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Full Length Research Paper

Lead - lag relationship between the futures and spot prices

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This paper examined the relationship between the futures market and spot market for the lean hogs and pork bellies markets during the sample period January 2001 through May 2010 and quantifies the price discovery function of commodity futures prices in relation to spot prices of the sample markets. The econometric tools like Unit root tests and Pairwise Granger Causality tests were employed in the study. The Augmented Dickey Fuller tests and Phillips-Perron tests employed in the study proved that both the selected markets were stationary series and the Granger Causality test proved bi-causality relationships among these markets. Hence, it was concluded that the profitable arbitrage does not exist in both of these markets and they are said to be in perfect equilibrium.

Key words: Price discovery, causality, lean hogs and pork bellies.

INTRODUCTION

More than a hundred commodities are today available for trading in the commodity futures market and more than fifty of them are actively traded. These include Bullion, Metals, Agricultural Commodities and Energy products. Bullion [Gold, silver and Platinum] accounts for around 42% of the total trade value, followed by agricultural commodities, which accounts for 23% of the trading value. The functioning of the market is closely monitored by the Forward Markets Commission and appropriate regulatory measures are taken by the Commission from time to time to ensure the proper functioning of the market.

There is further significant scope for development of the commodity futures market in India. The Forward Markets Commission has taken several steps to familiarize the market participants with the market and thereby encourage them to participate in the market for hedging their price risk. These include:

1. Conducting awareness programmes for various classes of participants including farmers;
2. Identifying agencies that can facilitate participation in the market such as cooperatives, banks, State and Central Government Offices, agricultural universities, etc and providing them training on the commodity futures markets;
3. Conducting regular meetings with various stakeholders of the market such as Members of the Exchanges, Cooperatives, Banks and various Trade Bodies etc, to understand their perspective of the market and take necessary regulatory measures, wherever necessary, to strengthen the market;
4. Identifying the agencies and the organizations that could eventually play the role of aggregators for the farmers, who find it difficult to enter the market directly because of the complexities involved.

In addition, to develop the market, the Forward Markets Commission is also committed to ensuring that the benefits of price discovery, an important economic function of the commodity futures market are made available to the farmers who because of lack of price information are still not able to get the right price for their produce. Thus, it can be said that the futures market performs two important functions, one of which is price risk management and the other one is price discovery (Garbade and Silber, 1983). The price risk refers to the probability of adverse movements in prices of commodities, services or assets, Whereas, price discovery is said to be the process of buyers and sellers arriving at a transaction price for a given quality and quantity of a product at a given time and place.

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In general, it is said that the forward and futures contracts are efficient risk management tools which insulate buyers and sellers from unexpected changes in future price movements (Black, 1976). These contracts enable them to lock in the prices of the products well in advance. Moreover, futures prices give necessary indications to producers and consumers about the likely future ready price and demand and supply conditions of the commodity traded. The cash market or ready delivery market on the other hand is a time-tested market system which is used in all forms of business to transfer title of goods. Futures and cash prices present an interesting case for application of causality-type relationships (Peck, 1985). One might expect, a priori, that a predictive relationship may exist between these two market prices. If one considers the futures prices at time t for delivery at time t + k as the expectation held at time t of the cash price in period t + k, then the relationship between futures price and cash price is defined by the order of integration of cash price (Bessler and Covey, 1991). As a result of this, it is interesting to investigate the causal relationship between both price series, in order to ascertain which series provides an indication of the other in the future, that is, if futures prices lead cash prices or vice-versa. If this is so, then cash market participants can use futures position as a risk minimization tool. Hence, this paper attempts to investigate the statistical relationship that exists between the price movements in the cash market and futures market with reference to selected non-storable commodities of lean hogs and pork bellies.

REVIEW OF LITERATURE

Ehrich (1969) studied the cash-futures price relationships for live beef cattle markets during 1948 to 1966. The results suggested that there were long run price relationships between the spot and futures prices of the sample market and it was also found that the cash markets lead the futures markets. Leuthold (1974) investigated the price performance of live beef cattle on the futures market during April 1965 to February 1971. From the results, it was found that cash cattle prices were found to be more accurate indicators of subsequent cash cattle price conditions than are the futures prices for distant contracts. In other words, evaluation of live beef cattle price relationships revealed that for distant futures, the cash price is a more accurate indicator of future cash price conditions than is the futures price.

Also, the futures price becomes less and less efficient both absolutely and relative to the cash price estimates. In other words, the cash price is more stable than the futures price for distant contracts. Oellermann et al. (1985) investigated lead lag relation between change in futures and spot price for live beef cattle between 1966 and 1982. The futures price led spot price during nearly every sub period analysed. Based on Granger causality test for various sub samples of their data, they concluded that change in live cattle futures price led change in live cattle spot price. They also found that the spot market responded to change in futures price within one trading day. The authors concluded that futures market was the centre of price discovery for live cattle. They suggest that a likely explanation for the results is that the futures market serves as a focal point for information assimilation. They concluded that the cattle futures market contributes towards a more efficient price discovery process in the underlying spot market for live beef cattle. Bessler and Covey (1991) studied the futures/cash price relationships for slaughter cattle, a non-storable commodity. They used daily settlement prices for the nearby live cattle futures contract from August 21, 1985 through August 20, 1986, and daily average cash prices (per cwt.) for direct sale of choice 900-1300lbs. slaughter cattle steers in the Texas-Oklahoma market.

Their cash series reflected a direct rather than auction sales market for slaughter cattle. Thus, their cash series included sales throughout the entire five-day business week. For a sample of 261 observations on daily live cattle prices, they obtained mixed results. Within sample fits (conducted on the first 130 data points) indicated that both cash and futures prices were generated by processes not statistically distinguishable from a random walk. Tests for cointegration based on residuals from a static regression (using the same 130 data points) showed marginal support for the cointegration hypothesis between cash and nearby futures prices. No cointegration was discovered between cash prices and more distant contracts. The results are consistent with the suggestion that the greater the temporal spread between futures and cash prices, the greater the degree of independence.

METHODOLOGY

The study period of this research was made during 2nd January 2001 to 31st May 2010. The spot and futures prices of lean hogs and pork bellies were obtained from Multi Commodity Exchange of India (MCX). The stationary of the data series was evaluated by Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests. The ADF test uses the existence of a unit root as the null hypothesis, that is:

H_0: $\alpha = 0$
H_1: $\alpha \neq 0$

The test for stationary are carried out by estimating the following equation:

$$Y_t = \alpha_1 Y_{t-1} + U_t \quad (1)$$

The distribution theory supporting the ADF assumes that the errors are statistically independent and have a constant variance. PP test allows the disturbances to be weekly dependent and heterogeneously distributed. The dynamic linkage between the

Table 1. Unit root test results: Augmented Dickey and Fuller (ADF) test.

Commodities	Null hypothesis	t-statistic	p-value*
Lean hogs	Futures prices series has a unit root	-3.545348	0.0070
	Spot prices series has a unit root	-3.389452	0.0114
Pork bellies	Futures prices series has a unit root	-4.138891	0.0009
	Spot prices series has a unit root	-5.210016	0.0000

Confidence level α = 0.05.

Table 2. Unit root test results: Phillips-Perron (PP) test.

Commodities	Null hypothesis	t-statistic	p-value*
Lean hogs	Futures prices series has a Unit Root	-3.702559	0.0042
	Spot prices series has a Unit Root	-3.046942	0.0309
Pork bellies	Futures prices series has a Unit Root	-4.259133	0.0005
	Spot prices series has a Unit Root	-4.586641	0.0001

Confidence level α = 0.05.

Table 3. Pair-wise Granger causality test results.

Commodities	Null hypothesis	Obs	F-Statistic	P - value
Lean hogs	Spot price series does not Granger Cause Futures price series	2250	12.1038	5.9E-06
	Futures price series does not Granger Cause Spot price series		5.17687	0.00571
Pork bellies	Spot price series does not Granger Cause Futures price series	2251	4.01830	0.01811
	Futures price series does not Granger Cause Spot price series		9.62422	6.9E-05

futures prices series and the spot prices series is given by the Pair-wise Granger Causality tests (Granger, 1986). Testing the causality between two stationary series X_t and Y_t are based on the following equations:

$$X_t = \alpha_0 + \sum_{j=1}^{k} \gamma_j x_{t-j} + \sum_{j=1}^{k} \beta_j y_{t-j} + u_{xt} \quad (2)$$

$$Y_t = \alpha_0 + \sum_{j=1}^{k} \gamma_j x_{t-j} + \sum_{j=1}^{k} \beta_j y_{t-j} + u_{yt} \quad (3)$$

Where k is a suitably chosen positive integer, γ_j and β_j , j = 0,1,……k parameters, α is a constant and U_t is disturbance term with zero means and finite variance. The null hypothesis that Y_t does not granger cause X_t is not accepted if β_j s,j > 0 as in Equation 2, are jointly different from zero using a standard joint test. Similarly, X_t Granger causes Y_t, if γ_j are j>0, coefficients in Equation 3 are jointly different from zero.

RESULTS

A necessary condition in a time series data is that the data have to be stationary. The tests of stationarity developed through Augmented Dickey Fuller, have been performed for the selected series and the results were presented in Table 1. To double check the robustness of the results, Phillips and Perron (1988) test of stationarity have also been performed for the series. The results of this test were presented in Table 2.

The optimal lag numbers of each series were tested by using the Akaike's Information Criteria (AIC). From the estimates of the Augmented Dickey Fuller (ADF) and Phillips Peron (PP) test results, it was found that the series were stationary at their levels.

The pair wise Ganger Causality tests were conducted to show, as to whether spot price series causes future price series or vice versa and the results were given in Table 3.

The reported F-statistic value and the probability value suggested that there was bi-directional causality between the selected futures price series and spot price series of the lean Hogs; and so is the case for the Pork bellies market also.

In the case of this market, also it was found that the futures price series causes spot price series and vice versa.

Conclusion

This study investigates lead-lag relationships for the non-storable commodities of lean hogs and pork bellies from January 2001 to May 2010. The stationary test results provided evidence that both the selected markets were stationary. Hence, the Granger causality test was followed. From the study we found that in short term future price series drive (Granger cause) the cash market and vice versa for both the selected markets. The result proved that there was no profitable arbitrage that exists and that the selected markets were perfectly efficient. Hence, new information disseminating into the market place immediately reflected in spot prices and the futures prices simultaneously.

In other words, this suggests that there was no lead-lag relationship between the cash and futures prices of the selected markets. The study can be very helpful to the investors, producers and academicians who are very keen in observing the trend of these markets. Since the interests of the investors on the non storable markets are comparatively low when compared to the agricultural products, research contribution to the knowledge on these markets can help in extending its market boundaries. At the same time, it is suggested that in future, the study can still be extended as the comparison between some of the storable assets and the non storable assets, so that a clear understanding on whether asset storability impacts price discovery can be empirically proven.

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