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VARIANCE-RATIO TEST OF RANDOM WALKS IN AGRICULTURAL COMMODITY FUTURES MARKETS IN INDIA

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Abstract: In this paper, we examine whether or not agricultural commodity futures markets in India follow random walks. To test the Random Walk Hypothesis (RWH), we have applied the Variance-Ratio test developed by Lo and MacKinlay (1988) to the data on the prices of three month futures contracts in fourteen agricultural commodity futures in India. Data are collected from the National Commodity Derivative Exchange (NCDEX) data base. The results show that, of the fourteen agricultural futures markets studied, eleven markets are found to follow the random walk hypothesis and remaining markets do not follow RWH. Thus, the results generally reveal that the prices of futures contracts in Indian agricultural commodity futures markets are independent and identically distributed so that their future movements cannot be predicted.

1. INTRODUCTION

Indian economy has been subjected to various structural reform measures in an intensified manner since 1990s. One of the stated objectives of the reform agenda was to make Indian markets competitive and efficient in such a manner that they are on the same footing with their international counterparts. The revival of the previously banned commodity futures trading in India in the year 2002-03 has to be seen as an outcome of the implementation of this kind of an agenda. Since then, the commodity futures trading including agricultural futures have witnessed a tremendous growth both in terms the trading volume as well as the development of the institutional mechanism for trading. Hence, it is an empirical research question to analyze whether Indian commodity futures markets are efficient or not.

The informational efficiency of financial as well as commodity markets have been one of the areas having attracted much academic researches and yet, still remain to be inconclusive. A sensible definition of Efficient Market Hypothesis (EMH) says that a market is regarded as efficient if the current price reflects all available information and there by eliminates the possibility of abnormal return in a consistent manner. Also an efficient market would provide reliable forecasts of spot prices in future. Tests of Random Walk Hypothesis (RWH) can be used to

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provide insights into the issue of market efficiency as it highlights the idea that prices wander in an unpredictable manner.

In this paper, we test whether or not the agricultural commodity futures markets in India follow Random Walk Hypothesis and there by these markets move in unpredictable manner. Lo and MacKinlay (1988) variance ratio test has been employed to test the behaviour of prices of fourteen agricultural commodity futures. The results altogether indicate that, except for coriander, the hypothesis of random walk cannot be rejected at 5% of significance level. This means that futures markets for all selected commodities except one are efficient.

The reminder of this paper is organised as follows. Section 2 reviews important previous researches exclusively on the behaviour of agricultural commodity futures prices. Data and methodology of the study are outlined in section 3. This is followed by section 4 with empirical results and finally section 5 concludes this paper.

2. LITERATURE REVIEW

Though, much empirical research has been done for studying the efficiency of stock markets of difference countries including India not much has been done on testing the efficiency of commodity markets in the Indian context. Naik and Jain (2002) evaluated the performance of the six agricultural commodity futures markets and found that those markets are yet to develop efficient mechanism of risk management and information absorption. Kaur and Rao (2009) tested the market efficiency of selected agricultural commodities in India. He has used serial correlation test and run rest to measure efficiency and the results shows that both futures and spot prices for all the selected agricultural commodities (guarseed, chana, pepper and refined oil) are efficient in week form. Similarly, Kaminsky and Manmohan (1990) analysed efficiency of commodity futures market and shown that the null hypothesis of efficient markets has not been rejected for three commodities but rejected for the other four. Raizada and Sahi (2006) found that wheat futures market at the National commodity Derivative Exchanges was not efficient even in the short run indicates poor price discovery. Wang and Bingfan (2002) studied the efficiency of Chinese wheat and soybean futures markets and the results suggested that a weak short term efficiency of the soybean futures market and the futures market for wheat was inefficient and also there existed long term equilibrium relationship between the futures price and cash price for soybean. This study analyses market efficiency of agricultural commodity futures using variance ratio test of random walks.

3. DATA AND METHODOLOGY

In this study daily price series of the near month futures contracts of fourteen agricultural commodities are used for the analysis. These commodities are introduced for trading at different dates so that the data of commodities are of varying ranges. Range of data is given in the appendix.

The raw price series is converted to logarithmic returns for the analysis. To test the RWH, we have used the Lo and MacKinlay (1988) variance ratio test. The underlying intuition behind this variance ratio test is that variance of a multi period return is the sum of single period variances when RWH is true. Tests like Lo and MacKinlay (1988) exploits any divergence from this prediction. According to this test, if a series follows random walk hypothesis, the variance of its q-differences would be q times the variance of its first differences.

$$\text{Var}\,(p_t - p_{t-q}) = q\text{Var}\,(p_t - p_{t-1})$$

Where q is any positive integer. The variance ratio, $VR\,(q)$, is defined as:

$$VR\,(q) = \frac{\sigma^2(q)}{\sigma^2(1)}$$

Where $\sigma^2(q)$ is 1/q times the variance of the q^{th} differences and $\sigma^2(1)$ is the variance of the first differences. The null hypothesis tested under VR test that ratio of variances in different investment horizons equals 1. For a sample size of nq =+1 observations (R_0, R_1,.....R_{nq}) $\sigma^2(q)$ and $\sigma^2(1)$ re calculated as follows:

$$\sigma^2(q) = \frac{1}{h}\sum_{t=q}^{nq}\left(R_t - R_{t-q} - q\hat{\mu}\right)^2$$

Where

$$h = q\,(nq + 1 - q)\,(1 - q/nq)$$

and

$$\hat{\mu} = \frac{1}{nq}\left(R_{nq} - R_0\right)$$

$$\sigma^2(1) = \frac{1}{(nq-1)}\sum_{t=1}^{nq}\left(R_t - R_{t-1} - \hat{\mu}\right)^2$$

The standard normal test statistic under homoscedasticity $Z\,(q)$, is then:

$$Z\,(q) = \frac{VR(q)-1}{[\varnothing(q)]^{1/2}} \approx N(0,1)$$

Where Ø(q) is the asymptotic variance of the variance ratio under the assumption of homoscedsticity defined as follows:

$$\varnothing(q) = \frac{2(2q-1)(q-1)}{3q(nq)}$$

4. EMPIRICAL RESULTS

Summary statistics of the data used for the analysis is given in Table 1. The summary statistics shows that nine out of fourteen commodities have positively skewed

distribution. This means there exist high outliers in the price data of these commodities. None of the commodities' prices have normal distribution. This indicates that futures price variation is high for all the selected commodities. This volatility in prices is contributed by the high and low outliers of the price data. This is clear from the high standard deviations of commodity prices.

Table 1
Descriptive Statistics

Commodity	*Mean*	*Median*	*SD*	*Skewness*	*Kurtosis*	*Jarque-Bera*	*Probability*
Castorseed	3051.64	2888.5	452.3857	0.6973	2.287	46.69	0.0000
Chana	2148.39	2219	400.39	0.0032	2.819	2.509	0.2852
Chilli	4286.17	3808	1207.41	0.5109	1.916	39.28	0.0000
Coriander	4364.82	4122	1656.99	1.559	4.548	348.14	0.0000
Gur gum	4494.01	4513	534.82	-0.022	2.991	0.1753	0.9160
Guarseed	1831.56	1768	317.28	0.5873	3.675	154.37	0.0000
Jeera	10117.6	10677	2517.46	-0.2031	2.034	81.266	0.0000
Maize	768.86	798	176.28	-0.0233	1.761	92.433	0.0000
Mustarseed	449.51	426.9	95.658	0.4198	1.841	179.17	0.0000
Potato	801.86	843.7	238.34	0.1064	1.665	18.336	0.0001
Refreshed soyoil	440.57	434.9	68.64	1.0085	4.279	316.39	0.0000
Soybean	1759.31	1675	453.41	0.3876	1.948	149.49	0.0000
Turmeric	4613.93	2883	3707.81	1.7074	4.661	1164.5	0.0000
Crude Palm oil	365.30	362	35.86	0.0069	2.229	19.59	0.0000

Source: Authors' calculation based on NCDEX price data

Under the null hypothesis that agricultural futures markets follow random walk, the Lo and MacKinaly (1988) variance ratios are expected to equal one as it assumes that the variance of the increments in a random walk is linear in the sampling interval. Hence, if a time series follows a random walk process, the variance of a qth-differenced variable is q times as large as the first –differenced variable. We have calculated the variance ratio for lags (q) of 2, 4, 6, 8, 10, and 20 and the results are shown in Table 2 along with associated test statistic.

Empirical results obtained from the variance ratio test for daily observed returns indicate the null hypothesis of random walk under the assumption of homoscedasticity cannot be rejected at the 5%of significance level for all commodities except for coriander. Although the results for castorseed indicates the rejection of random walk hypothesis for the lags from 2 to 8, the variance ratios and associated test statistic indicate that this market also follow random walk for higher lags like 10 and 20. Thus, the results in general show that the markets for Indian agricultural commodity futures follow random walk hypothesis and therefore, moves in an unpredictable manner.

Table 2
Variance Ratio Test Results for the Daily Agricultural Commodity Prices under Homoscedasticity Assumption

Variables	*Number q of base observations aggregated to form variance ratio*					
	2	*4*	*6*	*8*	*10*	*20*
Castorseed						
VR(q)	1.16	1.28	1.36	1.39	1.39*	1.43*
Z(q)	2.38	2.32	2.37	2.2	1.95	1.58
Chana						
VR(q)	0.99*	0.97*	0.96*	0.95*	0.92*	0.92*
Z(q)	-0.24	-0.48	-0.51	-0.59	-0.78	-0.54
Chilli						
VR(q)	1.08*	1.15*	1.18*	1.18*	1.15*	1.15*
Z(q)	1.61	1.86	1.18	1.64	1.24	1.00
Coriander						
VR(q)	1.12	1.28	1.33	1.39	1.45	1.71
Z(q)	3.85	4.12	3.43	3.34	3.27	3.29
Crude palm oil						
VR(q)	0.82*	0.61*	0.57*	0.53*	0.49*	0.45*
Z(q)	-1.81	-2.22	-1.90	-1.78	-1.74	-1.48
Guar gum						
VR(q)	1.07	1.13	1.19	1.19	1.20	1.22*
Z(q)	2.46	2.45	2.18	2.18	2.04	1.56
Guar seed						
VR(q)	1.05	1.08*	1.11*	1.10*	1.09*	1.09*
Z(q)	2.15	1.52	1.55	1.21	0.99	0.70
Jeera						
VR(q)	1.03*	1.01*	1.00*	1.01*	1.01*	1.03*
Z(q)	1.08	0.33	0.10	0.14	0.19	0.26
Maize						
VR(q)	1.00*	0.99*	0.98*	0.93*	0.91*	0.90*
Z(q)	0.35	-0.03	-0.24	-0.88	-0.97	-0.79
Mustard seed						
VR(q)	1.04*	1.03*	1.01*	1.01*	1.00*	0.95*
Z(q)	1.31	0.67	0.22	0.12	0.10	-0.37
Potato						
VR(q)	1.11*	1.08*	1.03*	1.06*	1.08*	1.28*
Z(q)	1.87	0.76	0.21	0.30	0.39	0.91
Refreshed Soy oil						
VR(q)	1.08	1.11*	1.11*	1.13*	1.18*	1.30*
Z(q)	2.08	1.56	1.23	1.14	1.38	1.64
Soybean						
VR(q)	0.99*	0.97*	0.96*	0.93*	0.93*	1.01*
Z(q)	-0.17	-0.29	-0.33	-0.52	-0.53	0.10
Turmeric						
VR(q)	1.03*	1.08*	1.07*	1.04*	1.01*	1.06*
Z(q)	1.46	1.87	1.30	0.60	0.23	0.53

Note: *indicates acceptance of RWH at 5% level

5. CONCLUSION

This paper investigates whether Indian agricultural commodity futures markets follow random walk hypothesis or not and thereby attempt to elicit the importance of the efficient market hypothesis. India, being one of the emerging nations and also home country of the millions of agriculture-dependent population, the efficiency and competitiveness of its market for agricultural commodities assumes much significance. We have used price data for fourteen agricultural commodity futures markets which are highly active since the commencement of electronic online trading of National commodity futures exchanges in 2003. The empirical results using Lo and MacKinaly (1988) variance ratio test reveal that except for a single commodity, coriander, markets for all other commodities follow random walk hypothesis. Thus, this finding sheds light on the efficiency and transparency of market for agricultural commodity futures markets in India.

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Appendix Table

Commodity	*Sample Period*
Castorseed	15 May 2009 – 9 November 2010
Chana	12 April 2004 – 12 November 2010
Chilli	10 November 2005 – 20 March 2006
Coriander	11 August 2008 – 12 November 2010
Crude palmoil	15 December 2003 – 19 October 2007
Guar gum	27 July 2004 – 12 November 2010
Guarseed	12 April 2004 – 11 November 2010
Jeera	3 February 2005 – 13 November 2010
Maize	5 January 2005 – 20 September 2010
Mustarseed	15 December 2003 – 13 November 2010
Potato	4 December 2008 – 18 September 2009
Refreshed soyoil	15 December 2003 – 17 November 2010
Soybean	15 December 2003 –17 November 2010
Turmeric	27 July 2004 – 18 November 2010