia, smallholder farmers sell bulk of their produce immediately after harvest to pay taxes, repay loans and meet their cash requirement for social services hence are not able to store to benefit from intertemporal arbitrage in future and besides, storage costs here are very high.

A study by [8] investigated the dynamic relationship between the spot price volatility and futures trading activity plus the trading volume (speculative) and open interest (hedging) by use of augmented GARCH model where spot volatility is modeled as GARCH (1,1) process and trading activity used as explanatory variable and decomposed the futures trading volume and open interest series into expected and unexpected component and found that both expected and unexpected futures trading volume affected contemporous spot volatility. The effect of speculative trading measured by trading volume on spot market volatility is positive unlike hedging activity measured by open interest which does not show a significant effect. CFTC is also making attempts to impose position limits (ceiling or accountability level) on a range of commodities and energy products intended to constrain the size of a derivatives position that can be taken by a single speculator except for commercial hedgers.

The Figure 2 below is a representation of the log returns of coffee, wheat and maize for the periods 2000 through 2014for Ethiopian Commodity Exchange where log returns is given by $r_t = \ln(p_t/p_{t-1})$. From the diagram we can see how great the fluctuations are for the maize and wheat with coffee having the least variability with returns close to a zero-mean at post-futures period.

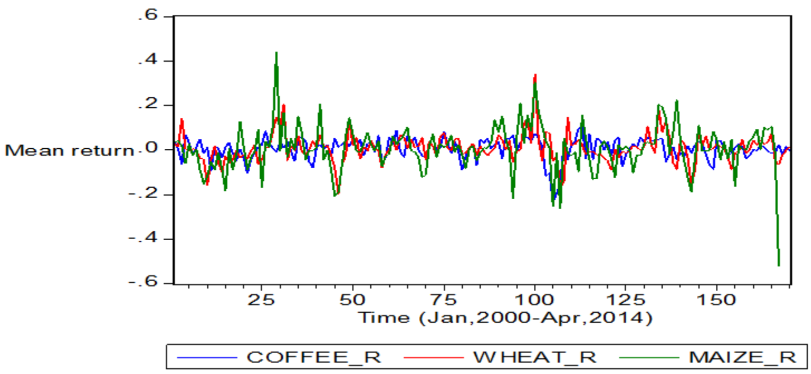

Figure 2. Monthly Log Returns (ECX)

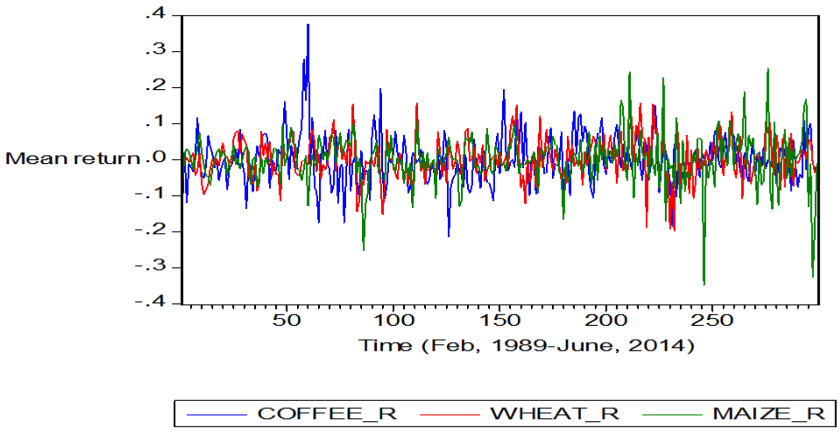

Figure 3. Log Returns (SAFEX)

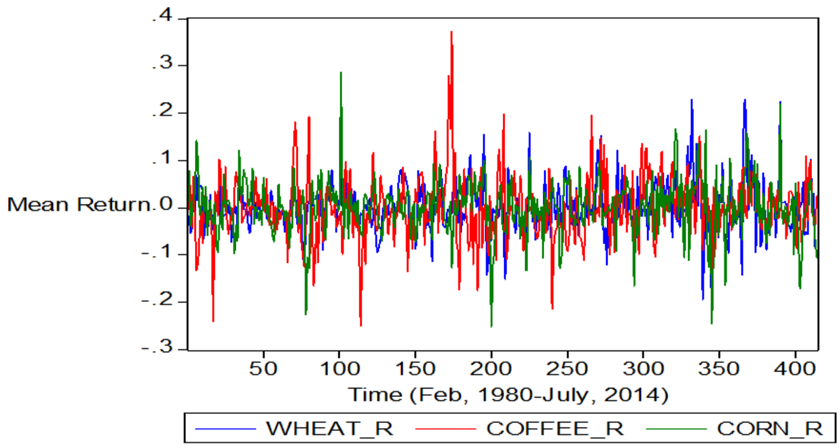

Figure 4. Log Returns (NYMEX)

In Figure 3 based on data from SAFEX, the least fluctuations is seen for wheat with that of coffee declining of late compared to earlier periods. Maize however, is seen to always be fluctuating.

In Figure 4 based on data from New York Merchantile Exchange, less fluctuations is evident for all the commodities at least in the post-futures period.

1.2. Overview of ECX, SAFEX and NYMEX

The key objective for formulation and implementation of a futures market is towards achieving and maintaining stability in the general level of prices in order to achieve desired growth rates through allowing investors to buy and sell asset contracts for delivery in the future hence limit wide swings in prices caused by oversupply or shortages that usually hit the grain sector especially for corn prices where the country faces a price fluctuation of up to 50% yearly hence the Ethiopian government launched the ECX in 2008. Several commodities have been incorporated in the trading including corn, coffee, sesame, wheat and by 2011; all of these commodities have required to be traded at the exchange. On the other hand, the SAFEX launched its official organized exchange for trading of standardized futures contracts to ensure protection of its farmers from the huge price fluctuations in grain sector hence stabilize its foreign earnings in form of revenues from its agricultural exports in January, 1996. NYMEX was officially listed after acquisition by CSE in November, 2006 as an organized exchange for commodities.

1.3. Problem Statement

The existing models of futures markets provide some insight on commodity price volatility behavior but theory is ambiguous in its predictions on the effect of futures markets on the volatility in the commodity market hence does not necessarily provide answers to the following questions: What are reasonable values for all of the model's parameters? Will the results be invariant to the kind of commodity considered? And most importantly, will the parameter values themselves remain constant before and after the introduction of futures markets? Thus the need to turn to early studies for instructive case studies on the subject [9].

The drastic increases in prices of crude oil since 2002 highlighted the importance of being able to predict accurately the evolution of the spot price as stated by [10] as policy making institutions like Fed and IMF use futures prices as a proxy of investors' expectations of future spot prices hence the efficiency of futures markets dictate the reliability of the policies implemented by these institutions.

1.4. Objective of the Paper

The paper seeks to determine the impact of introduction of futures trading on the spot price volatility.

Organization of the Study

The remaining part of this paper is organized as follows; chapter two provides a review of both theoretical and empirical, chapter three develops the methodology of the study; chapter four involves findings, data analysis, conclusion on the research findings; interpretation and areas for further studies.

2. Literature Review

2.1. Introduction

The impact of introduction of futures markets to spot price stabilization has been one of the major areas of concern in the financial field since early 1900s [11].

2.2. Theoretical Literature Review

[12] during his earlier studies demonstrated that in presence of futures markets, if futures prices are quick to adjust to new information and this process transferred to spot market through arbitrage mechanisms, the spot market volatility and market efficiency would go up simultaneously. He observed that if information were free of costs, all firms would be fully aware of evidence on futures conditions hence price expectations would never be influenced by futures trading. However, this is not the case since in real markets, bits of information are dispersed amongst many individuals and changes frequently and costly to acquire.

The gap of perfect integration between the spot and futures markets in Cox's paper is filled by [13] who relaxes the assumption and develops a theoretical relation between futures market's frictions and the spot price volatility. He shows that reduction in market frictions would increase both the market efficiency and the variance of short run spot price changes. Hence, both [12] and [13] note that futures market have less market frictions than the spot market. By futures markets adjusting quickly to new information and the effect being transferred to spot market through arbitrage between the two markets, it will be functioning to aid in reduction of market frictions in spot market.

[14] state that the futures market offers more convenient, lower cost trading due to its higher liquidity, transparent pricing system, high leverage, and allowance of short positions. They came to conclusion that futures may improve the efficiency of the underlying market by increasing the level of public information in the market. Specifically, the marginal benefit of becoming informed after the introduction of futures is greater given the superiority of futures as a speculative vehicle. This increase in marginal benefit results in greater information to traders. In turn, this increase in public information lowers information asymmetry, lowers the spread, improves liquidity, and reduces the variance of the pricing error, thereby making the underlying market more efficient and more stable in its pricing.

[15] contributes to the debate whether introduction of derivative markets in general stabilizes or destabilizes the spot markets. Even in the 21st century, it is still argued that due to higher degree of leverage, the futures markets tend to attract uninformed speculative investors thus leading to the destabilization of the cash markets by increasing volatility just as stated in [12]. However, most economists argue that these futures markets increase the overall market informativeness and depth which aids in price discovery, transferring of risks and actually reducing the spot volatility. His theoretical reasoning's limitation however has been the fact that evidence goes against it and has been concentrated on large cap markets like USA.

[16] states that one of the effects of onset of futures market is that the volume of storage becomes more sensitive to changes in the return to storage meaning that it will absorb huge part of shocks due to the market forces of demand and supply, hence reduction in the spot price volatility. He attempts to explore the role of speculator in the market and specifically, the relationship between speculation, futures markets and commodity price volatility. He finds out that the futures markets are systematically associated with lower volatility in commodity prices.

2.3. Empirical Literature Review

Early works of [17] recognizes the presence of speculators in the market and how their activities impact the efficiency of the futures market and go further on the use of an appropriate model that perfectly captures the correlation between volume of trading and variability of price change. The existing gap was failure of the speculative trading to explain the gentle decline in the variance of daily price change given the growth in trading volume. He therefore derives and estimates a more general model of price change and trading volumes on speculative markets. He goes as far as studying the relationship between the total volume of trading on speculative markets and variability of daily price change using an improved version of the Epps and Epps' model which does not invoke the assumption of positive correlation between the absolute value of change in market price and trading volume on each within-day market clearing. However, the gap that still exists is that of incorporation of futures market besides the volume of transactions in impacting the behavior of spot prices.

[18] later did an analysis by use of multi-commodity multi-country approach to evaluate futures market and benefits of stabilization schemes in face of incomplete insurance markets as is the case in most less developed countries. He concludes that large producing nations would enjoy revenue stabilization while smaller producers i.e. the primary producing countries would achieve price stabilization and he is therefore, in support of early works of [19] who illustrate the positive returns from hedging in terms of reduction of revenue variances.

From [16], futures markets can be responsible for lower price volatility in the absence of other aggravating factors. However, what remains less certain is how the introduction of pure speculation in the futures market affects the theoretical results with regard to price volatility. From their results the rational expectation model implies a reduction in price volatility with futures markets than without. Other factors might have contributed to this phenomenon but can be argued that since the "control" period without futures markets is followed by the "treatment" which is the introduction of the futures market, other time-varying factors could be responsible for the diminishment of the commodity price volatility e.g., improvements in the IT sector which has been a common weakness identified in earlier literature. His results strongly suggest that the futures markets are associated with and most likely caused lower commodity price volatility.

Later, [20] in his paper on the effect of futures trading on spot-price volatility with evidence for NSE Nifty applying the GARCH model, aims to study the impact of the introduction of Nifty index futures on the volatility of the Indian spot markets. His approach involved employing six measures of volatility, the dynamic linear regression model and the GARCH models on the NSE Nifty prices from 1997-2007 i.e. for both before and after the onset of the futures market. In his findings, the GARCH analysis confirmed that there was no structural change after the onset of the futures trading on Nifty i.e. the onset of derivative trading had not impacted on the spot price volatility.

[11] apply a panel data evaluation approach to investigate the effect of introduction of futures market on the spot price volatility in the Chinese stock market. They employed a recently developed panel data policy evaluation approach just as the earlier colleagues [21] did, to construct counterfactuals of the volatility in the spot market mainly based on the cross-sectional correlations between the Chinese and the international stock markets. However, there had and have been critics from [22] who earlier claimed that the futures trading may destabilize spot markets as a result of excess speculation especially during turbulent periods like the US stock market crash of 1987 and the 2007-2009 global financial crises. In [22], the approach involved use of a two-sample regression approach which included estimation of two similar regression models then doing a statistical tests or a dummy variable approach which involved estimation of a regression or a GARCH model in the whole sample period with a dummy variable designed to detect any mean shift in the volatility after the event (introduction of the futures market). The limitation of these approaches however is the fact that there is the existence of structural changes or uncontrolled market factors that impact on the market volatility which could cause some omitted variable bias on estimation of the impact of futures market.

2.4. Summary of the Review

From both the theoretical and empirical reviews, an improvement in the research on this topic is that researchers on the empirical studies of volatility now find it necessary to account for the distributional properties of the price changes unlike in the earlier studies that relied more on statistical techniques which assumed the distribution of the variances to be either normally or log normally distributed, an assumption that does not hold due to presence of heteroskedasticity. Owing to these studies done earlier, we can conclude that the impact of introduction of futures trading has been varying with markets with respect to different span of time and frictions in that specific market hence the need for this paper to take into account the linkage between spot volatility, futures trading and information flow by employing GARCH and EGARCH models. To curb most of the earlier studies done on this subject, this study incorporates futures trading in a developed, emerging and less developed economy i.e. USA, South Africa and Ethiopia respectively.

3. Methodology

The study involved cross sectional properties given that it employed returns and volumes of futures trading for coffee, maize and wheat for New York Mercantile Exchange, South African Futures Exchange and Ethiopian Commodity Exchange for the periods February, 1980-June, 2014; February 1989-June, 2014 and January, 2000-April, 2014 respectively. This study adopts a descriptive research design as it involves determining the relationship between futures trading and spot price volatility.

Of the commodities' exchanges that exist globally, the study focuses on the NYMEX, SAFEX and ECX as perfect representatives of the developed, emerging and less developed economies respectively and also due to the availability of data. The study also focuses on three agricultural commodities; i.e. coffee, maize and wheat given the huge fluctuations usually observed in the grain sector (maize and wheat) and coffee as the main export commodity and highly globally demanded.

3.1. Data Collection Methods and Procedures

The data was from Central Statistics Authority for monthly data prices for coffee, wheat and maize for ECX; SAFEX website for South African spot prices and International Monetary Fund, World bank and CME Group database for NYMEX spot prices for the periods before and after the introduction of the futures market.

3.2. Data Analysis

To analyze the impact of futures trading on the spot market volatility of coffee, maize and wheat, division of the period into the pre- and post-futures periods is required. The pre-introduction period covers the period prior to the introduction of futures trading in the Ethiopian economy i.e. from February, 2000 until April, 2008 and the post introduction period covers the period after the introduction of futures trading i.e. from December, 2008 to April, 2014 to cater for the skeptism by the locals to venture in these markets after its establishment. For the South African economy; the pre period is from July, 1989-December, 1994 and period after January, 1995 counts as the post futures trading period. For the NYMEX, the pre period is from February, 1980 to November, 2006 when it was first listed after acquisition by Chicago Stock Exchange (CSE). The study will make use of log returns calculated from the prices as;

$$r_{coffee,t} = \ln(p_{coffee,t} / p_{coffee,t-1}),$$
$$r_{wheat,t} = \ln(p_{wheat,t} / p_{wheat,t-1})$$
$$and\ r_{maize,t} = \ln(p_{maize,t} / p_{maize,t-1})$$

Where $r_{coffee,t}, r_{wheat,t}, r_{maize,t}$ are the monthly spot logs of return of the coffee, wheat and maize respectively at time, t; $p_{maize,t}, p_{wheat,t}, p_{coffee,t}$ are the current spot prices of maize, wheat and coffee respectively at time, t and $p_{maize,t-1}$, $p_{wheat,t-1}$, $p_{coffee,t-1}$ are the previous spot prices of maize, wheat and coffee respectively i.e. at time t-1.

To model the persistence of volatility before and after the introduction of the commodity exchange in Ethiopia (i.e. before and after April, 2008) GARCH (1, 1) model will be applied as per [23] to allow for conditional variance to vary with time with unconditional variance remaining constant and EGARCH (1, 1) as per [24] to capture leverage effect of volatility. GARCH (1, 1) is applicable as it captures clustering behavior of volatility incorporating presence of heteroskedasticity in the series [25]. It is also able to account for skewness and leptokurtosis in the series [26].

3.2.1. GARCH (1, 1)

Before estimating any GARCH equation, tests for stationarity and ARCH effect should first be conducted to ensure the appropriateness of the approach. Stationarity ensures correct forecast values while presence of ARCH effect necessitates use for GARCH family models to account for clustering, leptokurtosis and heteroskedasticity in the series.

3.2.1.1. Stationarity Test

Under stationarity, $E(\varepsilon_{t-1}^2) = E(\sigma_{t-1}^2)$, the unconditional variance of ε_t for the standard GARCH (1, 1) can be written as;

$$\sigma^2 = \alpha_0 / 1 - \alpha_1 - \beta_1$$

Where α_0 , α_1 and β_1 are nonnegative values. The stationarity also requires that $\alpha_1 + \beta_1 < 1$. The values of α_1 and β_1 close to unity implies high persistence in volatility [27]. If $\alpha_1 + \beta_1 > 1$ then the volatility is explosive i.e. a shock to volatility today will lead to an even greater volatility tomorrow [28].

Beginning with the early work, after its development by [29], the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) framework has proven to be an extremely robust approach to modeling the volatility of time series data as it allows conditional variance to be dependent on its previous lags [28]. Here, we interpret the current fitted variance, σ_t^2 as a weighted function of an average value α_0, information for the previous period's volatility, $\alpha_1\varepsilon_{t-1}^2$, and the fitted variance of the model in the previous period, $\beta_1\sigma_{t-1}^2$. In the standard GARCH model, forecasts of future variance are linear in current and past variances and the squared returns determine the revisions in the forecasts [30]. As per [27], GARCH models are more parsimonious than the ARCH models since they contain only three parameters thus more likely to hold the no negativity constraints and GARCH (1, 1) is as good as GARCH (p, q) hence the use of GARCH (1, 1).

According to [29] standard GARCH (1, 1) model is given by;

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2 + u \quad (1)$$

Where; σ_t^2 is the conditional variance for period t, ε_{t-1}^2 is the square error term of the previous period, α_1 (ARCH parameter) and β_1 (GARCH parameter) are the regression coefficients and u is the error term and if $\sigma_t^2 > 0$, it implies that the coefficients α_0 , α_1 and β_1 are positive i.e. greater than zero.

As per [31], the coefficient α_1 can be viewed as the "news" coefficient such that an increase (decrease) in the ARCH parameter means that the news is reflected in prices more rapidly (slowly) where α_1 refers to the impact of yesterday's price changes on today's price changes with a greater value implying that recent news has a greater impact on price changes [32]. The β_1 coefficient is the "old news" coefficient or persistence coefficient and an increase (decrease) in its value means that old news has a greater (lower) persistence effect on today's price changes. The sum of the coefficients $\alpha_1 + \beta_1$ determines the short run dynamics of the resulting volatility time series and a large ARCH error coefficient implies that volatility reacts intensely to movements in the market while a huge GARCH error coefficient indicates that shocks to conditional variance are persistent. Where given the sum of these two coefficients is close to unity then volatility shocks are more persistent and if $\alpha_1 + \beta_1 = 1$; (IGARCH) then the persistence of shocks to volatility is permanent [32], if $\alpha_1 + \beta_1 > 1$ then the volatility is explosive i.e. a shock to volatility today will lead to an even greater volatility tomorrow [28].[1]

However, GARCH models has symmetric response of volatility to both positive and negative shocks though it has been empirically found that negative shocks are likely to affect volatility of a financial time series more than positive shocks of same intensity [28].

3.2.2. EGARCH (1, 1)

This extension of the GARCH model was brought forth by [33];

$$\ln\left(\sigma_t^2\right) = \alpha_0 + \alpha_1 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \alpha_2 \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) + \alpha_3 \ln\left(\sigma_{t-1}^2\right) + u. \quad (2)$$

With the use of the log of variance we verify that the conditional variance will be positive even if the parameters are < 0. The α_2 can be seen as the "leverage effect" i.e. presence of the asymmetries and if $\alpha_2 < 0$, then the positive shocks generate less volatility than negative shocks or bad news [27].

3.2.3. UNCONDITIONAL VARIANCE

This is the easiest method for capturing the change on the volatility of the spot market. As [34], we first find the unconditional variance for GARCH (1, 1) model for both the pre-introduction period and the post-introduction period then compare the variance between the two periods. Such that before introduction of futures trading;

$$\sigma_{t,BFT}^2 = \alpha_0 + \alpha_{1,BFT}\varepsilon_{t-1}^2 + \beta_{1,BFT}\sigma_{t-1}^2 + u. \quad (3)$$

And for the post-introduction period;

$$\sigma_{t,AFT}^2 = \alpha_0 + \alpha_{1,AFT}\varepsilon_{t-1}^2 + \beta_{1,AFT}\sigma_{t-1}^2 + u. \quad (4)$$

Where $H_1: \alpha_{1,BFT} = \alpha_{1,AFT}$ and $\beta_{1,BFT} = \beta_{1,AFT}$ or $H_1: \alpha_{1,BFT} < \alpha_{1,AFT}; \beta_{1,BFT} < \beta_{1,AFT}$ are the alternative

[1] In estimating GARCH parameters for pre- and post-futures trading, assumption about the return distribution is made either normal distribution or t-distribution and stationarity test has to be conducted.

hypotheses and the significance tested by employment of the Wald test of equality; BFT represents before futures trading and AFT represents after futures trading.

4. Results and Discussions

Table 1 - Table 5 below are a representation of descriptive statistic for pre and post futures period. The results are analyzed as per the specific commodity i.e. coffee, wheat or maize.

Table 1 is a representation of the mean as one of the major descriptive statistics that characterize behavior of the compounded returns in terms of distribution. From the table, in the post futures period, the average return for coffee has reduced for both ECX and SAFEX as per the study's expectations implying a reduction in the average prices for coffee in these exchanges except for NYMEX. For maize and wheat, the average return has increased for both SAFEX and NYMEX implying an increment in the price of the commodity at these exchanges except for ECX where a reduction in maize prices has been witnessed.

Table 2 is a representation of the standard deviation as the other parameter that characterize the returns for maize, wheat and coffee. From the table, the standard deviation has decreased for NYMEX and SAFEX except for ECX after the introduction of the futures trading for coffee implying a reduction in spot price volatility as expected from first null hypothesis. However, for both maize and wheat, the standard deviation has increased in all the exchanges after the introduction of futures trading implying an increase in spot price volatility with futures trading which is against the study's expectations.

Table 3 is representation of the level of skewness observed from the log returns over the two periods. For coffee and maize, the skewness has reduced for all the exchanges in the post-futures trading period implying a reduction in asymmetry of probability distribution of the log returns about the mean except for wheat.

Table 4 represents the kurtosis output of normality test and from the table it is evident that for coffee, the value of kurtosis is more than 3 for both NYMEX and SAFEX for pre-futures period and within value of three for all the exchanges in the post period this means that the distribution has actually been normalized after the introduction of the futures trading for coffee. For maize and wheat, the values have been more than 3 for all the commodities across the 3 exchanges for both pre and post periods hence no impact on the distribution of returns with futures trading.

Table 5 is a representation of the Jargue bera test of normality. For all the commodities i.e. coffee, wheat and maize, the Jargue bera test rejects the null hypothesis of normality as the p-values are less than 0.05 which is as per expectations. Where * is significance at 1% level; ** at 5% level; *** at 10% level.

Table 1. Mean-Normality Test

MEAN	PRE-FUTURES			POST-FUTURES		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	-0.0024	0.0134	0.0114	0.0035	-0.0010	0.0099
MAIZE	0.0009	-0.0018	0.0087	0.0014	0.0027	0.0049
WHEAT	0.0006	-0.0005	0.0089	0.0035	0.0042	0.0084

Table 2. Standard Deviation-Normality Test

STD DEVIATION		PRE-			POST-		
		NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
STD DEV.	COFFEE	0.0729	0.0838	0.0141	0.0529	0.0638	0.0397
	MAIZE	0.0534	0.0397	0.0943	0.0741	0.0744	0.1081
	WHEAT	0.0477	0.0479	0.0588	0.0819	0.0608	0.0628

Table 3. Skewness-Normality Test

SKEWNESS	PRE-			POST-		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	0.5201	1.7166	-0.5977	-0.0972	0.1414	-0.0606
MAIZE	-0.1749	-0.2849	0.7734	-0.2052	-0.6243	-1.7518
WHEAT	0.1593	-0.0883	0.1409	0.4658	-0.1452	0.2455

Table 4. Kurtosis-Normality Test

KURTOSIS	PRE-			POST-		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	6.0384	8.1042	3.0018	3.9619	3.6218	2.9118
MAIZE	7.6191	3.8627	6.8628	4.2964	7.3930	10.7795
WHEAT	4.0669	2.4385	5.2940	4.1613	3.9138	4.2132

[Table 6](#) shows the conditional variance represented by standard deviations from ML-ARCH test for both pre- and post-futures trading periods for coffee, maize and wheat at NYMEX, SAFEX and ECX. For coffee, there has been a reduction in the conditional variance in the post-futures period in all the three exchanges while for wheat and maize, the conditional variance has increased after the introduction of the futures trading in all the three commodity exchanges. Where *, ** and *** is significance at 1%, 5% and 10% respectively.

The figures below are representations of conditional standard deviation from the table above with the vertical line dividing the whole period into pre- and post-futures periods.

Table 5. Jargue Bera-Normality Test

JARGUE BERA	PRE-			POST-		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	137.9506 (0.0000)	100.9073 (0.0000)	5.8346 (0.0000)	3.6579 (0.1611)***	4.5302 (0.1038)**	0.0589 (0.1100)***
MAIZE	287.0115 (0.0000)	2.85049 (0.2405)***	70.6990 (0.1980)***	7.0111 (0.0300)*	202.491 (0.0000)	181.989 (0.0310)*
WHEAT	16.58236 (0.0002)	0.9239 (0.0630)**	21.8122 (0.4532)***	8.4045 (0.01496)*	8.9251 (0.0115)*	4.5676 (0.0000)

Table 6. Conditional Variance

COND. VARIANCE (σ_t^2)	PRE-			POST-		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	0.0729 (0.1403)**	0.0838 (0.4058)***	0.0415 (0.0172)*	0.0529 (0.5887)***	0.0638 (0.7611)***	0.0397 (0.2220)***
MAIZE	0.0534 (0.5225)***	0.0404 (0.7977)***	0.0922 (0.6535)***	0.0741 (0.9190)***	0.0744 (0.3492)***	0.1081 (0.3058)***
WHEAT	0.0477 (0.7647)***	0.0480 (0.8962)***	0.0570 (0.0002)	0.0820 (0.6399)***	0.0608 (0.2871)***	0.0628 (0.3037)***

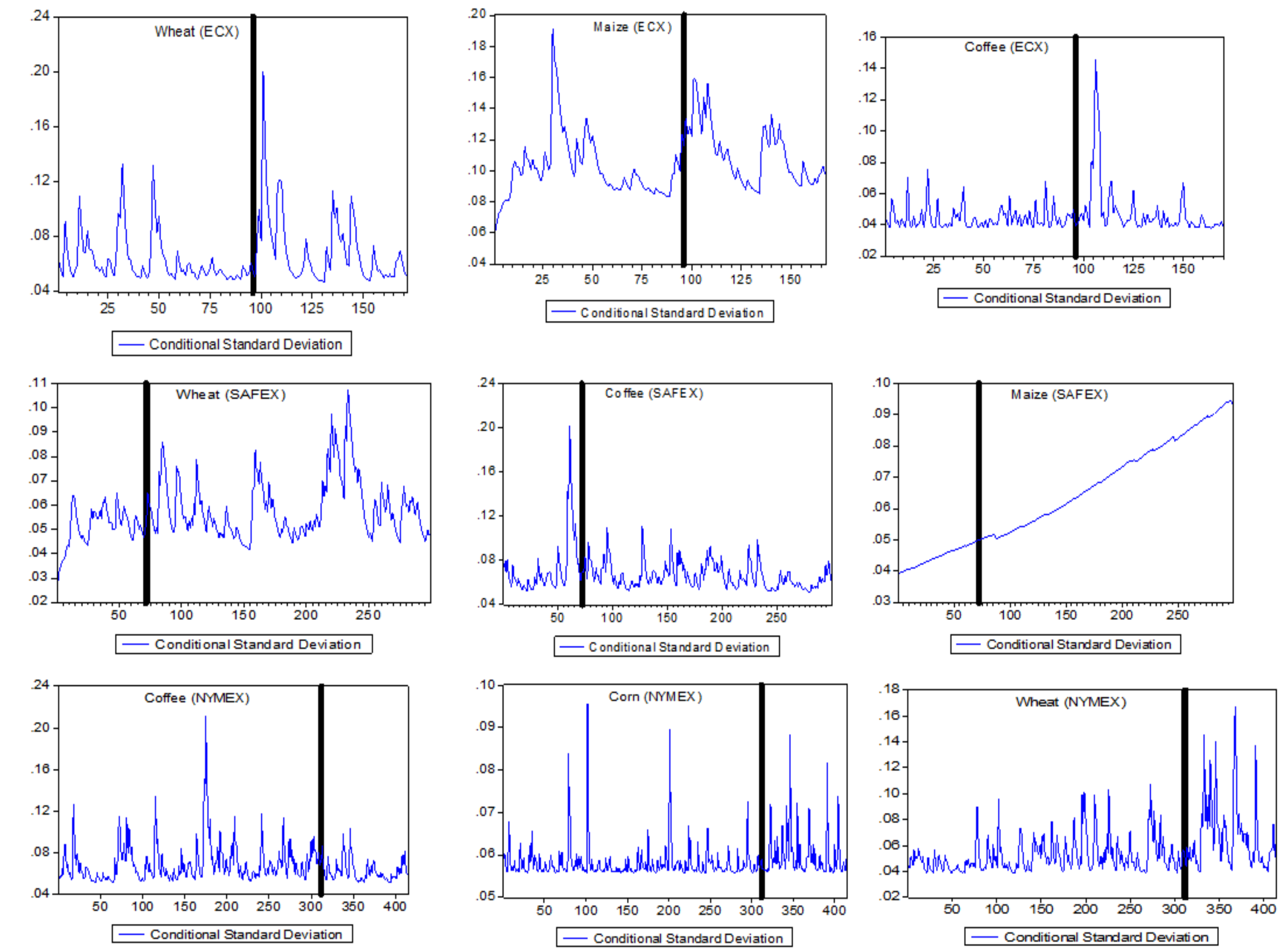

Figure 5.

Table 7. Unconditional Variance

UNCOND VARIANCE	PRE-			POST-		
	NYMEX	SAFEX	ECX	NYMEX	SAFEX	ECX
COFFEE	0.0055	0.0154	0.0017	0.0034	0.0042	0.0016
MAIZE	0.0029	0.0016	0.0139	0.0056	0.0062	0.0016
WHEAT	0.0024	0.0034	0.0039	0.0079	0.0038	0.0035

Table 7 is a representation of the unconditional variance from stationarity test of the GARCH model for both pre- and post-futures trading periods for coffee, maize and wheat at NYMEX, SAFEX and ECX given by $\sigma^2 = \alpha_0 / 1 - \alpha_1 - \beta_1$. For coffee, there has been a reduction in the variance after the introduction of futures trading. For wheat and maize, except for ECX, there has been an increase in the variability in the post-futures period.

Table 8-Table 10 are representations of the variance equation of the EGARCH model for both pre- and post-futures trading periods for coffee, wheat and maize at NYMEX, SAFEX and ECX.

Coffee: In the pre futures period, volatility is significantly sensitive to market events for NYMEX and SAFEX. In the post futures period, volatility is significantly sensitive to market events for all the exchanges. This implies that volatility of ECX became significantly sensitive to market news after the introduction of futures trading. In pre futures period, the good news has greater impact on volatility for NYMEX as compared to bad news which disappeared in the post-futures period. In pre futures period, bad news has a greater impact on the volatility for ECX as compared to the good news which became significant in the post period. The persistence of volatility has increased for both SAFEX and ECX except for NYMEX. Where * and ** is significance at 5% and 10%.

Maize: In the pre futures period, volatility is significantly sensitive to market events for NYMEX and ECX. In the post futures period, volatility is significantly sensitive to market events for only SAFEX. This implies that volatility for SAFEX became significantly sensitive to market news after the introduction of futures trading and insensitive to market news for NYMEX and ECX. In pre futures period, the good news has greater impact on volatility for SAFEX and ECX as compared to bad news which disappeared in the post-futures period for ECX. In pre futures period, bad news has a greater impact on the volatility for NYMEX in both the pre and the post periods. The persistence of volatility has decreased for both NYMEX and ECX except for SAFEX. Where * represents significance at 1%; ** significance at 5%; *** significance at 10%.

Wheat: In the pre futures period, volatility is significantly sensitive to market events for NYMEX and SAFEX. In the post futures period, volatility is significantly sensitive to market events for all the exchanges. This implies that volatility of ECX became significantly sensitive to market news after the introduction of futures trading. In pre futures period, the bad news has greater impact on volatility for all the exchanges as compared to good news which became significant in explaining volatility in the post-futures period for NYMEX and SAFEX. The persistence of volatility has increased for both SAFEX and ECX except for NYMEX. Where * is at 1%; ** at 5%, *** at 10%.

Table 8. EGARCH Variance Equation for Coffee

COFFEE	C(2)		C(3)		C(4)		C(5)	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
NYMEX	-2.115	-3.237	0.284	0.810	0.163	-0.020	0.643	0.567
	(0.00)	(0.06)**	(0.01)	(0.00)	(0.01)	(0.89)**	(0.00)	(0.05)*
SAFEX	-3.125	-0.923	-0.309	0.219	0.933	0.022	0.421	0.864
	(0.00)	(0.13)**	(0.44)**	(0.08)*	(0.00)	(0.73)**	(0.00)	(0.00)
ECX	-7.371	-2.713	-0.320	0.776	-0.340	0.283	-0.185	0.699
	(0.02)*	(0.31)**	(0.31)**	(0.06)*	(0.07)*	(0.22)**	(0.72)**	(0.07)*

Table 9. EGARCH Variance Equation for Maize

MAIZE	C(2)		C(3)		C(4)		C(5)	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
NYMEX	-4.924	-9.227	0.060	0.072	-0.178	-0.362	0.172	-0.733
	(0.03)*	(0.00)	(0.48)***	(0.75)***	(0.02)*	(0.05)*	(0.66)**	(0.00)
SAFEX	-8.682	-0.101	1.275	0.034	0.438	0.120	-0.161	0.785
	(0.00)	(0.01)*	(0.00)	(0.34)***	(0.13)**	(0.00)	(0.41)***	(0.00)
ECX	-0.802	-10.49	0.260	0.035	0.013	-0.293	0.866	-1.040
	(0.19)**	(0.00)	(0.07)*	(0.71)***	(0.90)***	(0.01)*	(0.00)	(0.00)

Table 10. EGARCH Variance Equation for Wheat

WHEAT	C(2)		C(3)		C(4)		C(5)	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
NYMEX	-2.579	-3.619	0.453	0.575	-0.020	0.044	0.636	0.372
	(0.00)	(0.03)*	(0.00)	(0.01)*	(0.75)***	(0.76)***	(0.00)	(0.22)***
SAFEX	-3.532	-0.535	0.956	0.181	-0.030	0.068	0.555	0.930
	(0.04)*	(0.05)**	(0.05)	(0.03)*	(0.91)***	(0.03)*	(0.04)*	(0.00)
ECX	-0.972	-5.496	0.104	0.863	-0.070	-0.524	-0.512	0.156
	(0.00)	(0.00)	(0.00)	(0.01)*	(0.65)***	(0.07)**	(0.00)	(0.59)***

4.1. Conclusion

This study used cross sectional data to examine the impact of futures trading on spot price volatility. It uses log returns gotten from monthly prices of the main agricultural commodities in most exchanges i.e. coffee, maize and wheat to compare the impact of futures trading on different crops in the agricultural sector. It applied ML-ARCH test and EGARCH model to test impact of introduction of futures trading on spot price volatility. The persistence of volatility has increased for both South African and Ethiopian economies in the case for coffee and wheat and decreased for both US and Ethiopia for maize.

From the results, it is evident that there has been a reduction in persistence of volatility in the post-futures period for all the three commodities in the US economy as shown by the NYMEX. This could be explained by the fact that Africa-based futures exchanges have been unable to attract significant trading volumes and open interest and besides, their role has been limited to providing information and standardized regulation. Moreover, with notable exception of South Africa, Ethiopia, commodity markets are small and highly informal [35] thus impeding development of both liquid spot markets and futures markets. Moreover, failure of farmers to deliver the good upon maturity of the contract has also been a major contributor of destabilizing spot prices in this sector.

4.2. Robustness Checks

With change of the data from use of monthly to daily and yearly spot prices for both South African and US economies; the results are more less the same with reduction of price volatility in the post futures period in US and an increase in the South African economy for all the three commodities. However, the persistence in volatility in the post futures period gives a positive feedback for both economies for the three commodities thus we could assume the results from monthly data are robust.

4.3. Policy Implication for East Africa Community

Given the small sizes of commodity markets in the five east African countries, developing a regional market has been an optimal move. Moreover, governments of involved countries should offer incentives to state institutions to hedge and channel their hedging operations to this regional market to boost trading volumes of futures contracts. For coffee, we have witnessed a reduction in the standard deviation/variance after the onset of the futures trading except for at least all the futures exchanges. However, this could be as a result of the low trading volumes witnessed in both maize and wheat contracts relative to that of coffee with huge trading volumes and open interest. Nonetheless, this could be as result of food crisis of 2007-08 which saw volatile prices for wheat and maize doubling by May, 2011.

Moreover, with the effectiveness of index-based crop insurance, governments in less developed countries should take initiative to ensure complete provision of insurance services to protect farmers against the yield risk.

4.4. Area for further Studies

To determine the effect of futures trading on spot price volatility for the three or more commodities after testing for these markets' efficiencies and even determining the level of integrations between the two markets.

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