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Whether Commodity Futures Market in Agriculture is Efficient in Price Discovery ? — An Econometric Analysis

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Abstract

In any agriculture-dominated economy, like India, farmers face not only yield risk but price risk as well. Commodity futures and derivatives have a crucial role to play in the price risk management process, especially in agriculture. The present study is an investigation into the futures markets in agricultural commodities in India. The statistical analysis of data on price discovery in a sample of four agricultural commodities traded in futures exchanges have indicated that price discovery does not occur in agricultural commodity futures market. The econometric analysis of the relationship between price return, volume, market depth and volatility has shown that the market volume and depth are not significantly influenced by the return and volatility of futures as well as spot markets. The Bartlett's test statistic has been found insignificant in both the exchanges, signifying that the futures and spot markets are not integrated. The exchange-specific problems like thin volume and low market depth, infrequent trading, lack of effective participation of trading members, non-awareness of futures market among farmers, no well-developed spot market in the vicinity of futures market, poor physical delivery, absence of a well-developed grading and standardization system and market imperfections have been found as the major deficiencies retarding the growth of futures market. The future of futures market in respect of agricultural commodities in India, calls for a more focused and pragmatic approach from the government. The Forward Markets Commission and SEBI have a greater role in addressing all the institutional and policy level constraints so as to make the agricultural commodity futures and derivatives a meaningful, purposeful and vibrant segment for price risk management in the Indian agriculture.

Introduction

'Commodity Futures' and 'Derivatives' have been well recognised for the functions of risk management and forward pricing for a long time (FMC, 1952). However, till late-1980s, its use was limited to a few developed countries where it has emerged as a highly developed market. During 1990s, the economic liberalisation in many countries led to increasing withdrawal of the government's intervention from the agricultural commodity sector, which made the agricultural prices dependent on the domestic and international market forces (UNCTAD, 1997; 1998). As a result, the need for an effective price risk management mechanism for the protection of commodity sector from price volatility has been realised earnestly.

Changing economic environment, increasing commodity uses through value addition at different stages, increasing number of market participants, changing demand and supply position of agricultural commodities and growing international competitions require wider roles for futures markets in the

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agricultural economy (Wang, 2003). Therefore, many countries have been establishing and promoting commodity futures market. In India also, where the futures market had been in a dormant stage for a long time, the interest in these markets has been revived and efforts are being made to promote the futures markets in the country for their wider role in the changing economic environment (FMC, 2000). At present, the futures and derivatives segment has been growing at an alarming rate, which is a positive sign of development. The present study has analysed the agricultural commodity futures market in its role in price discovery.

Futures and Price Discovery

Futures market perform two important functions of price discovery and price risk management with reference to the given commodity. It is highly useful to all the segments of economy. It is useful to the producer because he can get an idea of the price likely to prevail at a future point of time and therefore, can decide between various competing commodities and choose the best that suits him. It enables the consumer to get an idea of the price at which the commodity would be available at a future point of time. The futures trading is also much useful to the exporters as it provides an advance indication of the price likely to prevail and thereby helps the exporter in quoting a realistic price and secure export contract in a competitive market. Having entered into an export contract, it enables him to hedge his risk by operating in futures market.

Hedging in Futures Market

Futures market attracts hedgers for risk management and encourages considerable external competition from those who possess market information and price judgment to trade in these commodities. While hedgers have long-term perspective of the market, the traders or arbitrageurs, prefer an immediate view of the market. However, all these users participate in buying and selling of commodities, based on various domestic and global parameters such as price, demand and supply, climatic and market-related information. This results in efficient price discovery, allowing a large number of buyers and sellers to trade on these exchanges (Jones,1994). Hedging is the practice of off-setting the price risk inherent in any cash market position by taking an equal but opposite position in the futures market. This technique is highly useful in case of any long-term requirement for which the prices have to be confirmed to quote a sale price but avoids buying the physical commodity immediately to prevent blocking of funds and incurring large holding costs (Tomek and Peterson, 2001).

Process of Price Discovery

Futures prices increase or decrease largely because of the myriad factors that influence buyers' and sellers' expectations about what a particular commodity will be worth at a given time in future. As new supply and demand developments occur and as more current information becomes available, these judgments are reassessed and the price of a particular futures contract may be bid upward or downward. This process of reassessment of price discovery is continuous (Garbade and Silber, 1982). On any given day, the price of a July futures contract of a commodity will reflect the consensus of buyers' and sellers' current opinions about what the value of the commodity will be when the contract expires in July. As new or more accurate information becomes available or as expectations change, the July futures price may increase or decrease. Competitive price discovery is a major economic function— and, indeed, a major economic benefit— of futures trading. Through this competition, all available information about the future value of a commodity is continuously translated into the language of price, providing a dynamic barometer of supply and demand. Price "transparency" assures that everyone has access to the same information at the same time (Hazell, 1990).

Whether Futures Markets are Efficient in Price Discovery?

Farmers sought to lock in a value on their crop and were willing to pay a price for certainty. They give up the chance of very high prices in return for protection against abysmally low prices. This practice of removing risk from farm business plans is called hedging. As a rule of thumb, about half of the participants in the futures markets are hedgers

who come to the market to remove or reduce their risk. For the market to function, however, it cannot consist only of hedgers, seeking to lay off risk. There must be someone who comes to the market in order to take on risk. They are the "speculators", who come to the market to take risk, and to make money by doing it. But, our interest in the present study is to examine how far these futures markets are helpful to farmers who would like to hedge their produce as a means of price risk management. However, such type of hedging will be successful only if these futures markets are efficient in price discovery (Sudhir *et al*., 2004). The specific objectives of the study were:

(i) to assess the efficiency of commodity futures market in its role of price discovery and in providing hedge against price risk in select agricultural commodities;

(ii) to carry out an econometric analysis of price volatility and price behaviour of spot and futures market; and

(iii) to identify the bottlenecks in agricultural commodities trading and possible policy solutions for improving the futures markets in India.

Data and Methodology

In the present study, future and spot prices of four agricultural commodities (castor, cotton, pepper and soya) were collected from the MCX and NCDEX exchanges. Four contracts for each commodity were considered for the present study to assess the price discovery. The OLS method was utilized to estimate the equation for daily futures prices of above-mentioned four commodities. The problem of serial correlation was diagnosed and the iterative Cochrane-Orcutt procedure was used for making necessary adjustments in coefficient estimates. The Wald chi-square procedure was used for parametric restriction on coefficients to test the market efficiency and unbiasedness of futures prices. The interaction between volatility, return, market depth and trading volume was estimated econometrically. Bartlett's homogeneity of variance test was used to test the integration between spot and futures markets.

Expectations Theory

The price discovery is the process of determining the price of a commodity, based on supply and demand factors. The expectations theory hypothesises that the current futures price is a consensus forecast of the value of the spot price at a future point of time. For example, today's 90-day cotton futures rate is a market forecast of the spot rate that will prevail in the spot market after 90 days. The futures market for a commodity is said to be efficient when the *n*-period futures rate ($FP_{t,n}$) is equal to the future spot rate (SP_{t+n}). The efficient market ensures that the average difference between today's futures rate (with *n* days maturity) and the subsequent spot rate *n* days later is zero. The difference, if any, represents both the futures rates forecasting error and the opportunity for gain (or loss) from open positions in the market. The efficiency of the futures market is usually examined by testing the unbiasedness of futures rate as a predictor of spot rate that will prevail in the future (Sahadevan, 2002).

Hypothesis I

The hypothesis postulated in the present study is that "the futures markets are efficient in the sense that the price discovery does occur in futures market".

Econometric Analysis

The above hypothesis can be tested by the following set of regression equations with parametric restrictions on its coefficients:

$$DISCP^{i}_{t+1} = \mu + \lambda\, FUSP^{i}_{t} + \varepsilon^{i}_{t+1} \quad \ldots(1)$$

$$DISCP^{i}_{t+1} = (SP^{i}_{t+1} - SP^{i}_{t}) \quad \ldots(2)$$

$$FUSP^{i}_{t} = (FP^{i}{}'t - SP^{i}{}'t) \quad \ldots(3)$$

where, $t = 1,2,\ldots\ldots\ldots,T$

$i = 1,2,\ldots\ldots\ldots,n$ (commodities)

and SP_t and SP_{t+1} are the logarithms of the spot rate at times t and $t+1$, respectively; FP_t is the logarithm of the futures rate established at time t for period $t+1$, and ε_{t+1} is an error-term. In this form, if there is 'Price Discovery', then the unbiasedness hypothesis implies that intercept $\mu = 0$ and slope $\lambda = 1$. Such a

restriction is consistent with the model of a competitive market with no transaction costs, risk-neutral speculators and market expectations which are rational. For that model, the expectation of premium or discount in the futures market is given by Equation (4):

$$E_t[\ DISCP^i_{t+1}\ ] = FUSP^i_{\ t} \qquad \ldots(4)$$

where, E_t is the mathematical expectation operator conditional upon some information set. The test relation in Equation (1) and the joint null hypothesis of rational expectations and no risk premium implicit in Eqation (2) can be related by decomposing the actual change in the spot rate into two orthogonal components.

Testing of Hypothesis I

Testing of unbiasedness hypothesis involves estimating the regression Eqation (1) with coefficient restrictions and determining whether the coefficient estimates of $\mu = 0$ and $\lambda = 1$ are significantly different from zero and one, respectively and this joint null hypothesis can be tested by Wald chi-square test statistics. The study has utilized the OLS method to estimate the equation for daily futures prices of the selected agricultural commodities. The coefficient estimates of the equation were corrected for serial correlation by using iterative Cochrane-Orcutt procedure and the autoregressive parameter (ρ) estimates have been reported. The daily prices of multiple contracts have been used for estimation.

Empirical Results

The test results based on the estimates of Equation (1) are presented in Table1. It could be inferred from Table1 that the joint null hypothesis that $\mu = 0$ and $\lambda = 1$, was rejected in all sample cases (except Castor Sep 07 contract) of futures contracts. The significant Wald chi-square test statistics indicated that futures markets were not efficient in predicting the future spot prices which implied that price discovery did not occur in futures market. This result further emphasized the fact that the futures contracts were not perfect hedge against the variations in spot prices. A perfect hedge guarantees that the profit or loss on the futures contracts fully offsets the loss or profit on the physical transactions in the spot market. If there is any disparity between the futures price for a specific maturity contract and the spot prices in physical market on the day of the maturity of futures contract, it exposes the participants to basis risk. The users of futures markets face this risk because the specific physical commodity they wish to hedge does not have the same price development as that of the standardized futures contract. There may be many imperfections in the market for the commodities under study which would make spot prices deviate from the corresponding futures prices.

The absence of efficient price discovery in futures markets can be attributed to several factors. Wherever there is government intervention to manipulate the market by affecting supply (e.g. monopoly procurement in cotton), the relation between futures prices and spot market prices may get distorted. Also, in the commodities of export-orientation (like pepper), prices in the spot market are sometimes driven by the unexpected changes in exchange rate, which are not factored into the futures prices and by the demand situation in international market. Moreover, in most cases, futures exchanges are not located in the area where well developed spot market exists. Further, many a times, future exchanges have thin trading volumes and infrequent trading. Above all, unlike the industry, the agricultural production originates from the unorganised sector involving several lakhs of smallholdings and thereby allowing a scope for interplay of many intermediaries between farmer and wholesaler/exporter, which ultimately make the supply and price development in spot market unpredictable, that eventually results in inefficiency of futures market in price discovery.

Volatility, Trading Volume and Market Depth

Theories predict a positive contemporaneous correlation between trading volume and price volatility. Evidence from empirical studies such as those by Gallant *et al.* (1992), and Sahadevan (2002) have proved that return, volatility and volume are positively related. It is expected that higher the market depth, lower would be the price volatility. In the present study, the relationship of volume and market depth with return and volatility was

Table 1. Restricted least squares regression output

Commodity	Contract	μ	λ	Wald	D-W	Adj R^2	ρ_1	ρ_2
Castor	Mar. 2007	-0.14	0.60	352.42	1.45	0.96	0.70	-0.32
		(-8.18)*	(7.43)*	(0.001)			(5.21)	(-1.95)
	Jun. 2007	-0.11	0.47	175.07	1.68	0.92	1.14	-0.24
		(-2.20)	(94.08)	(0.00)			(8.30)	(-2.61)
	Sep. 2007	-0.01	0.92	3.71	1.85	0.97	1.30	-0.36
		(-0.14)*	(24.05)**	(0.16)			(8.95)	(-2.51)
	Dec. 2007	-0.02	0.64	27.62	1.96	0.94	1.19	-0.27
		(-0.71)*	(95.92)	(0.02)			(8.87)	(-1.74)
Cotton	Mar. 2007	0.04	0.51	10.56	1.57	0.94	1.02	-0.24
		(1.08)	(11.45)	(0.002)			(41.05)	(-1.46)
	May 2007	0.02	0.42	104.32	1.69	0.96	1.12	-0.38
		(2.94)*	(12.44)	(0.00)			(11.35)	(-1.65)
	Jul. 2007	0.01	0.69	29.74	1.40	0.98	1.20	-0.19
		(2.75)*	(30.81)**	(0.001)			(18.40)	(-6.59)
	Oct. 2007	0.13	0.67	48.54	1.51	0.97	0.98	-0.40
		(14.52)	(10.52)*	(0.00)			(36.48)	(-8.43)
Pepper	Sep. 2007	-0.24	0.31	81.24	1.71	0.96	1.30	-0.42
		(-1.64)	(0.95)	(0.02)			(18.36)	
	Oct. 2007	-0.19	0.27	134.56	1.86	0.95	1.21	-0.23
		(-8.54)	(3.14)*	(0.001)			(12.18)	
	Nov.2007	-0.45	0.19	158.27	1.49	0.97	1.04	-0.65
		(9.74)*	(1.28)	(0.00)			(40.05)	
	Dec. 2007	-0.36	0.41	169.35	1.92	0.95	1.52	-0.28
		(-2.10)	(5.64)*	(0.00)			(12.06)	
Soya	Oct. 2007	-0.04	0.73	94.55	1.72	0.96	0.86	-0.30
		(-0.25)*	(21.26)*	(0.02)			(20.35)	
	Nov.2007	-0.17	0.79	38.45	1.84	0.98	1.02	-0.15
		(-9.65)	(8.64)*	(0.01)			(50.05)	
	Dec. 2007	0.32	0.90	43.78	1.64	0.97	1.54	-0.40
		(-5.17)	(19.35)**	(0.00)			(24.17)	
	Jan. 2008	-0.02	0.58	34.30	1.70	0.94	0.98	-0.12
		(-4.78)*	(31.64)	(0.01)			(20.08)	

Note: The contract indicates the month and year in which the particular contract matured. The values within the parentheses are f-statistics and one, two and three asterisks indicate level of confidence at one and five per cent, respectively. Wald is the Wald *Chi-square* test statistic with the corresponding *p*-values within parentheses. D-W is the Durbin-Watson statistic. Adj R^2 is the adjusted R^2 value. The notations ρ_1 and ρ_2 are first and second order auto-regression parameter estimates.

investigated and the following relationship was specified for estimation:

$$FTRV_{it} = \gamma + \delta_1 FRTN_{it} + \delta_2 SVOL_{it+} \Omega!_{it} \quad \ldots(5)$$

$$MDEP_{it} = \omega + \gamma_1 FVOL_{it} + \partial_2 SVOL_{it} + \phi_{it} \quad \ldots(6)$$

where, $FTRV_{it}$ is the futures trading volume of the i^{th} commodity at time *t,* FRTN, MDEP, and FVOL represent return, depth and volatility of futures, and SVOL measures volatility of the spot market prices. The return is calculated from the closing price (P_{cit}) data as log (P_{cit}/P_{cit-1}). The open interest (position) is taken as a proxy for market depth because it reflects the current willingness of futures traders to risk their capital in the futures position, which indicates the level of market depth. The volatility of futures and spot price returns are defined as the deviations from their respective mean values. The coefficients δ_1 and δ_2 in Equation (5) are expected to have positive values, while ∂_1 and ∂_2 in Equation (6)

to have negative and positive values, respectively. The market becomes deeper and busy when return volatility is lower, and vice versa. If the volatility of the spot market is high, on the contrary, futures market becomes more active and deeper (Jones *et al*.,1994). The study has used month-end total open position, total volume and month-end closing prices of the contract closes to expiration and the study has covered the contract period for the respective commodities, ranging from Nov.2006 to Jan.2008.

Empirical Results

The coefficients corresponding to trading volume and market depth equations were estimated for all sample futures markets and the results obtained are reported in Tables 2 and 3, respectively.

The relationship between futures returns and volume of trade was found not significant in most of the sample futures market (except pepper in NCDEX exchange). The statistically insignificant δ_2 coefficient signifies that the futures markets are more utilized for speculative transactions than for hedging price risk. The overall results in Table 3 indicate that price return volatility in futures and spot markets do not determine the volume of trade in futures markets. Similarly, the estimates of Equation (6) reported in Tables 2 and 3 show that the net open positions in futures markets are not determined by spot and futures price return volatilities in most of the markets. Thus, the test of relationship between volume, futures price return and spot price volatility did not provide any uniform evidence across the markets. A highly volatile spot market boosts trading activity in futures and a resultant increase in the volume of activity which would eventually reduce futures price volatility. But, as far as the agricultural commodity futures are concerned, the price volatility in spot markets, in general, did not have any impact on the market conditions in futures markets and hence it shows that the futures market and spot markets are not integrated.

Hypothesis II

'There exists equal variances in the spot and future prices' of the agricultural commodities in India.

Table 2. Relationship between volume, return and volatility

Commodity (Exchange)	γ	δ_1	δ_2	D-W	Adj R^2	ρ_1	ρ_2
Castor (MCX)	-1.37	2.43	-4.62	1.86	0.24	0.36	-0.04
	(-6.42)*	(1.04)	(-1.14)			(2.90)	(2.18)
Cotton (MCX)	2.14	0.426	-1.14	2.03	0.38	0.82	-0.21
	(3.62)*	(0.84)	(0.91)			(9.54)	(-1.84)
Pepper (NCDEX)	3.65	4.12	-1.94	1.96	0.59	0.73	-
	(24.05)*	(2.61)**	(1.65)**			(9.47)	
Soya (NCDEX)	-0.17	-1.30	-0.74	2.11	0.22	0.39	-0.42
	(0.34)	(1.06)	(-1.22)			(2.24)	(-3.68)

Table 3. Market depth, return and volatility

Commodity (Exchange)	ω	∂_1	∂_2	D.W	Adj R^2	ρ_1	ρ_2
Castor (MCX)	-2.85	7.08	-10.14	1.79	0.34	0.17	-0.25
	(-18.41)*	(1.49)	(-2.04)*			(-2.16)	(-2.17)
Cotton (MCX)	-0.62	-0.019	0.425	2.10	0.41	0.72	-
	(7.46) *	(-0.02)	(0.231)			(6.23)	
Pepper (NCDEX)	-1.13	0.591	-0.478	1.76	0.38	0.79	-
	(-2.17)	(-0.824)	(1.21)			(8.25)	
Soya (NCDEX)	-0.24	-1.26	-0.78	2.05	0.23	0.92	-0.21
	(0.39)	(3.15)	(2.49)			(10.21)	(-1.85)

Testing of Hypothesis II (Test of Equality of Variances)

The uniform and interdependent behaviour of the two markets was verified by testing the equality of variances of futures and spot market price changes using Bartlett's statistic. According to the test, the null hypothesis of equal variances is rejected, if the test statistic exceeds the critical value from a χ^2 distribution with (n-1) degrees of freedom. The price and returns behaviour in futures and spot markets may differ. However, both the markets would be better integrated if the market is matured. Higher price volatility in the spot market would make the futures market more active as it provides hedge against the risk and better opportunity for speculators for booking profit. The results of Bartlett's homogeneity of variance test are reported in Table 4.

The Bartlett's test statistic was insignificant in both the exchanges, signifying that these two futures markets were not at all aligned with their respective spot markets. An essential condition for a vibrant futures market in any commodity is the presence of active participation of many trading members and frequent trading and proximity of developed spot market. This proximity and interdependence make risk management more efficient and accessible to various participants. A highly volatile spot market boosts the trading activity in futures and a resultant increase in the volume of activity which would eventually reduce futures price volatility. But, as far as the agricultural commodity futures are concerned, the price volatility in spot markets did not have any impact on the market conditions in futures markets and hence it shows that the futures market and spot markets are not integrated.

Table 4. Bartlett's homogeneity variance test

Commodity (Exchange)	Variance		Bartlett's statistic
	Futures return	Ready return	
Castor (MCX)	0.004	0.007	0.052
Cotton (MCX)	0.007	0.005	1.068
Pepper (NCDEX)	0.012	0.016	0.407
Soya (NCDEX)	0.017	0.020	1.013

Conclusions

In any agriculture-dominated economy, like India, the farmers face not only yield risk but price risk as well. Commodity futures and derivatives have a crucial role to play in the price risk management process, especially in agriculture. The present study has investigated the futures markets in agricultural commodities in India and has outlined the status of futures markets in agricultural commodities in the Indian context. More specifically, this study has attempted to assess the efficiency of futures market in India.

The statistical analysis of data on price discovery in a sample of four agricultural commodities traded in futures exchanges has shown that the futures market in those commodities are not efficient, which implies that the futures exchanges fail to provide an efficient hedge against the risk emerging from volatile prices of those commodities. Therefore, it is quite obvious that price discovery does not occur in agricultural commodity futures market. The difference between the futures prices and the future spot prices is an indication of inefficiency arising from the underdeveloped nature of the market.

The econometric analysis of the relationship between price, return, volume, market depth and volatility on a sample of four agricultural commodities has shown that the market volume and depth are not significantly influenced by the return and volatility of futures as well as spot markets. The price volatility in the spot markets does not have any impact on the market conditions in futures markets. Even the Bartlett's test statistic is insignificant in both the exchanges, signifying that these futures markets are not at all aligned with their respective spot markets. The results have indicated that the futures and spot markets are not integrated.

Even though several factors attribute to the inefficient functioning of futures market, the exchange-specific problems like thin volume and low market depth, infrequent trading, lack of effective participation of trading members, non-awareness of futures market among farmers, not well-developed spot market in the vicinity of futures market, poor physical delivery in many commodity markets, absence of well-developed grading and

standardization system and market imperfections are the major drawbacks retarding the growth of futures market. Only when, these problems are addressed by proper policy perspectives, the efficiency of these commodity futures market, especially in the agricultural sector can be improved to make the futures and derivatives as successful instruments in the commodity market.

Policy Implications

- The policy should facilitate the creation of a new 'institutional design' exclusively (like SEBI in the case of Stock Exchanges) for governing, monitoring and regulating the futures and derivatives markets in agricultural commodities.
- Policy should aim to reduce the margin money in commodities where there is less price volatility so as to increase the market depth.
- Institutional creation of a new service sector with public-private partnership (PPP) to deal with the standardization and grading of agricultural produce.
- Policy directives should ensure certain percentage of contract linked to compulsory physical delivery and off-take to avoid too much of speculation.
- Shifting the focus of the present system of 'Production-Oriented Extension' to 'Market-Oriented Extension' in agriculture to create awareness on futures and derivatives market among farmers.
- Enhancing the capacity building of farmers' organisations through NGOs' intervention for facilitating active participation in futures market.
- Quality linked 'On-line Pricing' with provisions for enforcement of appropriate sanctions against defaulters in commodity trading.

The future of futures market in respect of agricultural commodities in India, calls for a more focused and pragmatic approach from the government. The Forward Markets Commission and SEBI have a greater role in addressing all the institutional and policy-level constraints so as to make the agricultural commodity futures and derivatives a meaningful, purposeful and vibrant segment for price risk management in the Indian agriculture.

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