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Article · September 2016

DOI: 10.5958/2322-0430.2016.00157.8

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Indian Journal of Economics and Development

Volume 12 No. 3
July-September, 2016

Print ISSN 2277-5412
Online ISSN 2322-0430

Reprint

Society of Economics and Development
www.soed.in

www.soed.in

Indian Journal of Economics and Development
Volume 12 No. 3: 421-430
July-September, 2016
DOI: 10.5958/2322-0430.2016.00157.8

Effect of Futures Trading on the Volatility of Cluster Beans Prices in Rajasthan

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Received: December 17, 2015 *Accepted: July 20, 2016*

ABSTRACT

The study assessed effect of futures trading on cluster beans price volatility in selected three markets of Rajasthan during the period of 2003-2015 using symmetric GARCH (1,1), and asymmetric EGARCH (1,1) and TGARCH (1,1) models. The results indicate futures trading have significant effect in reducing cluster bean prices volatility in various selected markets of Rajasthan. In addition, averagely among the three cluster beans selected markets in Rajasthan, prices in Anoopgarh showed lower volatility according to the models used compared to Sri Ganganagar. However, Hanumangarh showed the highest price volatility from shocks. The persistence of shocks was however longer in Sri Ganganagar market compared to Anoopgarh with the lowest persistence of shocks on volatility recorded in Hanumangarh. The results further show asymmetric effect of prices volatility whereby cluster bean market prices respond with much more volatility to unexpected increases in prices (good news) than it does to decreases in prices (bad news).

Keywords

GARCH, ARCH, EGARCH, TGARCH, cluster beans, volatility, Rajasthan.

JEL Codes

C81, C82, E37, E65, Q13.

INTRODUCTION

Guar or cluster bean is basically a crop that is cultivated mostly in the arid and semi-arid areas as it is drought resistant. The world's total production of guar is approximately 20-25 lakh tonnes every year. India is the largest producer of guar and contributes about 80 percent of total guar and guar gum production in the world. Guar gum is an important ingredient in producing food emulsifier, food additive, food thickener and other guar gum products. Guar gum a product from cluster bean is purely an export oriented commodity with about 80 percent of total output exported from the country (NCDEX, 2013). India exports over 117000 tonnes of guar and its derivatives, which comprises of 33000 tonnes of refined split guar gum, and 84000 tonnes of treated and pulverized guar gum (Bannor and Melkamu, 2015) with net worth of the Indian exports estimated over ₹500 crores (Anonymous 2014 and 2015). The crop now accounts for around 18 percent of India's total agricultural exports (DGCIS and APEDA, 2012-13). The average production of guar seed in India for the last five years was 17 lakh tonnes and it is established that production fluctuates mainly due to variation in rainfall. Rajasthan State in the country alone, contributes about 70 percent of India's total production. In the state presently, guar production is done mainly in Sri Ganganagar, Churu, Bikaner, Jaisalmer, Barmer, Nagaur, Hanumangarh, Jodhpur, Jaipur, Sirohi, Dausa, Jhunjhunu and Sikar (APEDA, 2011 and Anonymous, 2014).

Agricultural commodities are highly susceptible to price volatility because of the nature of the production and marketing cycle of which cluster bean is of no exception. Cluster beans if not the highest volatile leguminous crop, is rather, among the most volatile leguminous crops in India, even though, it is widely agreed among researchers and policy makers that, high price volatility makes it difficult for producers to plan production since they do not know in advance how prices will be. In addition, it leads to low interest in production of the specific crop; decrease in marketing efficiency of the specific crop which consequently affect the livelihood of farmers and various value chain actors who have their source of livelihood from production and marketing of the crop.

To stabilise prices of high volatile crop like cluster beans, promote advance price discovery and also increase the marketing efficiency subsequently, the Government of India, enlisted cluster beans on the agricultural futures exchanges in 2004. However, quite uncharacteristically, prices of cluster beans soared up in 2012 by approximately 230 percent (Bannor and Melkamu, 2015). This skyrocked prices of cluster beans in 2012 according to some analysts and the public was caused by the excess speculation in commodity futures trade, which became an issue of concern for the government of India. In response to the public outcry against futures trading or markets of cluster beans and its perceived role in causing astronomical price increases of the crop, on March 2012, the FMC, at the suggestion of the Government of India, de-listed cluster beans from trading on futures exchanges. However, years later, the Government again, in May 2013, enlisted cluster beans on agricultural commodity futures trading. Whether cluster bean price volatility was due to future trading or not remains an important question that is left answered empirically, hence this research seek to identify the effect of futures trading on the volatility of cluster bean prices over the period cluster bean was enlisted, delisted and subsequently up to this day it still remains enlisted on the commodity futures.

METHODOLOGY

Sources of Data

The secondary data used for this study was sourced from www.agmarkweb.dacnet.nic.in, NCDEX, and NIAM reports on futures trading. Data set of three markets namely Sri Ganganagar, Anoopgarh, and Hanumangarh of Rajasthan were sourced, covering monthly cluster bean prices from January 2003 to September 2015. The markets selected are among the highest arrivals and important trading markets of cluster beans (guar) in Rajasthan.

Method of Data Analysis

Augmented Dickey Fuller Tests (ADF) test and Phillips Perron test were used for the stationarity tests whereas GARCH (1, 1), EGARCH (1, 1) and TGARCH (1, 1) were used to model the effect futures trading on cluster bean price volatility in the study area.

Unit root test

To model the effect of futures trading on volatility of cluster bean prices in selected markets of Rajasthan it was essential to test for unit root and identify the order of stationarity, denoted as 1(0) or 1(1). This was necessary to avoid spurious and misleading regression estimates. The framework of ADF methods is presented as:

$$\Delta p_t = \alpha + \beta p_{t-1} + \gamma T + \Sigma_{k=1}^{p} \delta_k \Delta_{t-k} + U_t ......(1)$$

Here, p_t is the cluster beans price series being investigated for stationarity, Δ is first difference operator, T is time trend variable, m_t represents zero- mean, serially uncorrelated, random disturbances, k is the lag length; a,b, g, and d_k are the coefficient vectors. Unit root tests were conducted on the b parameters to determine whether or not each of the cluster bean market series is more closely identified as being I(1) or I(0) process (Bannor and Sharma, 2015a, Bannor and Kobina, 2014, and Bannor and Sharma 2015b). Phillips Perron test used in addition to Augmented Dickey Fuller (ADF) to assess unit root or otherwise of the cluster bean price series.

Generalised Autoregressive Conditional Heteroscedasticity (GARCH) Models

Cluster bean price volatility is modelled in this study using Autoregressive Conditional Heteroskedasticity (ARCH)-type models such as the Generalised Autoregressive Conditional Heteroskedasticity (GARCH), Threshold Generalised Autoregressive Conditional Heteroskedasticity (TGARCH) and Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH). The goal of ARCH/GARCH model is actually to provide a volatility measure, such as the standard deviation or coefficient of variation, which can be used for making decisions concerning risk and derivative pricing (Engle, 2001). ARCH/GARCH models consider the variance of the current errors to be a function of the actual size of the previous errors. Enders (2004) explains that since the conditional heteroskedasticity of (ε_t) in equation (2) will result in heteroskedasticity in (y_t), ARCH-type models are able to explain periods of volatility and tranquillity. Thus, because of the presence of heteroscedasticity in the error term, ARCH-type models have an advantage over other volatility measuring mechanisms such as standard deviation and coefficient of variation (Mofya-Mukuka, 2011).

Converse to the homoscedasticity assumption in most linear models, ARCH/GARCH models are based on the expectation that not all data have all error term values that are the same at any given time. Especially for agricultural commodities like cluster bean prices that rely on external markets and heavily under rain fed production, the variance of the error term is not likely to be constant over time. In this case a problem would arise as heteroskedasticity or data in which the variances of the error term are not equal, resulting in errors and confidence intervals estimated by least squares being narrow, giving false sense of precision (Engle, 2001). To avoid this problem, ARCH models treat heteroskedasticity as a variance to be modelled. In this way, the deficiencies of least squares are corrected and a prediction is computed for variance of each error.

The basic ARCH-type model is the ARCH model itself and is composed of two equations, which are estimated simultaneously. The first equation is the conditional mean equation which describes the expected value of the stochastic process *(y_t)*. It is assumed that the price series of cluster beans in Rajasthan (is stationary with constant variance. The second equation is the conditional variance equation and the variance is assumed to be heteroscedastic. Since volatility is unobservable characteristic of a series, a proxy is chosen for it, which is the variance:

$$y_t = x_t + \varepsilon_t \text{ where } \varepsilon_t \mid \psi_{t-1} \approx N(0,\sigma_t^{\,2})\text{...... (2)}$$

$$\sigma^2{}_t = \omega + \sum_{i=1}^{p}\alpha_i\varepsilon^2_{t-1}\text{.......... (3)}$$

While in the ARCH model, the conditional variance depends on the squared residuals of the last period, in the GARCH model the conditional variance term will depend upon the lagged variances as well as the lagged (squared) residuals. This allows for persistence in volatility with a relatively small number of parameters. Presence of ARCH effects does not imply absence of GARCH effects. ARCH effects indicate presence of autocorrelation, such that, high order models are required. To evade such misspecification, volatility is better modelled using GARCH models, which combines the ARCH (q) and variance (p) equation into a non-linear ARMA (p,q) process presented as:

$$\sigma^2{}_t = \omega + \sum_{i=1}^{p}\alpha_i\varepsilon^2_{t-1} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-1}\text{...... (4)}$$

Equation (4) has been extended in equation 5 to allow for inclusion of dummy variable to incorporate breaks in the variance equation. The exogenous regressor represented by FT is futures trading. Where one (1) is when there was no futures trading of cluster beans or guar in India and zero (0) represents when there was future trading of cluster beans in the country. Taken, the prices of cluster beans of the various selected markets in Rajasthan, from January 2003- to March 2004, there was no future trading of guar and associated products. Again, future trading of cluster beans was suspended by the government from March 2012 to May 2013. Those periods also indicate no future trading of cluster beans.

$$\sigma^2{}_t = \omega + \sum_{i=1}^{p}\alpha_i\varepsilon^2_{t-1} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-1} + \delta FT\text{...... (5)}$$

If there are no GARCH effects the sum of the coefficients should be equal to zero:

$$\sum_{i=1}^{p}\alpha^2_{t-i} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-i} = 0\text{...... (6)}$$

In that case, the long run variance will be $w=s^2$. Since variance is strictly positive, sufficient conditions to ensure non-negativity are; $w>0$, $w\geq 0$, and $b\geq 0$.

Where i=1, 2,….., p If Equation 7

$$\sum_{i=1}^{p}\alpha_i\varepsilon^2_{i-1} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-i} < 1\text{...... (7)}$$

It means, volatility is stationary, that is, any shocks to the system will dissipate or vanish over time. But if Equation 8:

$$\sum_{i=1}^{p}\alpha_i\varepsilon^2_{i-1} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-i} \geq 1\text{...... (8)}$$

It suggests, the shocks will accumulate or persist over time. On the other hand, if Equation 9 is revealed, it means the shocks will persist indefinitely such that arbitrage will not be able to adjust the level of volatility to long run equilibrium:

$$\sum_{i=1}^{p}\alpha_i\varepsilon^2_{i-1} + \sum_{i=1}^{p}\beta_i\sigma^2_{t-i} = 1\text{...... (9)}$$

It should be noted that, due to nonlinearity of most time series data, ARCH/GARCH models are estimated using the maximum likelihood procedure.

A challenge facing the ARCH/GARCH model is the implication that positive and negative residuals have a symmetric impact on the conditional variance. That is, GARCH models assume that good and bad news have the same effect on volatility, an assumption which is often violated (Black, 1976). This is because most time series data exhibit asymmetric behaviour than symmetric behaviour as suggested by the ARCH/GARCH models (Mofya-Mukuka, 2011). To deal with the problem of asymmetric nature of most time series, asymmetric models which are extension of ARCH/ GARCH models have been developed. Notable among them is the Threshold Generalised Autoregressive Conditional Heteroskedasticity (TGARCH), Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH) just to mention a few. Threshold GARCH model adopted in the study is specified as:

$$\sigma^2_t = \alpha_0 + \sum_{i=1}^{p}\alpha_i\varepsilon^2_{i-1} + \sum_{i=1}^{p}\lambda_i\varepsilon^2_{t-i}d_{t-1} + \sum_{i=1}^{q}\beta_i\sigma^2_{i-1} = 1\text{.... (10)}$$

where l_i is the parameter capturing asymmetric effects in the model such that tests for asymmetry include a test of all l_i. If the l_i is statistically different from zero, the data contain a threshold effect. Equation 11 shows, Equation 10 with the inclusion of the exogenous dummy variable of futures trading.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p}\alpha_i\varepsilon_{i-1}^2 + \sum_{i=1}^{p}\lambda_i\varepsilon_{t-i}^2 d_{t-1} + \sum_{i=1}^{q}\beta_i\sigma_{i-1}^2 + \delta FT{=}1....(11)$$

The threshold in this case is e_{t-1}= 0 such that the effects of the shocks greater than the threshold will be different from those below the threshold. is an indicator function for e_{t-1} such that when e_{t-1} is negative and when e_{t-1} is positive. That means that negative values of e_{t-1} tend to increase the variance more than positive values. This is because the effect of the shock on the variance when is negative and will be a_i, g_i but when e_{t-1} is positive and the effect will be only the a_i,. Therefore a positive value of g_i means that a past negative return has a larger impact on conditional volatility than a past positive return of the same amplitude-a situation commonly referred to as leverage effect (Enders, 2004).

In addition to the GARCH and TGARCH, Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH) proposed by Nelson (1991) was also used in modelling the effect of futures trading on volatility of cluster bean prices in Rajasthan. This model, allows also for asymmetric effects to be captured also. The specification for conditional variance with inclusion of futures trading is presented as:

$$log\,\sigma_t^2 = \omega + \sum_{i=1}^{q}\beta_i\, log(\sigma_{t=1}^2) + \sum_{i=1}^{p}\alpha_i\left|\frac{u_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r}\lambda_k\frac{u_{t-k}}{\sigma_{t-i}} + \delta FT = 1.... \qquad (12)$$

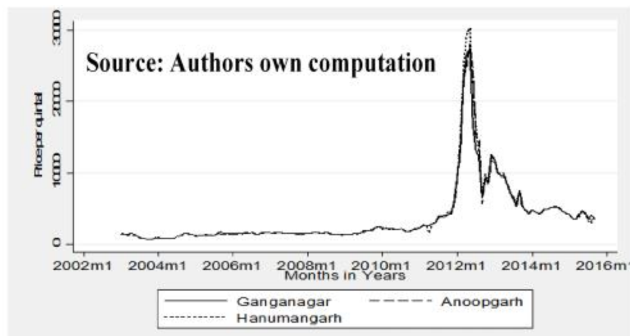
When is positive (good news), the total effect of is (1+l); however when is negative (bad news), the total effect of u_{t-1} is (1-l)$|u_{t-1}|$. The EGARCH is covariance stationary provided $\sum_{i=1}^{q}\beta_i<1$ (Zivot, 2009).

RESULTS AND DISUSSIONS

The results from Figure-I shows the trend of cluster bean prices in three markets of Rajasthan from January 2003 to September 2015. Cluster bean prices has been fairly steady from 2003 up to 2011. Figure-I indicates an astronomical increase in the price of cluster bean in the year 2012. The high prices in 2012 agrrees with Anonymous (2014); Bannor and Melkamu (2015) who argued that highest fluctuation in prices of cluster beans or guar was observed in the year 2012. Commenting on the high prices in 2012, Bannor and Melkamu (2015) argued that, the world demand for guar gum skyrocketed in 2012 and the price of guar increased by approximately 230 percent and even more, mainly because of increased oilfield shale gas demand. The value of guar gum exports according to them, to the United States rose nearly to a billion dollars in 2011 and subsequently to $3.4 billion in 2012 which put pressure on the domestic prices of cluster bean in India. Consequently, there was about 75 percent jump in exports from India during 2012. The same quantity in value terms was more than 81 percent. Also, figure one shows a downward fall in the price of cluster beans after 2012. Assigning reasons, Bannor and Melkamu (2015) argued that, downward movement could be attributed to the sharp decrease in demand from $3.4 billion in 2012 to $1.6 billion in 2013 of cluster beans (guar).

From Table 1, the skewness of the data set are not normally distributed as the skewness value ranges from 1.01 to 1.07 for the three cluster bean market prices.

Figure-I: Trend in prices of cluster bean in sample markets



Thus, the skewness is not zero, which means, all of the selected market cluster bean market prices in Rajasthan are not symmetric. The skewness therefore gives an indication that, asymmetric models will be the best as it were to analyse the cluster bean prices in Rajasthan. The kurtosis value of 3.4-3.6 shows the data set are near to the below expected value of 3 for normal distributed data. The positive kurtosis indicates heavier tails and a higher peak than the normal or extreme prices of cluster beans in the various markets (a phenomenon called 'leptokurtosis'). This was expected because of the clustering volatility of the data set which is a type of heteroskedasticity and it is responsible for excess kurtosis (fat tails). The minimum price of cluster bean in the

Table 1: Descriptive statistics of cluster beans price series, 2003-2015 (N=153)

(₹q[-1])

Markets	Ganganagar	Anoopgarh	Hanumangarh
Mean	3658.882	3695.176	3787.373
SD	4283.014	4500.295	4787.113
Minimum	793.5	772.89	649.088
Maximum	27431	28077.69	30343.08
Kurtosis	3.425702	3.503356	3.625019
Skewness	1.007184	1.029832	1.065578

Source: Authors own computation.

selected markets is ₹649.088 per quintal in Hanumangarh market whereas the maximum price was ₹30343.080 in the same market. It is therefore not surprisingly Hanumangarh market exhibit the highest price volatility among the studied markets.

Figure-IIa to II-c shows gives evidence of heteroskedasticity given that the variance is not the same over time. The results reveal cluster bean price series is not constant through time; periods of relatively low volatility and periods of relatively high volatility tend to be grouped together. From 2003 to 2011, all the residuals of the selected market price series show period of low volatility, however, later part of 2011 to 2013 also show high volatility in the residuals. Again, from 2014 to 2015 shows low volatility of price series cumulatively indicating a phenomenon called clustering volatility; a condition for the application of ARCH and GARCH model.

The Prob>χ^2 of the ARCH test results reveal ARCH effects in all the price series as shown in Table 2. The results further indicate that Hanumangarh has the highest volatility of cluster bean prices over the observed period with Anoopgarh having the second highest volatility in the price series. However, Sri Ganganagar prices are less volatile than the two selected cluster bean markets in Rajasthan. The volatility is significant in all series, an implying presence of heteroskedasticity indicating again, GARCH models can then be applied to examine volatility. To estimate persistence, symmetric and asymmetric effects of price shocks on volatility for the various cluster bean markets, GARCH (1, 1), EGARCH (1,1) and TGARCH(1,1) were employed. The value of α parameter (the ARCH component of the model) in equation (5), which is the sum of squared residuals, measures the impact of price shocks on volatility. The variance parameter β (the GARCH component of the model) and the exponential and threshold parameter λ show persistence and asymmetry of the price shocks respectively. Generally, the two conditions of clustering volatility and presence of ARCH effect is clear in the price series of cluster bean from the selected markets paving the way for the application of ARHCH and GARCH models and its extensions such EGARCH and TGARCH.

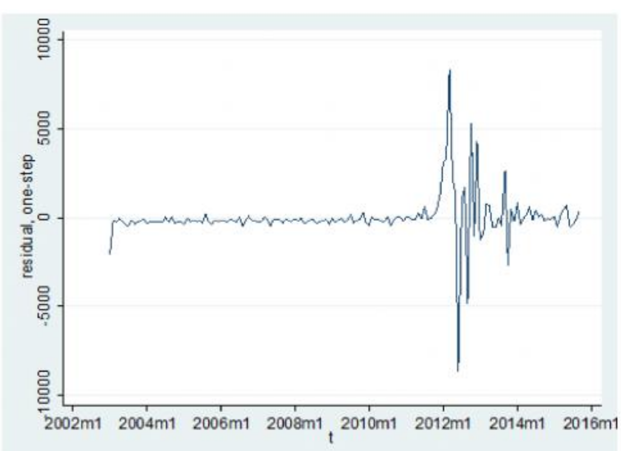


Figure-IIa: Sri Ganganagar Residuals

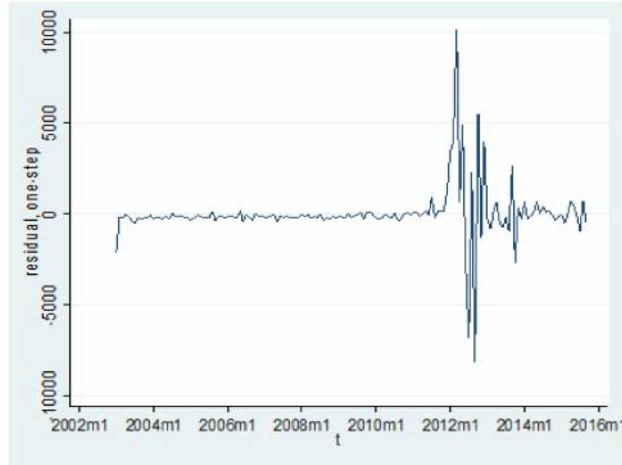


Figure-IIb: Hanumangarh residuals

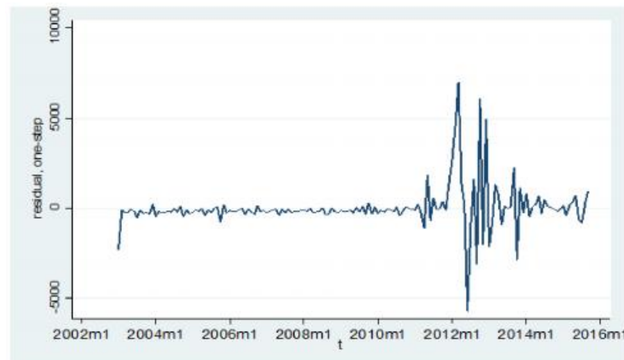


Figure-IIc: Anoopgarh residuals

H_o: variables are not stationary or has unit root, Ln= natural log

H_1: Variables are stationary or does not have unit root

NB: If the absolute value of ADF and PP Test Statistics is less than their 5 percent critical value we accept null hypothesis. It is also when the MacKinnon approximate p-value for Z(t) is insignificant.

Table 2: ARCH test results

Markets	χ^2	**Prob>χ^2**
Sri Ganganagar	3.434	0.0639*
Anoopgarh	8.171	0.0043***
Hanumangarh	12.99	0.0003***

Source: Authors own computation

H0: No ARCH affects. H1: ARCH (p) disturbance

****** and * denote significant at 1 and 10 level, respectively.***

After the data has been transformed into natural logs, the researchers then examined each market price series for evidence of non-stationarity in order to precede with the ARCH and GARCH modelling. From Table 3, at level 0, all the selected cluster bean markets price series in Rajasthan were not stationary. PP test and Augmented Dickey Fuller showed similar results. This means that if the current data is used in the modelling, there is high probability of the results being spurious.

The prices series were first difference and subsequently the Augmented Dickey Fuller and PP test were used to test stationarity of series again. The results in Table 4 show the market price series prices were stationary at first difference.

From Table 5, the results of cluster bean prices shows a and b significant at 1 percent for all the models (GARCH, EGARCH and TGARCH) except in TGARCH where a was significant at 5 percent. The results means that, previous months Sri Ganganagar cluster beans price volatility or price information influences current month, September (the last month price in the series used in the model) in Ganganagar. Again, ARCH component which measures the impact of price shocks on volatility shows that, any shock to the system, triggers 24.3 and 23.4 percent volatility in Sri Ganganagar according to the GARCH and EGARCH models respectively. However, the TGARCH model shows only a minimal shock of 7.4 percent volatility.

On the other hand, the results indicates that, price volatility due to a shock persists for 57, 97, and 89 months before disappearing in Sri Ganganagar cluster bean markets according to the GARCH, EGARCH and TGRACH models respectively.

Furthermore, the results from Table 5 reveal futures trading is significant variable that can explain the volatility of Sri Ganganagar cluster bean prices. In addition, the results reveal that without futures trading of cluster beans (guar), cluster bean prices volatility increases by 0.078 and 1.437 units compared to when there is future trading of cluster bean prices. This shows how guar prices volatility decreases because of future trading.

To capture the asymmetric effect in the price volatility, only the TGARCH model shows an asymmetric effect in the price volatility. The ë value of TGARCH is 0.2896 indicating; cluster bean market prices respond with much more volatility to unexpected increases in prices (good news) than it does to decreases in prices (bad news). This phenomenon is demonstrated graphically in in annexure one titled "News Response of GA (TGARCH)". The graphical presentation clearly shows that good news increases volatility of cluster bean prices than it does to bad news. In other words, positive

Table 3: Unit root testing at level

(CV= -2.887)

Variables	**Price Level 1(0) Intercept with Trend**	
Markets	**ADF Statistics**	**Phillips Perron Test Statistics**
Ln Sri Ganganagar	-1.501	-1.412
Ln Anoopgarh	-1.61	-1.438
Ln Hanumangarh	-1.625	-1.455

Source: Author's computation from price series data analysis
Ho: Variables are not stationary or has unit root,
Ln= Natural log
H1: Variables are stationary or does not have unit root
NB: If the absolute value of ADF and PP Test Statistics is less than their 5% critical value we accept null hypothesis. It is also when the MacKinnon approximate p-value for Z(t) is insignificant.

Table 4: Unit root testing at first difference

(CV= -2.887)

Markets	**First Difference 1 (1) Intercept with trend**	
	ADF Statistics	**Phillips Perron Test Statistics**
Ln Sri Ganganagar	-6.013	-10.500
Ln Anoopgarh	-6.543	-3.493
Ln Hanumangarh	-6.088	-3.493

Source: Author's computation from price series data analysis
Ho: Variables are not stationary or has unit root,
Ln= Natural log
H1: Variables are stationary or does not have unit root
NB: If the absolute value of ADF and PP Test Statistics is less than their 5% critical value we accept null hypothesis. It is also when the MacKinnon approximate p-value for Z(t) is insignificant.

Table 5: Volatility estimates of GARCH, EGARCH, and TGARCH models

Coefficient	GA GARCH	GA EGARCH	GA TGARCH	AP GARCH	AP EGARCH	AP TGARCH	HA GARCH	HA EGARCH	HA TGARCH
Mean model									
Mean model	0.0087	0.0131	0.0161	0.0116	0.0101	0.016	-0.0045	0.0023	0.0008
	-0.359	-0.134	(0.062)*	-0.183	-0.279	(0.044)**	-0.547	-0.813	-0.933
Variance model									
a	0.243	0.2344	0.0737	0.396	0.0196	0.0434	0.4273	0.1327	0.2747
	(0.002)***	(0.000)***	(0.046)**	(0.001)***	-0.875	(0.094)**	(0.001)***	-0.236	(0.028)**
b	0.5721	0.9688	0.8881	0.4761	0.6064	0.8872	0.5507	0.7544	0.558
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
y	-	0.0023	0.2896	-	0.7122	0.3052	-	0.7425	0.3293
		-0.979	(0.000)***		(0.000)***	(0.000)***		(0.000)***	-0.174
Futures trading	0.9327	0.0782	1.437	1.0841	0.6708	1.3438	1.3761	0.3723	1.8966
	-0.129	(0.044)***	(0.012)**	(0.101)*	(0.067)*	-0.181	(0.034)**	(0.063)*	(0.007)***
Constant	-5.9356	-0.1544	-7.626	-5.9186	-1.7351	-8.3749	-6.3297	-1.034	-6.5909
	(0.000)***	(0.039)**	(0.000)***	(0.000)***	(0.017)**	(0.000)***	(0.000)***	(0.041)**	(0.000)***
LL	107.1244	112.8785	-51.8352	106.0293	105.6379	111.18	96.7316	99.8824	97.8159
AIC	-204.2489	-213.757	115.6704	-202.0586	-199.2758	-210.3601	-183.463	-187.7649	-183.6318
BIC	-189.1295	-195.6137	133.853	-186.9392	-181.1325	-192.2168	-168.344	-169.6217	-165.4885

Source: Authors own computation, Where; GA=Sri Ganganagar, AP= Anoopgarh, HA=Hanumangarh and LL=Log likelihood.
The P>|z| are given in brackets.
*******, **, * denote significance at 1, 5, and 10 percent respectively.****

innovations (good news) or unanticipated price increases are more destabilizing to cluster bean prices than negative innovations suggesting that, for risk-averse investors or farmers and other value chain actors; large unanticipated rise in the market price of cluster beans in Sri Ganganagar is more likely to lead to higher volatility than large unanticipated decrease.

Moving ahead, the results from Table 5 further reveal a and b significant are 1 and 10 percent for GARCH and TGARCH respectively in Anoopgarh cluster bean market. The results again shows that, previous months Anoopgarh cluster beans price volatility or price information influences current month, September (the last month price in the series used in the model) in Anoopgarh. Further, any shock to the system, triggers 39.6 and 4.34 percent volatility in Anoopgarh market.

On the other hand, the results shows that, price volatility due to a shock persists for 47, 61, and 89 months before disappearing in Anoopgarh cluster bean markets according to the GARCH, EGARCH and TGRACH models respectively.

Moreover, the results reveal futures trading is significant variable that can explain the volatility of Anoopgarh cluster bean prices. In addition, the results reveal that without futures trading of cluster beans (guar), cluster bean prices volatility increases by 108 and 67.1 percent compared to when there is future trading of cluster bean prices. Furthermore, both EGARCH and TGARCH model show an asymmetric effect in the price volatility in Anoopgarh cluster bean prices. Both EGARCH and TGARCH reveal cluster bean market prices respond with much more volatility to unexpected increases in prices (good news) than it does to decreases in prices (bad news). From the figures in annexure one dubbed "News Response of AP (TGARCH)" indicates clearly good news causes more volatility than bad news. On the other hand, the EGARCH model dubbed "News Response of AP (EGARCH)", shows a little bit of volatility under bad news however good news again as shown in the figure clearly has more destabilising effect on price volatility of guar prices in Anoopgarh market than bad news.

Additionally, the results from table 5 indicate previous months Hanumangarh cluster beans price volatility or price information influences current month, September (the last month price in the series used in the model) in Hanumangarh. Further, any shock to the system, triggers 43.7 and 27.5 percent volatility in Anoopgarh market according to GARCH (1, 1) and TGARCH (1, 1) models respectively.

Also, the results shows that, price volatility due to a shock persists for 55, 75, and 58 months before disappearing in Hanumangarh cluster bean markets according to the GARCH, EGARCH and TGRACH models respectively.

Again, the results reveal futures' trading is significant variable that can explain the volatility of Hanumangarh cluster bean prices. The results reveal that without futures trading of cluster beans (guar), cluster bean prices volatility increases by 137.6 and 37.2, and 189.7 percent compared to when there is future trading of cluster bean prices. Furthermore, only EGARCH showed an asymmetric effect in the price volatility in Hanumangarh cluster bean prices. Again like other markets, the results reveal cluster bean market prices respond with much more volatility to unexpected increases in prices (good news) than it does to decreases in prices (bad news). The graphical representation again in annexure under the title "News Response of HA (EGARCH)" shows that positive asymmetry dominates the shape of the news response function. In fact, the response is a monotonically increasing function of news. The form of the response function shows that only positive, unanticipated price increases have the destabilizing effect which is observed as larger conditional variances in the graph.

Lastly, based on the least absolute values of the log likelihood, AIC and BIC, the results show TGARCH (1,1) was the best in modelling volatility in Sri Ganganagar whereas EGARCH (1,1) was best in Anoopgarh price volatility modelling and GARCH(1,1) was best in modelling Hanumangarh cluster bean price volatility. Generally, TGARCH (1,1) shows robustness in modelling of the effect of futures trading on cluster bean price volatility in Rajasthan.

CONCLUSIONS AND RECOMMENDATIONS

The research has identified futures trading has significant effect in reducing cluster bean prices volatility in various selected markets of Rajasthan. In addition, previous months cluster beans price volatility or price information of the various markets influence their current month price volatility. Averagely among the three cluster beans selected markets in Rajasthan, prices in Anoopgarh showed lower volatility according to the models used compared to Sri Ganganagar. However, Hanumangarh showed the highest price volatility from shocks. Persistence of shocks was however longer in Sri Ganganagar market compared to Anoopgarh with the lowest persistence of shocks on volatility recorded in Hanumangarh. Moreover, TGARCH (1,1) was the best in modelling volatility in Sri Ganganagar whereas EGARCH (1,1) was best in Anoopgarh price volatility modelling and GARCH(1,1) was best in modelling Hanumangarh cluster bean price volatility. This indicates there is no one best model in modelling prices volatility hence every data should be approached on its own merit with regards to selection of model.

In context of policy recommendations, it is therefore suggested that, government should focus a holistic approach to ensuring price stability through activities such as price forecasting of cluster bean prices during pre-sowing, pre harvesting and harvesting period to promote price transparency; price forecasting of international prices of guar and guar gum should also be done to promote price discovery and reduce price speculation. It is suggested also that FMC and commodity futures exchanges should endeavour to expand futures trading by educating producers of guar and processors of guar to form farmer based organisations so as to increase the participation of farmers and genuine hedgers in futures trading. Furthermore, there should be investment in domestic cluster bean production by government and partnership with private players in warehousing, processing factories and other infrastructure to be able to minimise cluster beans price volatility.

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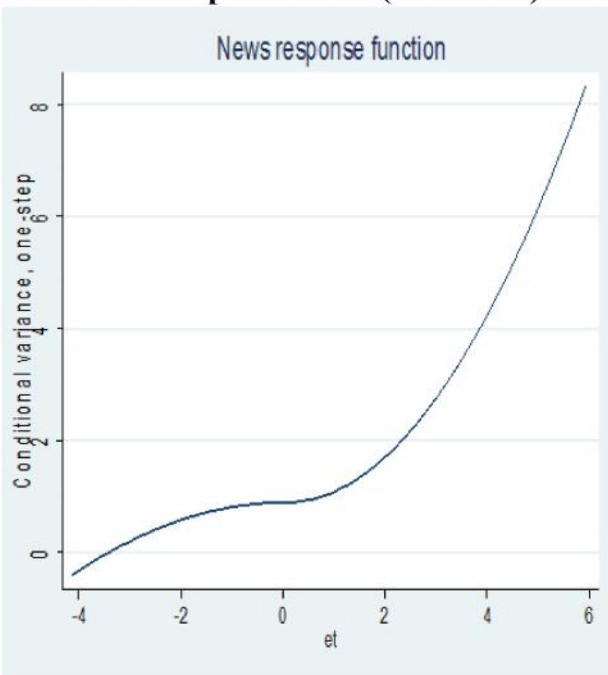
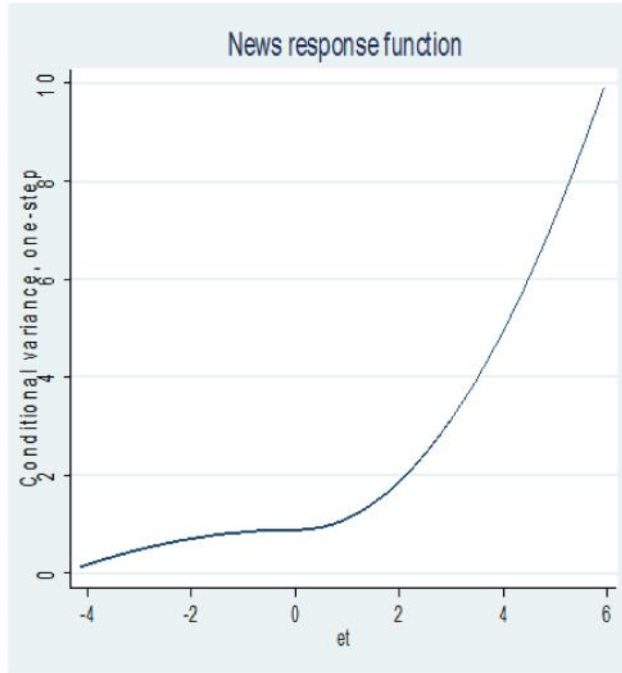
Annexure-I

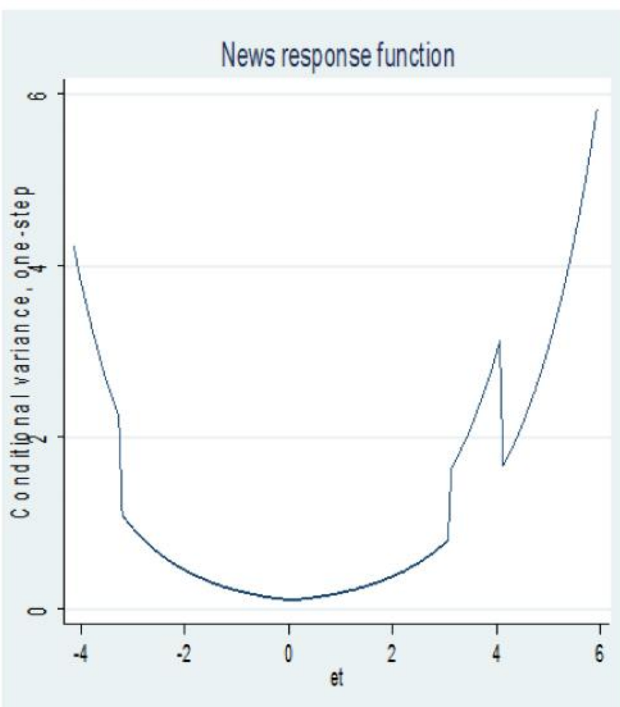
News Response of GA (TGARCH)



News Response of TA (TGARCH)



News Response of AP (EGARCH)



News Response of HA (TGARCH)