

A Study on Volatility of Spot Price of Turmeric using GARCH Model

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ABSTRACT

Turmeric is known as *curcuma longa* in the family Zingiberaceae. India is the largest producer and exporter of turmeric in the world, produces nearly 80-85% of world's turmeric crop. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka are the major producers of turmeric in India. Turmeric is used in several ways as a flavor, color to foodstuffs, cosmetics and in medicines. Indian Turmeric is considered as one of the good quality due to its high curcumin content and being known for its medicinal and cosmetic applications. The data are analyzed from 2004 to 2016 from NCDEX. Spot returns of turmeric volatility is modeled as a GARCH (1,1) process. The study examines the long run and short run relationships between the spot and future prices. To examine the relationship among spot volatility and unexpected futures trading activity GARCH (1,1) model is being used. Granger causality test is used to analysis the causality flows from unexpected traded volume to spot volatility and unexpected open interest to spot price return. Further the results came shows the long run relationship among the variables. This leads to study the granger causality between the future and spot prices. The results occurs will shows the effects on the interest of traders, investors and other regulatory bodies.

Introduction

Turmeric its botanical name is *curcuma longa* which belongs to zingiberaceae family, grows in red soils with temperature ranging between 20 to 30 degrees. Turmeric is used as cosmetics, in medicines and as a flavor and color in foodstuffs. India is the world's largest producer of turmeric which contributes 80-85% of world's total population, which stands 6.0 lakh MT to 7.0 lakh MT per year. India is not only known for the production of turmeric but it's a world largest exporter country. The major producers of turmeric are Pakistan, China, Haiti, Jamaica, Peru, Taiwan and Thailand. Asian countries consume turmeric for domestic use. Indian Turmeric is considered as the best quality due to its high curcumin content and is widely known for its medicinal and cosmetic applications. Andhra Pradesh, Tamilnadu, Orissa, West Bengal, Karnataka, Maharashtra are the leading producing states in India for turmeric. UAE, USA, Bangladesh, Sri Lanka, Japan, Malaysia are the major export markets for turmeric. Within the country, Andhra Pradesh leads in the production of turmeric, with an average of 55-57% of the total production.

Turmeric is widely used in a dried, powdered form as food adjunct imparting flavor as well as color to food stuff. Leaves of turmeric are also used to wrap and cook food in some parts of India. Turmeric oleoresin, which is obtained by solvent extraction of the groundspice, is used in pickles, mayonnaise and relish formulations, non-alcoholic beverages, butter and cheese etc.

The futures trading of turmeric in India was launched in April 2004 on NCDEX and since it shows a huge participation from various supply chain participants. With the help of futures platform producers can minimize their price risk. Increasing rate of export demand, exporters can insure themselves against price risk

too. Better stocks of Turmeric leads arbitrage opportunities to the various market participants. Speculators can easily enter or exit the market due to high liquid contract. Hence, turmeric contract provides space for every investor category.

Literature Review

Mishra and Goswami (2016) used GARCH model to investigate advanced forecasting techniques which can improve the predictability of sugar futures in the Indian commodity market. They found forecasting accuracy is better for a short futures perception. The paper analyzed the relationship among spot and futures prices of sugar. Srinivasan (2011) examined the relationship between NSE and BSE by using Johansen's Co integration and VECM model. He concluded that market is inefficient in the short run as compare to long run. Malhotra and Sharma(2015) used Garch model which indicates positive relationship among unexpected futures trading volume and spot returns volatility for guar seed. Ahmad and Sehgal (2015) examine the destabilization effect for the few agricultural commodities for the sample time period. They used GARCH model and found that both linear and non – linear causality results suggests destabilizing effect of commodity futures on the spot market for commodities. Mcmilan and Speight(2007) focused on the weekly forecasting of volatility with the help VAR calculations and GARCH model. The results shows that volatility measures provides superior volatility forecasts and also it allows to improve hedge ratio and VAR calculations. Bhaduri and Durai(2008) examined the effectiveness of optimal hedge ratios for stock index futures by using econometrics models i.e. VECM and MGARCH. Chauhan et.al (2013) used co integration test and GARCH model to find long term relationship between spot and futures prices of guar seed and chana. Zhong et al.(2004) analyzed the hypothesis of Mexican stock index futures market effectively which served the function of price discovery . The result shows that futures price index is useful price discovery vehicle and source of instability for the spot market with the help of VECM and EGARCH model. Antoniou and Foster (1992) examined the futures contract for Brent Crude Oil on spot price volatility in UK in the year 1988 with the help of GARCH model. He concluded that quality of information flowing from spot market has been improved by introducing futures market. No volatility spillover was found from futures to spot market in case of Brent crude oil. Yang(2001) observed optimal hedge ratio for daily stock index and SPI futures on the Australian market by using GARCH . Kumar and Pandey (2008) used VAR-MGARCH model to investigate the constant and dynamic HRs for S&P CNX Nifty index futures, gold futures and soybean futures. It was found that MGARCH model provides highest variance reduction as compared to other models.

Research Gap

The study used daily data of spot and future price of turmeric. The use of intra -day data could be more effective for the analysis.

Data and Methodology

The purpose of the study is to find the reason how trading activity is affecting turmeric price. The two indicators traded volume and open interest of trading activity is taken for the study. Both open interest and traded volume are divided into expected and unexpected values. GARCH (1,1) model has been used for measuring the time series volatility.

Stationarity test and decomposition of series

Augmented dickey fuller test is applied to check the stationarity of the series. The data has been converted into stationary when they are not stationary in the level. Hodrick Prescott filter was used for decomposing

open interest and traded volume into expected and unexpected series. Hodrick Prescott filter is a smoothing method which is widely used among economists to obtain a smooth estimate of the long term trend component of a series. It is two sided linear filter that computes the smoothed series s of y by minimizing the variance of y around s , subject to a penalty that constraints the second difference of s , i.e., the HP filter chooses to minimize s :

The expected component is:

$$\sum_{t=1}^T (y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1} ((s_{t+1} - s_t) - (s_t - s_{t-1}))^2 \tag{1}$$

The λ parameter is set to control the smoothness of the series. The larger the λ , the smoother the variance.

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model was developed in 1982 by economists Robert F. Engle. It is a process which depend on past squared observations and past variances to model for current variance. It is the model to estimate the volatility.

$$S_{t^2} = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 + \mu ETV + \varphi EOI + \omega UOI + \gamma UTV \tag{2}$$

Where S_{t^2} is the conditional variance of spot returns.

ETV refers to Expected traded volume, t refers to time, UTV is unexpected traded volume, EOI is expected open interest and UOI is unexpected open interest. With the help of GARCH model it is easy to interpret the current fitted variance.

Data

The daily closing price of turmeric spot and future prices are being used for the study. The data has been collected from the website NCDEX for the period from 27 July, 2004 to 6 Oct,2016. Trading activities takes place in near monthly contract hence nearly month contract data has been used. The daily continuous compound return is defined as the first logarithmic difference of closing prices on consecutive trading days, i.e., $dln St = (\ln St - \ln St-1)$ and $dln Ft = (\ln Ft - \ln Ft-1)$.

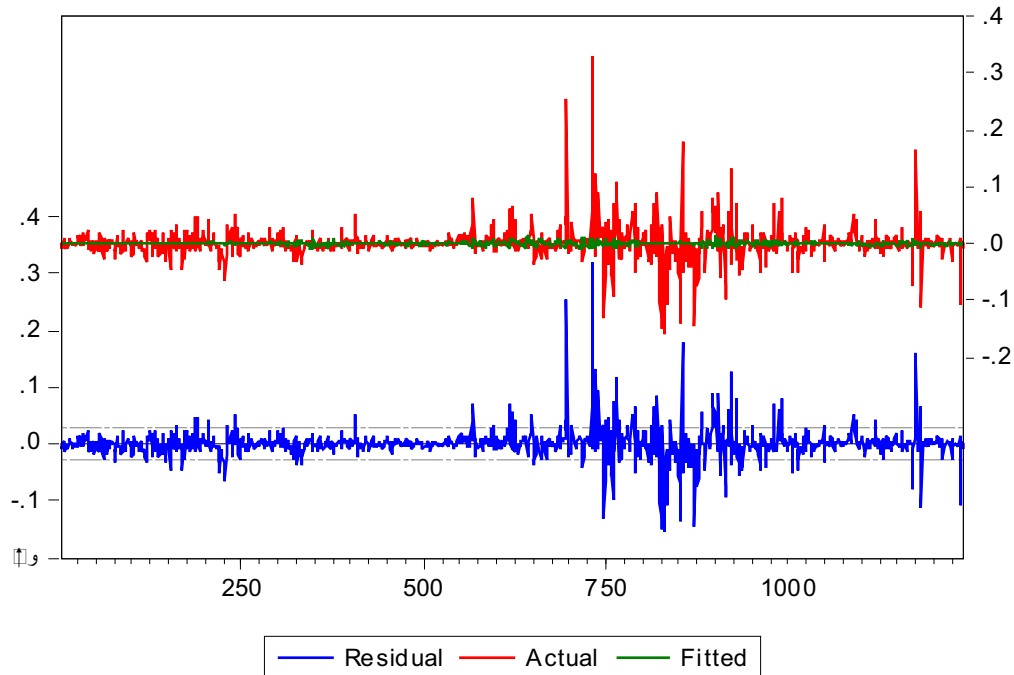
Results and Discussion

Firstly, ADF test has been applied to test the stationarity of spot price, open interest and traded volume. The stationarity test is also be done for unexpected series. The table 1 reflects the results of unit root test which becomes stationary after first difference for spot price, UOI and UTV. Open interest and traded volume series becomes stationary in the level.

	t-statistics	Prob.*
Spot Price (First Difference)	-27.5251	0
Open Interest (Level)	-4.83816	0
Traded Volume (Level)	-5.812453	0
Unexpected Open Interest(First Difference)	-11.054	0
Unexpected Traded Volume(Fir st Difference)	-12.6182	0
Note:* MacKinnon (1996) one sided p-values at 5% significance level.		

From Figure 1 , we can see that there is high volatility from 750 days to 1000 days and low volatility from 250 to 750 days. It is clear that there is small volatility is causing another small volatility for a long term. When the residuals are in this manner we can represent ARCH and GARCH model.

Figure 1: Residuals of spot price



It is observed from table 2 , that the null hypothesis have serial correlation . The probability is less than 5% for 36 lags .Hence , the model have serial correlation.

Table 2: Correlogram of standardized squared residuals

	AC	PAC	Q-stat	Prob.
1	0.048	0.048	2.8547	0.091
2	-0.009	-0.011	2.959	0.228
3	-0.027	-0.026	3.8665	0.276
4	0.018	0.02	4.252	0.373
5	-0.024	-0.026	4.949	0.422
6	-0.007	-0.005	5.0123	0.542
7	-0.011	-0.01	5.1552	0.641
8	-0.011	-0.012	5.305	0.725
9	-0.005	-0.004	5.3416	0.804
10	0.016	0.015	5.6632	0.843
11	-0.025	-0.028	6.4679	0.84
12	0.027	0.03	7.4148	0.829
13	-0.013	-0.016	7.6351	0.867
14	-0.009	-0.009	7.7332	0.903
15	-0.003	0.001	7.7423	0.934
16	0.001	-0.002	7.7445	0.956
17	0.023	0.024	8.4062	0.957
18	0.029	0.027	9.4966	0.947

	AC	PAC	Q-stat	Prob.
19	-0.022	-0.025	10.099	0.95
20	0.006	0.01	10.142	0.966
21	-0.013	-0.013	10.34	0.974
22	0.008	0.006	10.42	0.982
23	-0.008	-0.004	10.496	0.988
24	0.024	0.022	11.223	0.987
25	-0.014	-0.014	11.478	0.99
26	0.013	0.015	11.691	0.993
27	-0.001	-0.002	11.691	0.995
28	0.001	0	11.693	0.997
29	-0.013	-0.01	11.92	0.998
30	-0.005	-0.007	11.95	0.999
31	-0.025	-0.021	12.74	0.998
32	0.004	0.004	12.765	0.999
33	-0.002	-0.002	12.77	0.999
34	0.122	0.12	31.662	0.583
35	0.113	0.105	48.074	0.07
36	0.02	0.009	48.573	0.079

To test for heteroskedasticity the null hypothesis is that the residuals have no ARCH effect. The probability is 91.8 which is > 5%. So. We can say that there is no ARCH effect.

Table 3 : Results of Heteroscedasticity test of residuals

F-statistics	2.847
Obs. R	2.845

Relationship among spot price volatility and future trading activity

Granger causality test is applied to ascertain the relationship between spot price volatility and future trading activity. The table 4 reflects the results of granger causality test. It indicates that the volatility is flowing from open interest to spot price. And causality seems to flow from spot prices to volume . Similarly , UTV and unexpected open interest are causing spot prices. It clearly shows that spot price, expected open interest, expected traded volume ,unexpected open interest ,unexpected traded volume have casual influence on each other.

Table:4 Granger causality test results		
	f-statistics	Prob.
Open interest →spot price(OI →SP)	4.19634	0.0153
Spot price → open interest(SP →OI)	0.37814	0.6852
Traded volume→ spot price(TV→SP)	3.48159	0.0311
Spot price → traded volume(SP →TV)	8.07925	0.0003
Spot price→ Unexpected Traded Volume (SP→UTV)	3.87528	0.021
Unexpected Traded Volume →Spot Price (UTV → SP)	12.6664	4.00E-06
Spot Price→ Unexpected Open Interest(SP→UOI)	0.19903	0.8196
Unexpected Open Interest→ Spot Price(UOI→SP)	0.71532	0.4892

Note: the→ denotes the hypothesized direction of granger causality between the two variables ;and * Rejection of null hypothesis of no causality at 5% significance level.

To measure volatility in spot price GARCH(1,1) normal gaussian model has been used. In table 5 ARCH and GRACH terms,UTV, OI and UOI all are significant. Positive relationships is found between spot returns volatility and unexpected open interest. This indicates the increase in the level of open interest followed by greater volatility in the underlying spot market of turmeric causing destabilization in spot prices of turmeric.

Table 5 : GARCH Estimation Results

ARCH term	GARCH term	ETV	UTV	OI	UOI
0.649784 (0.00)	0.556239 (0.00)	3.64E-07 (0.00)	6.88E-08 (0.00)	2.08E-07 (0.00)	6.25E-08 (0.00)

Note: Dependent variable : turmeric spot return volatility; Methods ML-ARCH (Marquardt):Normal distribution ;and Figures in parenthesis show the probability at 5% significance level.

Hedging activity is found in the futures trading market which has a impact on spot price volatility. Traded volume represents the activity of speculators ,which implies that there is no evidence of increase in spot price due to speculation. Unexpected traded volume does not have impact on spot volatility. The probability is more than 5% ,hence it shows that it is not significant. Table 5 shows that a causality exists among the two variables.

Conclusions

The future trading of turmeric was introduced in April 2004 on NCDEX. The paper shows the impact of futures trading activity on the volatility of turmeric spot market prices . the period covered for the study is from 2004 to 2016. The data for the study have been collected from NCDEX website. The results of heteroskedastic can be represents with the help of ARCH and GARCH model. The results show that model does not have serial correlation and the residual does not have any ARCH effect. Unexpected traded volume, open interest ,ARCH and GARCH term are significant to explain the volatility in spot price. The hypothesis shows that granger does not cause spot price.

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