A STUDY ON MARKET BEHAVIOUR AND PRICE DISCOVERY IN INDIAN COMMODITY MARKETS

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ABSTRACT

The study analyzes the market behavior and causality effects between spot and futures prices in Indian commodity markets. The pattern is quite different for different commodities. Commodities that suffer from chronic backwardation should be analyzed in more detail, in order to understand the causes, and controls (known as backwardation limits) should be instituted for the same. Causality in commodities markets can be used to either hedge or speculate price movements: if changes in spot prices drive changes in futures prices, efficient hedging strategies can be formulated; whereas if changes in futures prices drive changes in spot prices, efficient speculation strategies can be formulated. Further, causality can be used in forecasting commodity spot and futures prices.

Keywords: commodity markets, spot and futures prices, contango, backwardation, causality effects

INTRODUCTION

Commodity prices are typically characterized by substantial volatility. The uncertainty that accompanies price volatility affects traders whose trading strategies are based, in part, on short-term volatility movements, and investors interested in hedging an underlying diversified portfolio of commodities. In particular, producers need to manage their exposure to fluctuations in the prices for their commodities. They are primarily concerned with fixing prices on contracts to sell their produce; hence the existence of futures markets.

One of the most important functions of futures markets is that of price discovery. Futures markets should be able to generate prices that express future expectations on cash prices, and should be able to transmit that information effectively across the market (Working, 1942; Tomek, 1980). Studies show that futures prices play a dominant role in the discovery and transmission of price information.

Effective price discovery requires the direct participation of several players in commodity markets: farmers/producers, intermediaries, wholesalers, consumers, investors, and other players. In India, the majority of farmers/producers traditionally produces mainly for consumption, and

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so do not generally participate in commodity markets. Thus, commodity markets in India are generally dominated by speculating traders and brokers. In fact, often trading in futures markets is banned because prices become too speculative (Nath and Lingareddy, 2008).

Also, thin markets are expected to be inefficient and to be characterized by price variability; that is, low trading volume implies a relatively small amount of information and perhaps information of low quality (Tomek, 1980). The poor flow of information would be expected to affect the price discovery function.

Price discovery also depends heavily on physical market infrastructure, as well as handling costs, storage costs, transportation costs, tax rates, and other factors. In India, there is nationwide a network of regulated markets for commodities, though the rural periodical markets are largely unregulated.

LITERATURE REVIEW

The literature on price discovery is extensive. Many studies are based on the Garbade-Silber framework, along with Granger causality, co-integration, and error correction models to determine the relationship between futures and cash prices.

Garbade and Silber (1983) modeled spot and futures prices using simultaneous price dynamics, in which changes in spot and futures prices on *t* are a function of the basis on *t-1*. They used the model to examine the characteristics of spot and futures prices for four storable agricultural commodities. Based on their model, they suggested that market size and liquidity might affect the price discovery role of futures markets.

Oellermann et al. (1989) and Schroeder and Goodwin (1991) studied the short-run price discovery mechanism for livestock, and found that information tends to be discovered first in futures markets and then transferred to cash markets. Also, they found a short-run relationship between cash and futures prices based on Garbade-Silber model, but failed to find a long-run relationship using either Granger-causality or co-integration procedures.

Koontz et al. (1990) studied price discovery in the livestock market, investigating the spatial nature of the price discovery process. They adopted Geweke's (1982) causality tests and measures of interaction between major cash markets, and between cash and futures markets. They found that there was generally a high degree of interaction between cash and futures prices. They also found that the price discovery process is dynamic and is influenced by the structure of the underlying markets.

Yang et al. (2001) studied price discovery performance of futures markets for storable and non-storable commodities. They found that asset storability does not affect the price discovery function, although it may bias futures markets estimates. They concluded that futures markets can be used as a price discovery tool in both types of markets.

Mattos and Garcia (2004) investigated the relationship between cash and futures prices in Brazilian agricultural markets, focusing on the effects of trading activity on the price discovery mechanism. Their results suggested that higher trading activity is linked to the presence of long-run equilibrium relationships between cash and futures prices, while in thinly-traded markets, neither long-run nor short-run interactions are significant.

Nitesh (2005) studied the impact of soy oil futures in Indian markets using simple volatility measures and concluded that the futures trading was effective in reducing seasonal price volatilities but did not bring down daily price volatilities significantly.

Sahi (2006) studied the impact of introducing futures contracts on the volatility of the underlying commodities in India. He found that unexpected increase in futures activity in terms of rise in volumes and open interest has caused increase in cash price volatilities, suggesting that futures trading had a destabilizing effect on spot prices of commodities.

Nath and Lingareddy (2008) studied the impact of futures trading on spot prices for a set of Indian agricultural commodities. The commodities that were analyzed were those for which futures trading had been banned by government due to pressure on spot prices. They found that the introduction of futures has not reduced the seasonal/cyclic fluctuations in spot prices. They also found that futures had increased the volatility in the spot market for some commodities.

In sum, the recent studies of price discovery tend to show that futures prices play a major role in the price discovery process. The literature pertaining to price discovery in futures markets has largely been limited to commodity markets in the developed world. Though commodity markets in emerging economies like India have been growing by leaps and bounds, commodities and commodity derivatives are neither popular asset classes, nor have they been adequately researched. Therefore, there is a need to study price discovery in commodity markets in emerging economies, especially where thinness in market trading may be highly prevalent and have a significant impact on the transmission of market information. The purpose of this paper is to analyze the effects of futures market trading activity on the price discovery mechanism of Indian commodity futures markets.

DATA AND METHODOLOGY

The sample used for the study was a sample consisting of twenty-one commodities which were actively traded on NCDEX in the study period of Jan. '05 - Apr. '07, selected according to the availability of data over the study period. The data consisted of the closing spot and futures prices of each of the sample commodities during the study period, which were collected from the NCDEX website[2] and other commodity databases.[3]

[2] www.ncdex.com
[3] www.commoditycontrol.com

Market behavior was examined in terms of contango, i.e. the percentage of time that futures price was greater than spot price, and backwardation, i.e. the percentage of time that the spot price was greater than the futures price. Further, paired-samples t-test was used to detect differences in commodity spot and futures prices.

The effects of futures market on the spot market and vice versa were analysed using Granger causality techniques (Granger, 1969) to identify short-run interactions, as suggested by Geweke (1982) and adopted by Koontz et al (1990). To test for causality of spot prices on futures prices, compare the unrestricted model:

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{m_1} \beta_{1i} \Delta y_{t-i} + \sum_{j=1}^{m_2} \gamma_{1j} \Delta x_{t-j} + \varepsilon_{1t}$$

with the restricted model:

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{m_1} \beta_{1i} \Delta y_{t-i} + \varepsilon_{1t};$$

on the other hand, to test for causality of futures prices on spot prices, compare the unrestricted model:

$$\Delta x_t = \alpha_2 + \sum_{i=1}^{m_1'} \beta_{2i} \Delta x_{t-i} + \sum_{j=1}^{m_2'} \gamma_{2j} \Delta y_{t-j} + \varepsilon_{2t}$$

with the restricted model:

$$\Delta x_t = \alpha_2 + \sum_{i=1}^{m_1'} \beta_{2i} \Delta x_{t-i} + \varepsilon_{2t},$$

where $\Delta x_t = x_t - x_{t-1}$ is the first order forward difference in the spot prices and $\Delta y_t = y_t - y_{t-1}$ is the first order forward difference in futures prices; α, β, γ are the parameters to be estimated, and ε_1, ε_2 are standard random errors with zero mean and constant variance. Finally, the orders m_1, m_2, m_1', m_2' are the optimal lags chosen by Akaike's (1969) information criterion. In order to test the significance of γ_1 and γ_2, the usual F-statistic as below is employed:

$$F = \frac{\left(SSE_R - SSE_{UR}\right) \Big/ (df_R - df_{UR})}{MSE_{UR}}$$

The equations above provide a convenient framework for examining linear causality relationships. If the estimated lagged coefficient vector γ_1 is statistically significant while the estimated lagged coefficient vector γ_2 is not statistically significant, then it can be inferred that changes in spot prices Granger cause changes in futures prices, with no feedback (i.e. a unidirectional causality exists from spot prices to futures prices), implying that knowledge of past values of spot prices improves the predictions of changes in futures prices, while knowledge of past values of changes in futures prices has no predictive power over spot prices. On the other hand, if the estimated lagged coefficient vector γ_1 is not statistically significant while the estimated lagged coefficient vector γ_2 is statistically significant, then it can be inferred that changes in futures prices Granger cause changes in spot prices with no feedback (i.e. a unidirectional causality exists from futures prices to spot prices), implying that knowledge of past values of changes in futures prices improves the predictions of changes in spot prices, while knowledge of past values of changes in spot prices has no predictive power over changes in futures prices. If both estimated lagged coefficient vectors γ_1 and γ_2 are statistically significant, then bi-directional causality exists, implying that knowledge of past values of either variable is

useful in the prediction of the other. Finally, if neither estimated lagged coefficient vectors γ_1 and γ_2 are statistically significant, then no causality exists between spot prices and futures prices. Further, as the data in question is of a short period only, any causality that is identified would be interpreted as a short-run effect between spot prices and futures prices.

ANALYSIS AND INTERPRETATION

The results of the analysis of commodity spot and futures prices for the sample of twenty-one commodities are shown in the Table.

Wheat prices were found to exhibit chronic backwardation, both with high incidence of backwardation (87. 22%), and with futures prices significantly lower on average than spot prices. Further, the variability of futures prices (7.21%) was less than the variability of spot prices (9.80%). In terms of price discovery, it was found that there was significant effect of futures prices on spot prices, but the effect of spot prices on futures prices was not statistically significant. Thus, price discovery was found to partially break down for wheat prices.

Potato prices were found to show a mixed pattern, with higher incidence of contango (67.57%), with spot prices lower on average than futures prices (but not statistically significant). Also, the variability of futures prices (15.01%) was less than the variability of spot prices (20.09%). In terms of price discovery, it was found that there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Maize prices showed a prevalent pattern of contango (71.89%), with spot prices significantly lower than futures prices. Also, the variability of futures prices (12.17%) was more than the variability of spot prices (8.81%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Barley prices were found to show backwardation (69.31%), with spot prices significantly higher than futures prices. Also, the variability of futures prices (6.87%) was more than the variability of spot prices (2.36%). In terms of price discovery, it was found that there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Masoor prices showed a highly prevalent pattern of contango (81.15%), with spot prices significantly lower than futures prices. Also, the variability of futures prices (13.08%) was more than the variability of spot prices (12.61%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Jeera prices were also found to show a mixed pattern, with almost equal incidence of contango and backwardation, with no significant difference between spot and futures prices on average. Also, the variability of futures prices (24.65%) was more than the variability of spot prices (21.23%). Nevertheless, in terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Gur prices were found to show backwardation (69.71%), with spot prices significantly higher than futures prices on average. Also, the variability of futures prices (3.93%) was less than the variability of spot prices (5.92%). However, there was found to be neither a significant effect of futures prices on spot prices, nor of spot prices on futures prices. Thus, price discovery was found to break down for gur prices.

Groundnut oil prices showed a prevalent pattern of contango (82.76%), with spot prices significantly lower than futures prices on average. Also, there was no difference between the variability of futures prices (11.07%) and the variability of spot prices (11.01%). In terms of price discovery, it was found that there was no significant effect of futures prices on spot prices, but there was significant effect of spot prices on futures prices. Thus, price discovery was found to partially break down for groundnut oil prices.

Groundnut (in shell) prices were found to exhibit backwardation (65.93%), with spot prices higher on average than futures prices (but not statistically significant). Also, the variability of futures prices (6.56%) was less than the variability of spot prices (7.17%). In terms of price discovery, however, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Guar seed prices showed a strong prevalence of contango (99.63%), with spot prices significantly lower than futures prices on average. Also, there was no difference between the variability of futures prices (5.69%) and the variability of spot prices (5.70%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Sesame seed prices exhibited contango to some extent (60.43%), with spot prices lower on average than futures prices (but not statistically significant). Also, the variability of futures prices (6.73%) was less than the variability of spot prices (7.37%). In terms of price discovery, however, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Mustard seed prices were found to show a prevalent pattern of contango (74.36%), with spot prices significantly lower than futures prices on average. Also, the variability of futures prices (5.96%) was less than the variability of spot prices (6.03%). However, there was found to be neither a significant effect of futures prices on spot prices, nor of spot prices on futures prices. Thus, price discovery was found to break down for mustard seed prices.

Cashew prices showed a high prevalence of contango (87.18%), with spot prices significantly lower on average than futures prices. Also, the variability of futures prices (2.65%) was less than the variability of spot prices (2.71%). In terms of price discovery, it was found that there was no significant effect of futures prices on spot prices, but there was significant effect of spot prices on futures prices. Thus, price discovery was found to partially break down for cashew prices.

Arabica coffee prices showed prevalence of contango (82.39%), with spot prices significantly lower on average than futures prices. Also, the variability of futures prices (8.66%) was less than

the variability of spot prices (9.09%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Chilli prices were found to show a mixed pattern, with almost equal incidence of contango and backwardation, but with spot prices significantly higher on average than futures prices. Also, the variability of futures prices (15.09%) was less than the variability of spot prices (16.56%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Castor seed prices showed a strong prevalence of contango (96.21%), with spot prices significantly lower than futures prices on average. Also, the variability of futures prices (9.72%) was less than the variability of spot prices (10.85%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Cotton prices showed a strong prevalence of contango (96.21%), with spot prices significantly lower than futures prices on average. Also, the variability of futures prices (3.16%) was more than the variability of spot prices (2.64%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Mentha oil prices were found to exhibit backwardation (66.08%), with spot prices significantly higher on average than futures prices on average. Also, the variability of futures prices (19.72%) was considerably more than the variability of spot prices (10.98%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Gold prices were found to show a mixed pattern, with almost equal incidence of contango and backwardation, but with spot prices significantly higher on average than futures prices. Also, the variability of futures prices (7.65%) was more than the variability of spot prices (3.78%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Silver prices showed prevalence of contango (79.56%), with spot prices significantly lower on average than futures prices. Also, the variability of futures prices (6.67%) was more than the variability of spot prices (6.43%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Aluminium ingot prices showed a prevalent pattern of contango (69.01%), with spot prices significantly lower than futures prices. Also, the variability of futures prices (4.37%) was less than the variability of spot prices (4.41%). In terms of price discovery, there was significant effect of futures prices on spot prices and of spot prices on futures prices.

Overall, most commodity prices showed contango, though a few prominent commodity prices suffered backwardation. Also, most commodities had bi-directional price discovery effects, again with a few exceptions.

DISCUSSION

The study examined the market behavior and causality effects of spot and futures prices in Indian commodity markets. The pattern is quite different for different commodities.

In terms of market behavior, it was found that the commodities that showed contango to a marked extent, with average spot prices significantly lower than average futures prices, were as follows: guar seeds (99.63%), castor seeds (96.21%), cotton (94.87%), cashew (87.18%), groundnut oil (82.76%), arabica coffee (82.39%), masoor (81.15%), silver (79.56%), mustard seeds (74.36%), maize (71.89%), and aluminium ingot (69.01%). In fact, potato and sesame seeds were also found to show contango to a marked extent (67.57% and 60.43%, respectively), but the difference in their average spot prices and their average futures prices was not statistically significant. On the other hand, it was found that the commodities that showed significant backwardation, with average futures prices significantly lower than average spot prices, were as follows: wheat (87.22%), gur (69.71%), barley (69.31%), and mentha oil (66.08%). In fact, groundnut (in shell) was also found to show backwardation to a marked extent (65.93%), but the difference in average futures prices and average spot prices was not statistically significant. Also, chilli and gold were found to show backwardation to a moderate extent only (48.82% and 45.75%, respectively), though their average futures prices were significantly lower than their average spot prices. Finally, it was found that one commodity, viz. jeera, showed mixed tendencies of contango and backwardation, with no significant difference in average spot prices and average futures prices. [In fact, rice, which was not included in the analysis because of problems with data availability, also showed backwardation to a marked extent.] Generally, the phenomena of contango and backwardation can be explained by the interplay/trade-off between the cost-of-carry and the convenience yield, the latter arising due to demand-supply gaps, as commodity price fluctuations are typically sensitive to short-term demand imbalances. In particular, commodities that suffer from chronic backwardation should be analysed in more detail, in order to understand the causes, and controls (known as backwardation limits) should be instituted for the same.

In terms of price discovery (i.e. effects of futures prices on spot prices, and vice versa) it was found that for 76.19% of the sample commodities (i.e. sixteen of the twenty-one sample commodities) there were significant bi-directional effects between spot prices and futures prices. On the other hand, for 9.52% of the sample commodities (viz. groundnut oil and cashew), there was significant effect of spot prices on futures prices, but not of futures prices on spot prices; while for 4.76% of the sample commodities (viz. wheat), there was significant effect of futures prices on spot prices, but not of spot prices on futures prices. Finally, for 9.52% of the sample commodities (viz. gur and mustard seeds), there was no significant effect of futures prices on spot prices, and no significant effect of spot prices on futures prices. By and large, changes in futures prices do cause changes in spot prices and vice versa in Indian commodity markets, but with some exceptions.

The results of the study suggest that the price discovery mechanism is quite effective for most commodities, but may not very effective for some commodities. In particular, causality in commodities markets can be used to either hedge or speculate price movements: if changes in spot prices drive changes in futures prices, efficient hedging strategies can be formulated; whereas if changes in futures prices drive changes in spot prices, efficient speculation strategies

can be formulated. Further, causality can be used in forecasting commodity spot and futures prices.

There are some limitations inherent in the present study. Liquidity analysis could not undertaken be done as the trade volumes were not available. Further, the study was limited to the period from January '05 to March '07. Further, the number of commodities was limited to only twenty-one from only one commodity exchange and some important commodities could not be taken as data was not sufficiently available for them. Finally, data availability was a major issue; the data that was available was in some cases recorded once, and in other cases recorded twice daily. Therefore, only the prices which were nearest to the closing time were chosen.

There is tremendous scope for further research in the domain of price discovery in Indian commodity markets. Liquidity/trade volume would be expected to affect the price discovery mechanism, especially thin trading (Mattos and Garcia, 2004). In particular, liquidity/volume effects can be studied in the Granger causality framework by extended the model to include volume terms. The dominance of market participants such as hedgers and speculators and market micro-structure in general may also distort price discovery. Finally, several natural processes such as seasonal cycles based on harvests, monsoons, depressions, and other weather events would also be expected to have an impact on price discovery in commodity markets; this is another area that needs to be studied.

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Table: descriptive statistics, correlation, paired-samples t-tests, and Granger causality of spot and futures prices

commodity	spot price		futures price		correlation	p-value	contango	backwardation	paired-samples t-test		effect of futures prices on spot prices		effect of spot prices on futures prices	
	mean	std. dev.	mean	std.dev.					t-value	p-value	F-value	p-value	F-value	p-value
AGRICULTURE- FOODS														
wheat	1060.2983	103.9340	981.1271	70.8199	0.5186	0.0000	12.78%	87.22%	14.2743	0.0000	2.5892	0.0188	2.0160	0.0640
potato	689.4740	138.5450	698.9230	104.8908	0.9067	0.0000	67.57%	32.43%	-1.8541	0.0657	13.4410	0.0000	12.0798	0.0000
maize	675.7863	59.5454	700.5502	85.2772	0.5367	0.0000	71.89%	28.11%	-5.3338	0.0000	2.8610	0.0104	3.0081	0.0075
barley	804.4312	18.9854	783.1307	53.7629	-0.1647	0.0998	30.69%	69.31%	3.5742	0.0005	3.9579	0.0016	3.4632	0.0042
masoor	1968.7035	248.2427	2003.7131	262.1422	0.9887	0.0000	81.15%	18.85%	-13.3911	0.0000	6.2613	0.0000	17.1103	0.0000
jeera	8959.9650	1902.3204	8951.1022	2206.8753	0.9936	0.0000	52.78%	47.22%	0.3103	0.7567	22.3235	0.0000	9.4551	0.0000
gur	539.1317	31.9263	529.5497	20.8181	0.6846	0.0000	30.29%	69.71%	5.4414	0.0000	1.1689	0.3255	1.0603	0.3886
groundnut oil	550.3739	60.6190	555.3856	61.5693	0.9918	0.0000	82.76%	17.24%	-10.2528	0.0000	0.6381	0.6997	36.6650	0.0000
groundnut (in shell)	387.9470	27.8026	387.3544	25.4064	0.9800	0.0000	34.07%	65.93%	1.1809	0.2397	10.0128	0.0000	9.6638	0.0000
guar seeds	1849.7652	105.4223	1946.6630	110.6932	0.9183	0.0000	99.63%	0.37%	-36.1961	0.0000	87.0469	0.0000	72.0035	0.0000
sesame seeds	3256.9391	240.0350	3266.2435	219.8537	0.9161	0.0000	60.43%	39.57%	-1.4664	0.1439	2.8568	0.0107	10.0690	0.0000
mustard seeds	356.9603	21.5246	365.6541	21.8086	0.7817	0.0000	74.36%	25.64%	-8.4789	0.0000	0.5287	0.7860	0.2724	0.9493
cashew	4671.0470	126.7707	4693.6752	124.4288	0.9781	0.0000	87.18%	12.82%	-9.2846	0.0000	0.2492	0.9586	8.1776	0.0000
arabica coffee	108.8855	9.9008	109.7742	9.5020	0.9917	0.0000	82.39%	17.61%	-8.5422	0.0000	8.3795	0.0000	49.1567	0.0000
chilli	5585.6738	924.8841	5423.1118	818.3496	0.7330	0.0000	51.18%	48.82%	3.2884	0.0012	30.3814	0.0000	28.4447	0.0000
castor seeds	340.9076	36.9922	354.5175	34.4537	0.9789	0.0000	96.21%	3.79%	-25.4930	0.0000	18.4917	0.0000	15.6236	0.0000
AGRICULTURE- NONFOODS														
cotton	19983.8012	526.9997	20193.9615	637.9100	0.9789	0.0000	94.87%	5.13%	-16.1233	0.0000	55.8870	0.0000	41.3655	0.0000
mentha oil	600.7367	65.9823	569.2040	112.2633	0.9340	0.0000	33.92%	66.08%	6.3598	0.0000	5.3222	0.0001	43.7352	0.0000
METALS														
gold	9257.0409	349.6129	9079.5020	694.5601	0.9122	0.0000	54.25%	45.75%	4.7752	0.0000	9.0276	0.0000	3.5322	0.0023
silver	18219.1174	1171.4027	18374.5083	1224.8660	0.9631	0.0000	79.56%	20.44%	-6.3385	0.0000	63.1542	0.0000	17.9051	0.0000
aluminium ingot	119.0895	5.2464	121.1152	5.2984	0.7162	0.0000	69.01%	30.99%	-6.6684	0.0000	2.2818	0.0388	11.0664	0.0000

(Source: primary data)