ROLE OF COMMODITY FUTURES MARKET IN SPOT PRICE STABILIZATION, PRODUCTION AND INVENTORY DECISIONS WITH REFERENCE TO INDIA

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Abstract

The findings of this paper suggest that the allegation against futures market in India 'that it distorts the spot market price and creates artificial scarcity by allowing unnecessary hoarding', is a misconception. This paper finds out that there is a co-movement among futures price, production decision and the inventory decision. With the assumption that future market is monopolistically competitive, the paper finds that future price elasticity of production always being greater than or equal to one, an increase in profit by increasing price is not possible. Therefore, the doubt about its distorting effect on spot price can be ruled out. The suspicion about the increasing hoarding resulted from futures market can also be proved unjustified from results. Our results show that futures price elasticity of inventory is inversely related with the carrying cost. Therefore, an unnecessary hoarding will increase the carrying cost leading to a lower responsiveness of inventory to futures prices. This paper also finds out the effect of expected production shocks on futures price elasticity of supply.

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Introduction:

Attacks on commodity futures trading in the Indian context have always involved the charge that speculation caused both excessive and unwarranted price fluctuations. It has also been charged that the futures market only benefits the speculators who manipulate prices and works against the interest of growers and consumers. In the period before World War II, futures market in India was attacked for malpractice also. As a consequence, the cotton, jute and oilseeds exchanges were reorganized. During late fifties and sixties, future trading in many commodities has been prohibited in India on the ground that it distort prices by aggravating its rising trend. This decision of the Government generated a heated debate against the ban on the commodity futures trading in India.

Based on some general issues in the literature as discussed in the next section and some specific issues in the Indian context, this paper tries to answer the following questions in the context of Indian commodity futures market:

(i) Whether futures market can be used as a control measure to iron out price volatility in the commodity market.

(ii) What role does futures contract play in production and inventory decision.

And,

(iii) Whether futures market decisions depend on the expected production shock or not.

This study is divided into two broad sections. Apart from introduction and conclusion, section I is devoted to the background and the literature survey. Based on the debate that is going on for last couple of decades, this section brings out the relevant issues regarding the role of commodity futures market in Indian context. In section II, we build up a model to answer the questions regarding the influence of expected production shock on futures sale decision, inventory decision and the efficacy of futures market in price stabilization.

Section I : Back ground and Relevance of the Study in the Indian context:

To define it - a futures contract is an agreement that calls for the delivery of some commodities at a specified later date at a price decided at the time of contracting. In other words, this contract in agricultural commodities can be regarded as a commodity bond payable in terms of the commodity at the contract-specified date. Futures contract is a superior version of forward contract with two basic improvements: (i) First, is the concept of clearing house. It facilitates the transaction and also helps in avoiding breach of contract. By keeping a margin from both sides it ensures the coverage of any kind of default from each party. (ii) Second, futures market mechanism, entitles both the parties the right to sell the contract. This transfer of right to sell or purchase is known as option. The final transaction under futures contract takes place between the ultimate buyer and seller.

A brief history of futures market in India suggests that, Bombay Cotton Trade Association Ltd was the first to start futures trading during 1875 as a joint stock company. It was established by the European traders and its share capital was held entirely by them. In 1890, an independent institution named `Bombay Cotton Exchange' was formed. After this, a third body called the Bombay Cotton Brokers' Association was established in 1915 (Natu, 1962). The government of India took the first initiative to set up cotton contracts committee in 1918. In 1919, Cotton Contract Board replaced the committee to control the cotton trading. Ultimately, in 1922, a Central Cotton Association was formed and became popular as East India Cotton Association Ltd.

After cotton, the first futures market in oilseed was established in Bombay in 1900 followed by many others in Gujarat, Saurashtra and Punjab. The wheat futures market at Hapur began functioning from 1913 and subsequently, other futures markets in wheat and other food crops then developed in Punjab and UP as well as at Bombay and Calcutta. Futures trading in raw jute and Hessian began in Calcutta in 1912. Before the independence, though the stockholders of these different organizations were British but in many cases local Indian people also used to take part (Natu, 1962).

But futures market did not continue for a very long period of time. The Government of India banned futures trading with the allegation that it not only distorts prices but also helps malpractice to flourish. The futures market in molasses was banned in 1963. In 1965, futures trading in major oilseeds (such as groundnut, rapeseeds and mustard) and their products were also banned. Futures market in cotton remained closed even after the removal of price and distribution controls in 1967. This happened because the cotton textile industry was opposed to its reopening (Pavaskar, 1970).

Given this backdrop and the following literature on futures market, this paper is an endeavor to justify the importance of future market in the Indian context. If we look at the volume of arguments posed both by the critiques as well as the proponents of futures market in India, it is not a very easy task. According to some protagonists of futures marketing, the action of the Indian government was not supported by empirical evidence. Pavaskar (1970) states that the critics erroneously believe that speculators aggravate price rises by accumulating long commitments in the future markets. He argued that in the absence of a market mechanism such as futures, uncertainties regarding futures price levels may induce traders and others to hoard, the effect of which would be more serious on prices than any possible impact of legitimate futures trading.

On November 1960, in a press note, the Forward Market Commission (FMC) noted "that at a time when arrival of groundnut at the terminal markets are good and gathering momentum from day to day, future prices are being continuously pushed up to higher and higher levels". In the same press note, while referring to castor seeds futures, FMC observed "the removal of special margin with regard to castor seeds has been misused and rampant speculation is pushing up prices, particularly when no demand has developed for the new crop [Forward Markets Bulletin, Vol. II, No. 10, Dec. 1960, p. 42].

In contrary to the view taken by the government in favor of prohibiting futures trading due to its detrimental effects on spot price, Naik, A.S. (1970), in her book "Effects of Futures Trading on Prices", has shown clearly that the price fluctuation was higher when there was no futures trading as compared to the prices when there was future trading. She has shown it for three crops like linseed, hessian and groundnut. In her work, she divided the period 1951-52 to 1965-66 in two parts - (i) when there was little and no futures trading and (ii) when there was effective futures trading. She has shown that the percentage of respective frequency for the lower degree of fluctuations is higher for the years when there was effective futures trading as compared to the years when there was no futures trading (Annexure III, pages 99-105).

In a press interview, V. Jayashankar, Chairman, The Spice Board, has pointed out "price fluctuations are more in a commodity in which there is no futures trading". To illustrate his point, he pointed out that "fluctuations in turmeric price have been minimal in view of the existence of a futures market in Sangli, Maharashtra, where as price fluctuations in comparison have been higher in case of Chili [Commodity Futures Trading Gaining Ground, PTI, New Delhi, Oct. 12, 1998].

We built up a theoretical model in the following section to address the above mentioned issues and come up with specific answers. But before constructing our model to describe the role of futures market in the context of India, we would like to mention some of the empirical and theoretical findings that influence it. In the next section we cited some important findings relevant for our study and try to test their relevance in the context of a developing country like India.

Section II: Baseline Model and Findings

T.W. Schultz (1949) classified the following three settings to find the impact of farm prices on the production decisions through the level of utilization and allocation of resources.

(1) resource commitments for the distant future,

(2) commitments for the near future and

(3) the spot situation covering decisions that involve only a fraction of one production period.

His empirical evidences suggest that the market for milk, a highly perishable product with no futures prices has been relatively efficient in guiding the allocation of resources in agriculture. While on the other hand, the market for cotton or wheat which are quite durable in nature and storage of which is not very costly with highly developed spot and futures price quotations are quite inefficient in bringing about an optimum utilization of resources used in growing these two important crops. In a nutshell, he concluded that for more durable products, the price variation is much higher. He also mentioned that for such durable goods, neither the spot nor the futures price has been as meaningful to farmers in making production plans as has the spot price in the markets of most of the more perishable farm products.

The findings of Schultz are somewhat misleading because in futures market system, the contract is made beforehand and commodity is supplied after a specified later date. Then, in this situation the seller has perfect knowledge or information about the quantity to be supplied and which quality to be supplied at what price. If this is known beforehand then the seller or the owner of the inventory can allocate his resources to increase it or to produce it as per the contract. Now, in this situation, the producer hedges certain amount of the commodity he is producing in the period t for the futures sale at $t+1$ against all possible values of risk and earns profit by taking these risks. Therefore, the premium he pays to protect the amount from all kinds of risk is contingent upon the probability density function of the risk and per unit cost of hedging.

Masahiro Kawai (1983) presented a theoretical model that explains the effect of commodity futures market upon the process of price formation and the overall welfare of the society in a stochastic rational expectation framework.. He has calculated separately the effect of spot prices on the production and then introduced possibility of futures trading in the model. He has shown that the optimum level of output depends only on the futures price and the cost coefficient. According to him the quantity of futures contract is determined by optimum level of output and speculation which reflects the difference between the producer's subjective expectation about the next period spot price and the corresponding futures price. Kawai did not consider the effect of expected production shocks on future market decision. Moreover, the production decision is made entirely separately from the futures trading decisions without depending on attitudes towards risk and the probability distribution of the spot price. He further argues that the producer enters into the futures contract not only to hedge against price risk but to exploit speculative opportunities as well.

In our model, production shock plays a crucial role in the formation of both production as well as futures market decision. Consideration of production shock in commodity futures market decision is important in the context of most of the developing countries like India. Instability in agricultural production is a common phenomenon in the developing countries because of its dependence on weather - a major stochastic factor. This results in high instability in the prices of agricultural commodities which, in turn, leads to an uncertain farm income. Many Governments have taken different policy measures over time to reduce the amplitude of price fluctuations avoiding hardship to producers and consumers. These include direct price interventions like fixing of minimum support price, buffer stocking and price controls. On the same ground futures price contracts can also be considered as one of such tools.

Lapan, Moschini and Hanson (LMH) (1991) has analyzed the production and hedging decisions of a competitive firm operating in both futures and option markets by using expected utility model. With the assumptions that the commodity in question is non storable in character, they have proved that futures price and basis are the only source of uncertainty. The authors have also shown that output depends on the existing futures prices and not on what the agent thinks what the end of period futures price would be (Lapan H.G, Moschini and S. Hanson 1991, pp 66-74).

Our model is an extension of LMH model but with much more added complexities. In our model we not only consider that the commodities are storable we also included the production shock. As a result, the inventory decision of the supplier not only considers the expected end of period futures price but also incorporate the expected production shock into it allocation decisions in the spot and futures market.

Kawai and LMH have shown that production decision does depend on futures price but they have completely ignored the inventory decisions by assuming that the commodity is not storable. They also assumed the production process as deterministic. In this section we extended the model of LMH by incorporating exogenous production shock and the possibility of storage of the commodity. We also have taken into account the fact that inventory decision too is not free from losses and there is a cost of carry over to protect the inventory from different states of the nature. In other words, the cost of carry over can be considered as the premium of contingent claim for securing a certain amount of inventory for the next period to adjust the supply in the futures market.

Model Specification

Let us assume that the futures market is monopolistically competitive. This assumption ensures the following facts:

(i) Products are differentiated and the producer (supplier) earns positive accounting profit in the short run but in the long run it is zero.

(ii) There is excess supply in the short run. This assumption ensures the existence of inventory in the short run. In the long run market clears due to free entry and exit.

Based on the above assumptions we considered that at period t, the producer undergoes futures contract for period $t+1$. Once the futures price is decided the supplier plans its allocation of period t spot supply decision and inventory carry over for period t+1. Now this inventory decision helps the producer to decide how much to produce. Let Q_{t+1} be the expected production that matures at the beginning of period $t+1$ and θ be the share of expected production that goes to the futures market. Inventory, y_t', is the fraction of period t output hedged through contingent claim such that actual realized inventory supply in the futures market is y_t at price f_t. In this regard let us assume that the state of the economy evolves according to Markov process described by density, $g(y_t', y_t)$ as

$$\Pr ob\{x_{t+1} \leq y_t \mid x_t = y_t^{'}\} = G(y_t^{'}, y_t) \qquad (1)$$

Let us suppose that inventory decision is characterized as follows:

In period t if the economy is in state x_t then the producer stores y'_t through purchasing a claim. This claim ensures that in period $t+1$ the supplier is going to receive a certain amount, y_t, contingent on the event that x_{t+1} is the state of the economy in period $t+1$. The state, x_{t+1}, belongs to the universal set Ω in period $t+1$. To secure y_t for the period $t+1$ the producer has to incur a certain amount of cost dependent on the state of the economy in terms of the time t good. Let $p = p(x_{t+1}, x_t)$, be the state dependent per unit cost of storage. Therefore, based on the state of the economy, expected supply in period t, F_{t+1}, in the futures market is

$$F_{t+1} = \theta(z_{t+1}Q_{t+1}) + y_t \qquad (2)$$

After the supply decision to futures market is made, the producer allocates of the rest of the amount between the spot market supply and inventory for the period $t+1$, based on the actual spot price and future price for the next period. Let δ be the share of the rest of the production that goes to the spot market when ps_{t+1} is the expected spot price at period $t+1$, and (1- δ) is the fraction of output that is allocated for inventory for period $t+1$.

The supplier chooses Q_{t+1} and y_t to maximize profit. Next period's inventory adjusts the following way

$$y'_{t+1}(x_{t+2}, x_{t+1}) = (1-\delta)(1-\theta)\, z_{t+1}Q_{t+1} \qquad (3)$$

where, z_{t+1} is the expected exogenous production shock which is being realized after the production decision is made for period $t+1$ with $z_{t+1}=\rho z_t + \xi_t$, where $E(\xi t) = 0$.

Based on the above conditions the maximization problem of the supplier can be laid out in the following way:

$$\max_{Q_{t+1},\, y_t} E_t\{U(\pi_{t+1})\} = [\delta(1-\theta)z_{t+1}Q_{t+1}]ps_{t+1} + f_t\theta(z_{t+1}Q_{t+1}) + f_t y_t$$

$$-\tfrac{1}{2}[c_1(Q_{t+1})^2 + c_2(y_t)^2] - \int_{x_{t+1}\in\Omega} y_t\, p dy_t \qquad (4)$$

where, $E_t\{U(\pi_{t+1})\}$ is the expected utility from profit in the next period. Parameters c_1 and c_2 are the cost coefficients to produce Q_{t+1} and y_t. The last term within the integral in the right hand side is the cost of hedging the risk of carrying y_t from t to $t+1$ contingent on all adversities. After solving the maximization problem of the supplier with respect to Q_{t+1} and y_t we get

(1) FOC w.r.t. Q_{t+1}

$$\delta(1-\theta)z_{t+1}ps_{t+1}+\theta z_{t+1}f_t-c_1(Q_{t+1}) \qquad (5a)$$

(2) ***FOC w.r.t. $y_t\,(x_{t+1})$***

$$f_t-c_2y_t-py_t \qquad (5b)$$

Now , using total differentiation we get the following system of two equations,

$$[\delta(1-\theta)z_{t+1}]dps_{t+1}-[\delta ps_{t+1}z_{t+1}]d\theta+[ps_{t+1}z_{t+1}\theta]d\delta+[\delta(1-\theta)ps_{t+1}]dz_{t+1}+$$
$$[z_{t+1}f_t]d\theta+[\theta z_{t+1}]df_t+[\theta f_t]dz_{t+1}-[Q_{t+1}]dc_1-[c_1]dQ_{t+1}=0 \qquad (6a)$$

$$df_t-c_2dy_t-y_tdc_2-y_tdp-pdy_t \quad =0 \qquad (6b)$$

In matrix form

$$\begin{bmatrix}-c_1 & 0\\ 0 & -[c_2+p]\end{bmatrix}\begin{bmatrix}dQ_{t+1}\\ dy_t\end{bmatrix}=$$

$$\begin{bmatrix}(-\theta z_{t+1})df_t+(\delta z_{t+1}ps_{t+1}-z_{t+1}ft)\,d\theta+(Q_{t+1})dc_1-(\delta z_{t+1}(1-\theta))dps_{t+1}\\ -(ps_{t+1}z_{t+1}\theta)d\delta-(\delta(1-\theta)ps_{t+1}+\theta f_t)dz_{t+1}\\ \\ -df_t+y_tdc_2+y_tdp\end{bmatrix}$$

By using Cramer's rule we get

$$\frac{dQ_{t+1}}{df_t}=\frac{\theta z_{t+1}}{c_1} \qquad (7a)$$

$$\frac{dy_t}{df_t}=\frac{1}{c_2+p} \qquad (7b)$$

If we extend *(7a)*

$$\frac{dQ_{t+1}}{df_t}=\frac{z_{t+1}\theta}{c_1} \quad \textit{we get}$$

$$\frac{f_t}{Q_{t+1}}\cdot\frac{dQ_{t+1}}{df_t}=\frac{\theta z_{t+1}}{c_1}\cdot\frac{f_t}{Q_{t+1}}$$

$$\varepsilon_{f_tQ_{t+1}}=\frac{[Expected\ marginal\ revenue\ from\ futures\ market\ sale]}{Marginal\ cost\ of\ production}$$

Where $\varepsilon_{f_tQ_{t+1}}$ is the futures price elasticity of supply from production. Now, the crucial upshot of the above expression is that $\varepsilon_{f_t Q_{t+1}}$ will always be greater than or equal to one. This is because under monopolistic competition marginal revenue will have to be greater than marginal cost in the short run to assure profit and in the long run they are same. Therefore, one thing is clear from the above equation that as a rational agent, the supplier will always operate on the upper part of the demand curve where futures price elasticity is greater than or equal to 1. At this region one unit increase in price will decrease the quantity demanded for the commodity by more than one unit and, as a result, revenue will decline with each unit increase in price. Therefore, there will not be any tendency of the supplier to increase its profit by increasing price in the futures market. This corroborates the view that futures price does not distort the spot price rather promises stability in both the markets.

Another point to be noted here is that the supply in the futures market does depend on the expected production shock. As we see from equation (7a) that depending upon the nature of the expected shock the supplier adjusts his supply commitments in the futures market. Now intuitively this result is correct because when the expected shock is positive the supplier knows that there will be a glut in the spot market leading to a fall in spot price. To hedge against this, the supplier will either commit more in the futures market or increase its inventory depending on next period's futures price and vice versa. Therefore, futures market not only hedges the price risk but also the production risk simultaneously.

Following result show that futures price elasticity of inventory is positively related to the marginal revenue generated from inventory and inversely related to its marginal production as well as carrying cost.

$$(7b)\ \frac{dy_t}{df_t} = \frac{1}{c_2 + p}$$

$$\frac{f_t}{y_t} \cdot \frac{dy_t}{df_t} = \frac{f_t}{y_t(c_2 + p)}$$

$$\varepsilon_{f_t y_t} = \frac{f_t}{c_2 y_t + p y_t}$$

$$= \frac{Marginal\ revenue\ from\ inventory\ sale\ in\ the\ futures\ market}{Marginal\ cost\ of\ production\ of\ inventory + marginal\ carrying\ cost}$$

This futures price elasticity of inventory plays a crucial role in inventory as well as production decision. Once the futures price is set supplier decides his allocation of production between the spot market supply and inventory for the next period. Even though there is a co movement between futures price and inventory, our result rejects the possibility of hoarding due to the following reasons:

First, in the same vein as above, we can say that the supplier always operate in the elastic part of the demand curve. As a result, per unit rise in price lowers the quantity demanded by more than one unit leading to a decrease in total revenue. Therefore, decrease in quantity demanded by more than one unit due to each unit of price rise discourages hoarding.

Second, hoarding increases the marginal carrying cost. Elasticity being inversely related to the carrying cost, other things remaining constant, an increase in carrying cost decreases the price responsiveness of inventory. As a result hoarding is not a profit maximizing behavior for the suppliers according to our model. Our results can be supported by the view of Raj Krishna (1967) that "the carrying over stock from the harvest to the lean period is sometimes misconstrued as hoarding. Storage demand decreases as current prices rise in relation to expected prices over the season. Thus it might be incorrect to believe that traders abnormally add to their inventories over period of rising prices and then unload their stocks over period of falling prices".

Conclusion

We began our study with a vast literature survey in section I to address the issues related to the effectiveness and importance of commodity futures market in spot price stability and inventory decisions. In the second part of the study we tried to answer those questions based on the findings from our model. Our analysis indicates that futures market does not distort the spot price rather stabilizes it. Moreover, we show that under monopolistic competition when a rational supplier's main objective is to maximize profit then the supplier always wants to operate on the elastic part of the downward sloping demand curve. In that part of the demand curve increase in price decreases the revenue leading to a decrease in profit. Therefore, the supplier will not try to increase it's profit by allocating more to the futures market from the spot market at higher price. This leads to stable equilibria in both spot and futures markets.

Another important upshot of this paper is that change in production with respect to futures price is dependent on expected production shock (equation (7a)). In our model production shock is exogenous and can be considered as the outcome of many non price constraints such as weather and other factors. Therefore, we can say that by incorporating the expected production shock in the production decision with respect to futures price the supplier takes all those non price elements into account.

The third and the most important finding of our study is the futures price responsiveness of inventory decision. The importance of this finding is mainly two folds.

First, under monopolistic competition inventory decision takes care of the excess supply in the market and adjusts production for each period through it's equation of motion as described by equation (3). Second, our model rules out the possibility of the increasing hoarding. As we see from equation (7b) that futures price responsiveness of inventory is directly related to the futures price but at the same time inversely related to its marginal production cost as well as carrying cost. And, as inventory increases, it increases the carrying cost leading to a decrease in the future price responsiveness of inventory. But being a profit maximizing agent the supplier would not be willing to operate on the lower part of the downward sloping demand curve where price elasticity is less than 1. In our model in monopolistically competitive market long run equilibrium is reached where price elasticity is 1 or, in other words, where marginal revenue is equal to marginal cost. Therefore, hoarding is not a profit maximizing outcome in our model in the long run even if there is some kind of collusion in the market in the short run.

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