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# Role of Thin Commodity Futures Markets in Physical Market Price Making: An Analysis of Wheat Futures in India in the Post-Ban Era

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# Role of Thin Commodity Futures Markets in Physical Market Price Making: An Analysis of Wheat Futures in India in the Post-Ban Era

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## ABSTRACT

*There is a belief that even thin futures markets can act as a forum for reference pricing and create more volatility in the physical market prices. This article tests that hypothesis, given a few problems affecting the efficiency of the wheat futures markets in India, after the resumption of wheat futures in May 2009 following a ban of more than two years. The article tries to answer three questions: Do physical market players use the futures price of wheat as a reference price? Does the volatility in futures prices cause price volatility in the physical markets? What are the determinants of volume and volatility in the wheat futures markets, as also their interrelation? The article finds little evidence to suggest that futures price serves as reference price for transacting contracts in the physical market, and, as a natural corollary, futures market volatility cannot lead to volatility in the physical market. The level of liquidity was low in the futures markets, as the markets were not only bereft of speculative volumes, it did not even seem to have served the purpose of hedgers. Hence, while rejecting the hypothesis set for testing, this article concludes that it is not possible for a thin market, bereft of adequate participation and liquidity, to provide a forum for discovering the reference price for the physical market, and thus it cannot destabilize the latter. These conclusions have been arrived with time series econometric analysis, consisting of Vector Autoregression (VAR) methods, Granger causality tests, Autoregression methods (AR), and seemingly unrelated regression equation methods.*

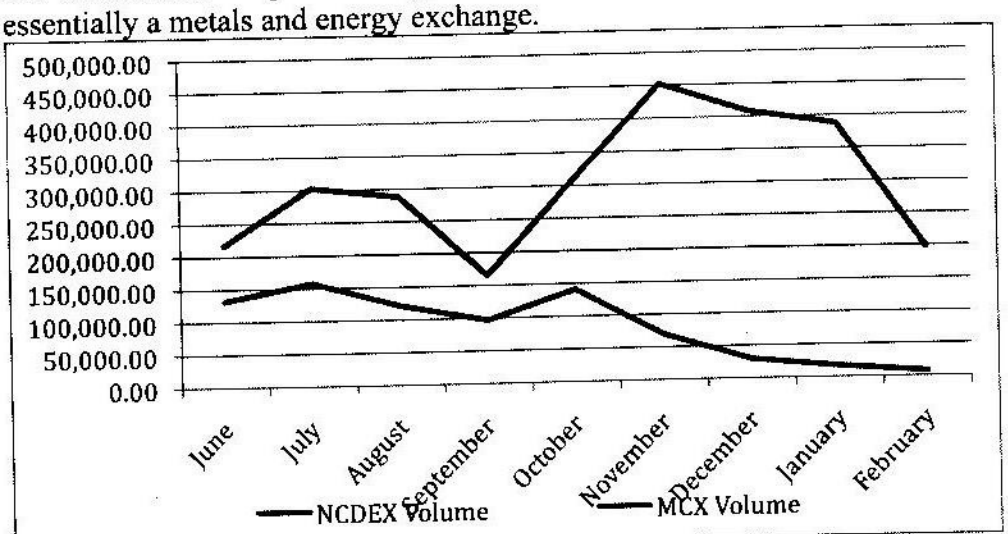
**Keywords:** Futures Market, Physical Market (Mandi), Volume, Volatility, Open Interest

## INTRODUCTION

Derivative trading in wheat resumed in commodity futures exchanges in May 2009 after a ban over such trading in the preceding two years. Incidentally, whether the wheat futures ban helped to cool down inflation in the economy is really a debatable issue, especially since the wheat prices in India and abroad ruled high throughout the ban period, thereby proving the tyranny of the market fundamentals rather than the suspected price aggravating role of the futures markets. The ban was lifted after the wheat prices in the country became stable by 2009, as also because various studies revealed that futures markets could not be held responsible for creating inflationary pressures in the economy (Sharma, 2009). Interestingly, the ban on futures trading in rice has not yet been lifted, despite the fact that futures trading in wheat and rice were banned on the same day when the Union Budget for 2007-08 was presented. The reason given is that rice, as a commodity, might not succeed in the futures market in attracting either trading volume or open interests, so as to enable the futures platform to perform the functions of price discovery and price risk management.

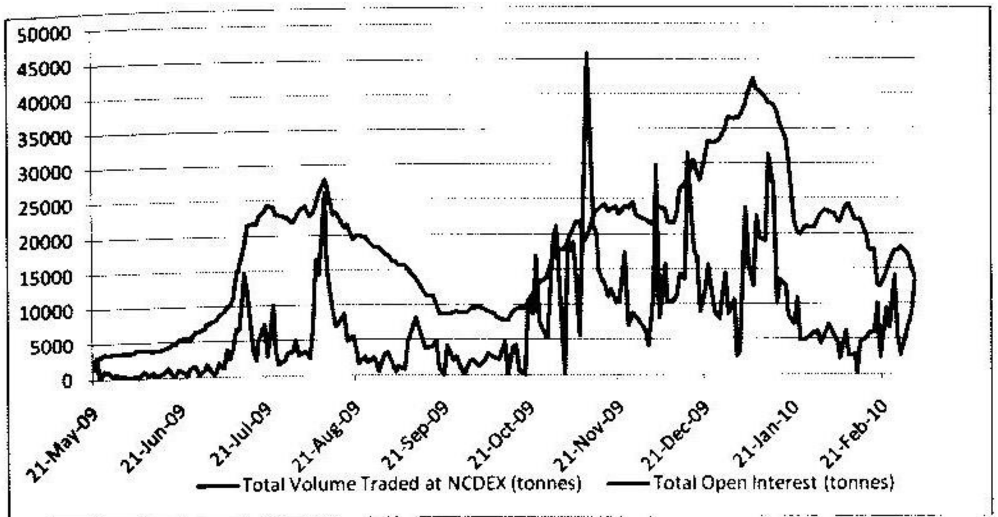
True, when rice contracts were traded in the futures markets, they did not evince good market interest or turnover. The performance of wheat futures then was not inspiring either. On the day when wheat and rice futures were banned (February 28, 2007), the volume of trading in wheat on Multi Commodity Exchange of India Limited (MCX), the largest commodity exchange in the country, was zero (Chary, 2007). Moreover, the post-ban volume for wheat on National Commodities Derivatives Exchange (NCDEX), which has otherwise better volumes in agro-commodities, has not been significant, too.

Since the resumption of futures trading in wheat in June 2009, NCDEX has shown much higher trading volumes (Figure 1) than MCX, which is essentially a metals and energy exchange.




Source: MCX intranet

Figure -1: Wheat trading volumes at MCX and NCDEX (Tonnes per month)




Source: NCDEX website

Figure - 2: Volume and Open Interest of Wheat Futures Contracts at NCDEX (tonnes/ day)

Though NCDEX has relatively high trading volumes in wheat, the daily volume of trades and open interest at NCDEX (Figure 2) are far from satisfactory. Most of the times, the volume has been below 5000 tonnes in a day, in-between spikes of more than 30,000 tonnes of trades on sporadic occasions notwithstanding. This is just a minuscule fraction of the trades actually taking place in the physical wheat markets (*mandi*s) of India. With such low volumes of trade in the wheat futures markets, is it, at all, possible for wheat futures markets to affect either the *mandi* prices or prices of forward contracts traded in terminal wholesale markets? Any commonsensical market participant will answer in the negative. However, a few agricultural econometricians, by a quizzical turn of logic, argue that even thin derivative markets are capable of influencing the physical market prices (e.g. Elumalai et al., 2009; Carter, 1989; Karbuz & Jumah, 1995; Mattos & Garcia, 2004). This argument is based on the assumption that even though thin and inefficient for effective hedging, physical market traders tend to follow the price signals from the futures. The low trading volume of thinly traded futures markets may generate a small amount of information of considerably low quality, but can still be useful for the physical market trades by way of reference or benchmark prices (Elumalai et al., 2009; Carter, 1989).

There is no doubt that wheat futures markets in India are thinly traded markets, despite the efforts put by the exchanges to increase the volumes therein. Ghosh et al. (2007) attempted to test the efficacy of the wheat futures markets in the pre-ban era, and could not find any conclusive evidence on the price discovery function of the futures markets. Neither did they find any conclusive evidence of the futures markets causing physical market volatility. None of the analyses on the efficiency of Indian futures markets, however, have considered variables like traded volumes and open interests. Rather, efficiency of futures markets has been defined merely with the price dynamics between the two markets (e.g., Thomas & Karande, 2001; Roy, 2009; Singh et al., 2009).

This article is all about looking at how efficient are wheat futures markets working after the resumption of futures trading. Some of the critical questions it seeks to answer are:

1. Does futures price of wheat serve as a reference price for physical-market players?
2. What is the extent of volatility in the futures market? Does this volatility increase the price volatility in physical markets?
3. What are the determinants of volume and volatility in wheat futures markets, and what is the nature of their interrelation?

To answer these questions, the study has relied on data from NCDEX, as wheat futures trading seems to be relatively more active there than at other futures exchanges, though not encouraging enough according to some of the market functionaries.[1] In Section 2 is presented a brief description of the data and methodology. Section 3 discusses the answers to the various questions posed. Section 4 offers the concluding remarks.

## DATA AND METHODOLOGY

As stated earlier, the daily futures market data have been obtained from the NCDEX website (www.ncdex.com) for the period from May 21, 2009 to March 4, 2010. For all wheat contracts at NCDEX, the delivery centre is Delhi. On the other hand, the physical market data for the corresponding period have been obtained from the website of Directorate of Marketing and Information, Ministry of Agriculture, Government of India (www.agmarknet.in). The physical market considered in this case is the Narela Mandi in Delhi. The reasons for the selection of Narela Mandi in Delhi, for this analysis, are more than one. First, the only delivery centre for the NCDEX wheat futures contract is Delhi. The reason for this might be

[1] Personal communication with Naveen Mathur, Associate Director, Angel Commodities.

that Delhi is a major centre for wheat trading, with the adjoining states of Uttar Pradesh, Punjab and Haryana being the largest wheat producing states of the country. Second, Narela Mandi has the highest trading volume in Delhi, and its price is often considered an "indicator price" in India. The variety of wheat considered is the Mexican variety, which is the basis variety in NCDEX contract, considering the quality characteristics. The Mexican variety is produced more ubiquitously in India than the latter. Data have been obtained on the following variables, with the associated symbols used in the econometric equation given in each parenthesis with the respective variable:

I. Futures Volume (*F_Volume*)
II. Open interest (*OI*)
III. Near Month closing futures price (*FP*)
IV. High price at the futures market (*High_price*)
V. Low price at the futures market (*low_price*)
VI. Arrivals at the physical market or Mandi (*Arrival*)
VII. Minimum price quoted at the Mandi (*Min_price*)
VIII. Maximum price quoted at the Mandi (*Max_price*)
IX. Modal price quoted at the Mandi (*Modal_price*)
X. Closing Mandi price (*SP*)

For variables on futures markets, the present paper has considered data for eight contracts with varying maturity periods. The maturity months for the contracts were August 2009, September 2009, October 2009, November 2009, December 2009, January 2010, February 2010, and March 2010. The futures price has been defined by the price of the near month futures contract (the contract whose maturity is most imminent). For the volume of trading and open interest, the volume traded has been added up for the various contracts on a particular day. The same has been done for open interest on a particular day. This has given the total volume and the open interest figures for a particular day in the futures exchange.

The price volatility has been computed with the following formula:

$$f\_price\_vol = (High\_price - low\_price)/FP \quad \ldots (1)$$

In (1), *f_price_vol* indicates futures price volatility quoted on a day. Rather than the average or the closing price, it is usually better to take the modal price in the denominator as that reflects the most frequently quoted price, and normalizes the range (defined by the difference between the maximum and the minimum) around the price at which maximum transaction has taken place. However, the modal price was not available for the futures market.

But, for the physical markets, the modal price was available, and then the range has been normalized the range with the modal price. The formula used is:

$$s\_price\_vol = (SP_{High} - SP_{low}) / SP_{mode} \quad \ldots (2)$$

In (2), *s_price_vol* is the spot price volatility, $SP_{High}$ is the maximum physical market price, $SP_{low}$ is the minimum physical market price, while $SP_{mode}$ is the modal physical market price.

It is true that this is a very crude measure of price volatility. Readers might even argue that this is not really volatility, as this is merely based on the high and low end prices, and does not consider the entire vector of prices quoted at which transaction has taken place throughout the day. It is further acknowledged that this measure of volatility has merely been confined to a "relative range" in the statistical sense, and does not entail the real measure of volatility that actually should have been delineated and estimated by the "coefficient of variation" (or the quotient of standard deviation of the prices and the mean of the prices, multiplied by 100). Yet, there were problems in computation of coefficient of variation. The problem arises with the availability of data on a real time basis on the prices on which transactions have taken place. At the same time, for computation of standard deviation as also the mean, and a true reflection of the coefficient of variation, the analysis also needed the data on the volumes transacted at each quoted price. In the absence of both of these types of information, the study needed to take a crude measure of dispersion, given by "range", and standardized it by the closing price or the modal price, as available. Hence, given the data constraints, it seems that (1) and (2) are the best possible way out to define intra-day volatility.

Due to the time series nature of the data, before the data gets subjected to any kind of econometric analysis, it is essential to test for *stationarity* in the data. Also known as the unit root test, the study has used the standard Augmented Dickey-Fuller (ADF) test to test for the existence of unit roots in the various variables. The econometric package used for the analysis is STATA 10. The results, based on Appendix 1, are given in Table I.

*Table I. Results from the ADF Test*

| Variable | Does Unit Root Exist? |
|---|---|
| Futures Volume (F_volume) | No |
| Open Interest (OI) | No |
| Futures Price (FP) | Yes |
| Mandi Price (SP) | No |
| Mandi Price Volatility (s_price_vol) | No |
| Futures Price Volatility (f_price_vol) | No |
| Arrival at the Mandi (Arrival) | No |

Table I shows that all the variables, except FP, are stationary. Hence, in case any regression analysis on FP by relating it with the other associated variables need to be conducted, one needs to take the first difference and check whether the series is "difference stationary." The new series with the first difference is created and is found to be stationary. As a result, to avoid spurious regressions, this new series has been taken for the main analysis.

In the main analysis, first of all, the study conducted a Vector Autoregression (VAR) followed by Granger causality test to test whether a direction of causality exists between futures price series (considering the difference stationary given by *Fp_first_diff*) and physical market prices. This will provide an indicative answer to the first question on the role of futures prices as the "reference price" for the physical market under consideration. Though, apparently, only one physical market is being talked about here it is needed to reiterate that Narela Mandi is a very important Mandi, being the biggest regulated market for food grain in Delhi. Hence, this might roughly indicate whether futures market is, at all, integrated to this physical market, and also physical markets of similar characteristics. To answer the second question, estimation has been done in regard to the volatility in the futures and physical markets with the formulae (1) and (2), and have used the following ARIMA (2,0,0) or AR (2) regression equation:

$$s\_price\_vol = \alpha + \beta . f\_price\_vol + \eta . f\_vol\_lag + \gamma . s\_vol\_lag + \lambda_1 . s\_price\_vol(-1) + \lambda_2 . s\_price\_vol(-2) + \omega \quad ...(3)$$

Because all the variables involved in (3) have been found to be stationary, ARIMA (2, 0,0) or AR (2) series is supposed to give efficient results. In (3), *f_vol_lag* indicates the first lag in futures volume, *s_price_vol (-1)* indicates the lag of first order in physical price volatility for the AR process, while *s_price_vol (-2)* indicates the lag of second order in physical price volatility for the AR process.

Finally, to answer the third question, an attempt has been made first to conduct a VAR with two lags between futures price and volume, followed by the Granger causality test. By establishing the degree of dependence as also the direction of causality between the two variables, the following system regressions have been run:

$$f\_price\_vol = \phi(F\_volume, arrival, OI) \ldots (4)$$

$$F\_volume = \varphi(s\_price\_vol, f\_price\_vol, arrival, OI) \ldots (5)$$

Equations (4) and (5) will offer the degree and nature of the interrelations between the two variables, as also the effects of open interest and arrival at *mandi* on futures volume and futures price volatility.

## PROPOSITIONS, RESULTS, AND DISCUSSIONS

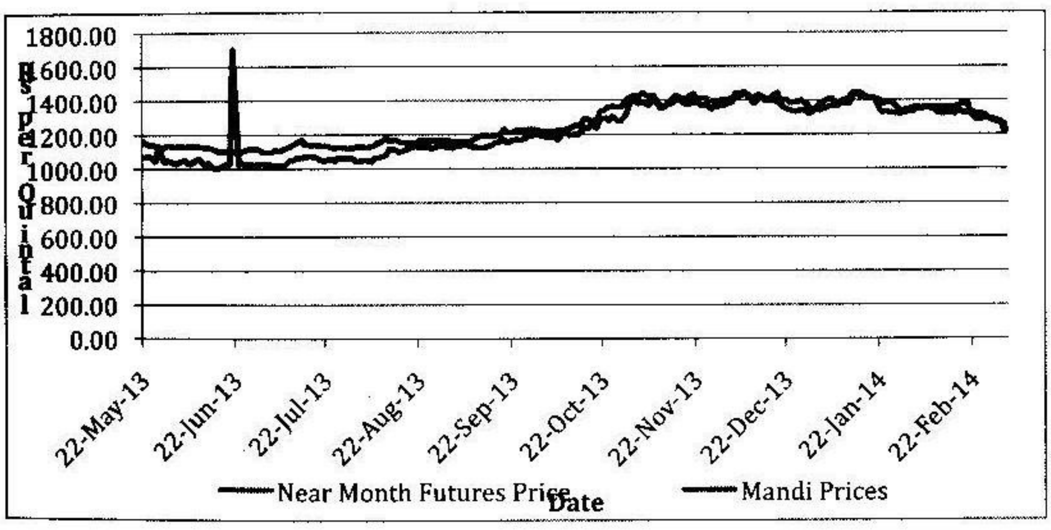
Before proceeding to this paper's propositions, a few descriptive statistics have been presented in Table II on a few critical variables. As can be seen in the table, in the case of volume, the presence of extreme values has affected the mean and the standard deviation. Prices (both futures and spot) have, however, not revealed much "spiky" behaviour, as is exhibited by their low SD (standard deviation) values. This low volatility in the prices is an expected phenomenon because of the several steps taken by the government to curb spiraling price rise like stock holding limits for traders, ban on exports, elimination of import duty, etc. during 2008-09.

*Table II. Descriptive Statistics of Wheat Trading*

| | **Total Volume Traded at NCDEX (tonnes/ day)** | **Total Open Interest (tonnes/ day)** | **Near Month Futures Price (Rs. / quintal)** | **Spot Prices (Rs./ quintal)** | **Mandi Arrivals (Tonnes/ day)** | **Daily Futures Price Volatility** |
|---|---|---|---|---|---|---|
| Maximum | 45950.00 | 42280.00 | 1448.80 | 1701.00 | 1641.30 | 0.03908 |
| Minimum | 0.00 | 1470.00 | 1097.00 | 1000.00 | 2.00 | 0.00178 |
| Mean | 7065.86 | 17967.44 | 1259.22 | 1222.40 | 276.01 | 0.01131 |
| Median | 4670.00 | 18940.00 | 1231.40 | 1205.00 | 219.25 | 0.00958 |
| SD | 7367.77 | 9575.23 | 118.33 | 149.02 | 240.29 | 0.00743 |

The thinness of the wheat futures market can be made out from the fact that the mean of the total traded volume in the futures forum is as low as 7065.86 tonnes, and the mean of the open interest is as low as 17967.44 tonnes. During the study period which spans for almost 10 months, the total volume traded in the NCDEX platform is merely 1.43 million tonnes, with the sum of the daily open interest accumulating to 3.64 million tonnes. When one considers the fact that NCDEX is the only futures exchange that evinced the maximum volume in wheat futures trading, the volume is indeed insignificant as compared to the production of more than 80 million tonnes of wheat in the Indian economy. As has been discussed in various forums (e.g. Parikh 2007), a commodity showing vibrancy in the futures market exhibits a futures trading volume that is many times higher than the physical production. Parikh (2007) showed that in 2005-06, in the MCX platform, Chana (gazebo bean) futures trading revealed 21 times higher volumes than production, while urad (black lentil) trading in the futures forum revealed 67 times higher volume than its annual production. The thinness of the wheat futures market is amply exhibited by the fact that its futures volume is less than 2% of the annual production.

Now each of the questions has been taken up to formulate the propositions, show the results, and discuss them. For the first question, despite a number of researches on wheat futures markets that stress their roles in market integration, the author's contention still goes in favour of the market participants who feel that low volumes in futures markets can never result in price making. There is, however, something more interesting that the paper would like to present here before it gets into the econometric exercise. As one examines Figure 3, one finds that there apparently seems to be a high correlation between the futures and mandi prices.




Source: Author's compilation from www.ncdex.com and www.agmarknet.in

Figure – 3: Futures Price and Mandi Price of Wheat (Rs. per Quintal)

In fact, the correlation coefficient between the physical market price and the futures price has been found to be as high as 0.934. This reveals a high degree of association between the two markets. This is a reflection of the fact that both prices are affected by some common factors of market fundamentals. In other words, there is an indication that probably both the markets are taking information about availability and demand conditions and eventually showing up their respective prices. Yet, a high degree of association does not necessarily imply that one market is dependent on the other. Any simple regression analysis might provide a spurious relation as both prices might be affected by common factors. As it is, the futures price has been found to be non-stationary, and the paper has already taken the first difference to avoid the unit root. As it is, the futures price has been found to be non-stationary, and the study has already taken the first difference to avoid the unit root. This clearly exhibits the existence of a spurious relation between the futures and the physical market prices. Hence, the present paper's position is just the opposite of what has been presented in Figure 4.

*Proposition 1:* Under low volume conditions in futures markets for wheat, it is unlikely that physical market players will take up futures prices as the reference price.

Appendix 2 shows the results of the VAR, as also the Granger causality test. In the VAR model it becomes clear that the futures price does not take up any autoregressive lag, and neither the two lags in the physical market prices affect it. On the other hand, the physical market, in no way, shows any dependence on the futures prices' first and the second lags. Physical market price, however, gives strong evidence of being in autoregression. At the same time, the Granger causality test clearly shows that there is no existence of causality between the futures and the physical market price of wheat. Hence, there is no indicative evidence of the physical-market players considering the futures prices as reference price for wheat.

This apparently establishes the inefficiency of the wheat futures market, and its inability to act as a forum for reference prices for the physical market. From this, it seems that there cannot be much evidence of futures price volatility affecting physical market price volatility. Hence goes the proposition 2.

*Proposition 2:* With futures and physical market prices being independent, there is no scope of futures market affecting the intra-day volatility of the physical market.

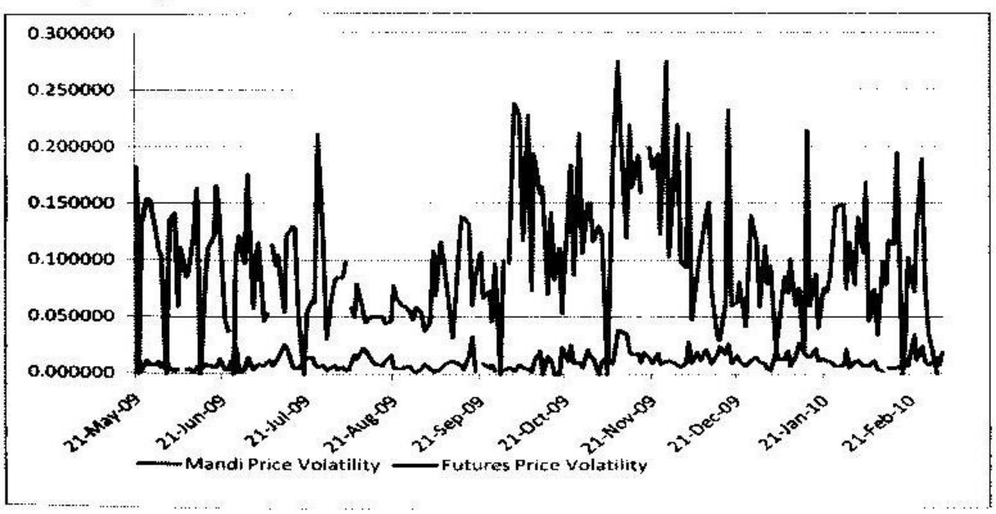
To reinforce this contention, the ARIMA (2, 0, 0), or AR (2) has been run, The equation emerging from the results, as given in Appendix 3, can be rewritten as:

$$s\_price\_vol = \underset{(0.00)}{2.566} + \underset{(0.066)}{0.068}.arrival + \underset{(0.132)}{0.072}.f\_price\_vol - \underset{(0.43)}{0.061}.f\_vol\_lag$$

$$+\underset{(0.16)}{0.112}.s\_price\_vol(-1) + \underset{(0.216)}{0.127}.s\_price\_vol(-2) \qquad ...(6)$$

The figures in the parentheses reflect on p-values. As can be seen from (6), arrival at the mandi might influence physical market price volatility, though there is no indication of futures price volatility, neither its first lag affecting the same. None of the autoregressed coefficients (first and second lags of physical market price volatility) have been found to be significant. This result further reinforces the independence of the physical market from the futures market.

As it is, the volatility in the physical market is much higher than that of the futures market. This can be seen from Figure 4. One of the reasons of low levels of participation of speculators and day-traders is low volatility. This is because day-traders survive on intra-day margins. A low volatility on the futures platform might not be too lucrative for these players to play in the futures markets. In futures markets for more liquid commodities, around 75-80% of the market is dominated by day-traders, scalpers, and jobbers. They are the ones who offer liquidity to the market, and their roles in market making and price discovery have been well documented (Pavaskar & Ghosh, 2008).




Source: Author's estimates

Figure - 4: Intra-day Price Volatility in Futures and Physical Markets

As a result, in most of the liquid markets, the open interest as a proportion of trading volume is generally low. However, for wheat, this proportion is very high (Figure 3). In fact, during most of the period, open interest has been more than volume. This indicates very low levels of participation of the day traders, scalpers, and jobbers, thereby making the market thin. It is quizzical that such a thin market does not even reveal adequate volatility, which usually characterizes thin markets due to large differences in bid and ask prices. In any case, this analysis, however, has not considered bid and ask data, but only the prices at which transactions have taken place. Consideration of the bid–ask spread at real-time might bring in another dimension to the analysis.

Yet, the crucial question that still remains is: does volume and volatility affect each other? What are the determinants of each? This brings to the third proposition that is related to the relation between volume and volatility in the futures market.

*Proposition 3:* At low volume, as is evident in wheat futures markets, a rise in volume will only be associated with a rise in volatility. On the other hand, a rise in volatility might necessarily result in obtaining more volumes in the markets.

The VAR model suggests the statistically significant effect of the first lag of futures price volatility on volume (Appendix 4). There is also evidence of the two lags of futures volume affecting the trading volume variable. On the other hand, there are some indications that futures price volatility gets affected by the second lag of volume, as revealed by the VAR. The Granger causality test, however, suggests the existence of causality from both directions (i.e. from volume to volatility in the futures market, and vice versa). This brings to the next quest for deciphering the nature of the relation.

To comment on the nature of the relation, as also to find the possible effects of some other variables, here is an endeavour to run regression equations given in (4) and (5), treating them as "seemingly unrelated regression equations," (SURE) and using Zellner's techniques. The primary reason for choosing a SURE model over a two-stage or three-stage least squares is that the equations are not identified, and from an economic logic perspective, there remains enough evidence to believe that common factors have been affecting the disturbance term of each of the equations through excluded factors like general market fundamentals. The "under-identification" status through the order conditions does not allow for the use of two-stage or three-stage least squares, while the possible existence of correlative disturbances tends to justify the use of SURE models. The results, as given in Appendix 4, can be re-written as:

$$f\_price\_vol = \underset{(0.00)}{10.185} + \underset{(0.00)}{0.503} F\_volume - \underset{(0.823)}{0.018}.arrival + \underset{(0.00)}{1.001}.OI$$

$$R^2 = 0.1043,\ RMSE = 1.027 \ldots (7)$$

$$F\_volume\_vol = \underset{(0.00)}{14.577} + \underset{(0.00)}{0.994}.f\_price\_vol - \underset{(0.312)}{0.131}.s\_price\_vol. + \underset{(0.392)}{0.0952}.\ arrival + \underset{(0.00)}{1.867}.OI$$

$$R^2 = 0.3948,\ RMSE = 1.43 \ldots (8)$$

The figures in the parentheses reflect on the p-values. Equation (7) shows that an increase in futures volume increases the volatility in the futures prices. This is precisely because the markets are thin, and increase in participation destabilizes the price positions. On the other hand, increase in open interests leads to lowering of the price volatility. This is because rising open interests reflect on the positions of those who intend to take a relatively more long-term position in the market, and this tends to settle the market, rather than unsettling it. Arrival in the *mandis* does not play any significant role in determining futures price volatility.

From (8), it is clear that a rise in futures price volatility can lead to more volume, while an increase in open interest can also lead to an increase in trading volume. As stated earlier, the volatility in the futures market is low, and this can be stated as one of the reasons for low volumes in the futures market. Neither the price volatility in the physical market, nor the volume of arrivals in that market plays any role in determining volume of trading in the futures markets.

From (7) and (8), it is amply clear that none of the physical market variables has any role to play in the volume and volatility in the futures markets. This reinforces the previous contention of independence of the futures and the physical markets.

## CONCLUDING REMARKS

A few important points have emerged from this analysis. The first is on the ineffectiveness of the futures market in wielding any influence on physical market prices. This might be a foregone conclusion for market participants, but not so much for academicians. This analysis contested the possibility of thin wheat futures markets of discovering prices. Rather it has found that the two markets, willy-nilly, are not taking information from each other. Neither the futures market takes up any information on arrival, prices, and so on in the physical market, nor do physical-market players consider any information from the futures platform.

It maybe added that Delhi is the centre for physical delivery as mentioned in the futures contract. Even if small when compared to the physical market, physical deliveries take place. Ideally, the delivery locations should be chosen where the physical and futures market prices are somehow correlated. However, though one may argue the high degree of correlation between the two prices as stated earlier, unfortunately that does not take away the fact of futures markets' futility in the price making process, as shown in this analysis.

The second element arises with the notion of price stabilization or de-stabilization function of the futures market. There is generally a low volume and low volatility in the futures market, and there is no evidence of this volatility affecting the physical-market price volatility. There, thus, seems to be a misconceived perception that futures market will destabilize the physical-market prices. The low liquidity associated with low volatility in the futures platform also confirms the poor participations of speculators, jobbers, and day-traders who are supposed to provide liquidity to the market. The key reason behind the lack of liquidity in the wheat futures market seems to be on the question of lack of speculators who are supposed to take up hedger's risk. Low volatility has, of course, not helped in attracting such investors in the futures markets.

The third remark is more policy-oriented than anything else. With the kind of price relation that exists, it definitely drives away fear from the minds of the policymakers that futures markets can cause price rise in the physical market during shortages. Quite unfortunately, while this contention is misplaced, as an efficient futures market merely signals the forthcoming availability with its price; a thin and inefficient futures market like the wheat futures cannot even do so. Given this condition, there are apprehensions whether the wheat futures market is, at all, playing the important role of price risk management, with hardly much participation of speculators to take up the hedgers' risk.

One critical factor that acts against working of wheat futures markets is the existence of minimum support prices (MSP), and the government's procurement mechanism. Of course, it seems difficult for essential commodities to succeed in achieving volumes in futures exchanges till the MSP exists, which acts as a "put option" for hedgers (Ghosh, 2010). Hence, wheat futures market presently is a forum that is of little interest to both speculators and hedgers, and as a result, is bereft of adequate participation to perform its functions.

The objective of this paper is not merely to report on the (in)efficiency problems of the futures markets. It also had the objective to comment on the hypothesis that thin futures market can destabilize physical markets, in case the former acts as a forum for reference price. Though it is not intended to generalize the finding so as to contest or support the above proposition, this paper finds indications of the problems of thin markets, bereft of adequate participation and liquidity, to act as a forum for discovering the reference price, and thus it does not have the ability to destabilize physical markets. However, the study can now argue more convincingly against the hypothesis under quotation only when the paper carries out the exercise with more commodities, for which thin futures markets exist. This remains an agenda for future research.

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# APPENDIX 1: RESULTS OF ADF TESTS ON VARIOUS VARIABLES

```
dfuller F_Volume,
    lags(0)
Dickey-Fuller test for unit root                    Number of obs          202
=
                                 ---------- Interpolated Dickey-Fuller ----------
                 Test           1% Critical       5% Critical       10%
Critical         Statistic        Value             Value
Value
------------------------------------------------------------------------------
                 -9.620          -3.476            -2.883          -2.573
Z(t)
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t)   0.0000
=

. dfuller OI,
lags(0)
Dickey-Fuller test for unit root                    Number of obs          202
=
                                 ---------- Interpolated Dickey-Fuller ----------
                 Test           1% Critical       5% Critical       10%
Critical         Statistic        Value             Value
Value
------------------------------------------------------------------------------
                 -4.235          -3.476            -2.883          -2.573
Z(t)
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t)   0.0006
=

. dfuller FP,
lags(0)
Dickey-Fuller test for unit root                    Number of obs          202
=
                                 ---------- Interpolated Dickey-Fuller ----------
                 Test           1% Critical       5% Critical       10%
Critical         Statistic        Value             Value
Value
------------------------------------------------------------------------------
                 -1.082          -3.476            -2.883          -2.573
Z(t)
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t)   0.7223
=

. dfuller SP,
lags(0)
Dickey-Fuller test for unit root                    Number of obs          202
=
                                 ---------- Interpolated Dickey-Fuller ----------
                 Test           1% Critical       5% Critical       10%
Critical         Statistic        Value             Value
Value
------------------------------------------------------------------------------
                 -3.196          -3.476            -2.883          -2.573
Z(t)
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t)   0.0202
=

. dfuller arrival,
lags(0)
Dickey-Fuller test for unit root                    Number of obs          188
=
                                 ---------- Interpolated Dickey-Fuller ----------
                 Test           1% Critical       5% Critical       10%
Critical         Statistic        Value             Value
Value
------------------------------------------------------------------------------
                 -6.508          -3.481            -2.884          -2.574
Z(t)
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t)   0.0000
=
```

```
. dfuller S_price_vol, lags(0)

Dickey-Fuller test for unit root                 Number of obs        202
=
                                    Interpolated Dickey-
              Test        1% Critical   Ful5%erCritical    10%
Critical      Statistic     Value          Value
Value
Z(t)          -11.965        -3.476           -2.883             -2.573

MacKinnon approximate p-value for Z(t)     0.0000
=
. dfuller f_price_vol,
lags(0)
Dickey-Fuller test for unit root                 Number of obs        202
=
                                    Interpolated Dickey-
              Test        1% Critical   Ful5%erCritical    10%
Critical      Statistic     Value          Value
Value
Z(t)          -12.595        -3.476           -2.883             -2.573

MacKinnon approximate p-value for Z(t)     0.0000
=
. dfuller OI,
lags(0)
Dickey-Fuller test for unit root                 Number of obs        202
=
                                    Interpolated Dickey-
              Test        1% Critical   Ful5%erCritical    10%
Critical      Statistic     Value          Value
Value
Z(t)          -4.235         -3.476           -2.883             -2.573

MacKinnon approximate p-value for Z(t)     0.0006
=
. dfuller arrival,
lags(0)
Dickey-Fuller test for unit root                 Number of obs        188
=
                                    Interpolated Dickey-
              Test        1% Critical   Ful5%erCritical    10%
Critical      Statistic     Value          Value
Value
Z(t)          -6.508         -3.481           -2.884             -2.574

MacKinnon approximate p-value for Z(t)     0.0000
=
dfuller FP_first_diff, lags(0)

Dickey-Fuller test for unit root                 Number of obs   =    201

                                    Interpolated Dickey-Fuller
              Test        1% Critical    5% Critical     10% Critical
              Statistic     Value          Value           Value

Z(t)          -12.812        -3.476         -2.883          -2.573

MacKinnon approximate p-value for Z(t) =   0.0000
```

# APPENDIX 2

Vector autoregression

| | | | |
|---|---|---|---|
| Sample: 4 - 203 | | No. of obs | = 200 |
| Log likelihood | = 936.9158 | AIC | = -9.269158 |
| FPE | = 3.23e-07 | HQIC | = -9.20242 |
| Det(Sigma_ml) | = 2.92e-07 | SBIC | = -9.104243 |

| Equation | Parms | RMSE | R-sq | chi2 | P>chi2 |
|---|---|---|---|---|---|
| FP_first_diff | 5 | .012066 | 0.0204 | 4.167261 | 0.3838 |
| SP | 5 | .046106 | 0.8607 | 1235.705 | 0.0000 |

| | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| FP_first_d~f | | | | | | |
| FP_first_d~f | | | | | | |
| L1. | .0997393 | .0706101 | 1.41 | 0.158 | -.0386539 | .2381325 |
| L2. | -.0852213 | .0702281 | -1.21 | 0.225 | -.2228658 | .0524232 |
| SP | | | | | | |
| L1. | -.0060168 | .0164452 | -0.37 | 0.714 | -.0382488 | .0262151 |
| L2. | -.0005855 | .0164317 | -0.04 | 0.972 | -.0327911 | .0316202 |
| _cons | .0473473 | .0501087 | 0.94 | 0.345 | -.0508638 | .1455585 |
| SP | | | | | | |
| FP_first_d~f | | | | | | |
| L1. | .3609256 | .2698052 | 1.34 | 0.181 | -.167883 | .8897341 |
| L2. | .1107337 | .2683456 | 0.41 | 0.680 | -.415214 | .6366814 |
| SP | | | | | | |
| L1. | .4845291 | .062838 | 7.71 | 0.000 | .361369 | .6076893 |
| L2. | .4629629 | .0627867 | 7.37 | 0.000 | .3399033 | .5860224 |
| _cons | .3736716 | .1914681 | 1.95 | 0.051 | -.001599 | .7489421 |

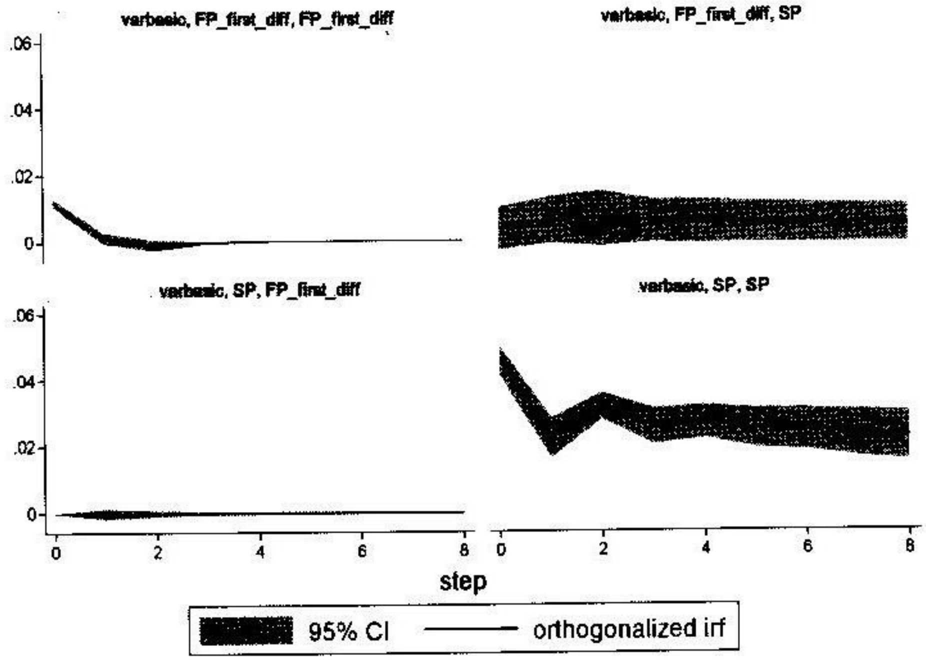
```
. graph save Graph "D:\Wheat Futures Markets\VAR.gph"
(file D:\Wheat Futures Markets\VAR.gph saved)

. varsoc
```

Selection-order criteria
Sample: 4 - 203 Number of obs = 200

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| 0 | 737.258 | | | | 2.2e-06 | -7.35258 | -7.33923 | -7.31959 |
| 1 | 911.977 | 349.44 | 4 | 0.000 | 4.0e-07 | -9.05977 | -9.01973 | -8.96082 |
| 2 | 936.916 | 49.878* | 4 | 0.000 | 3.2e-07* | -9.26916* | -9.20242* | -9.10424* |

Endogenous: FP_first_diff SP
Exogenous: _cons




Graphs by irfname, impulse variable, and response variable

# APPENDIX 3

ARIMA regression

Sample: 2 - 203, but with gaps

Log likelihood = -204.8529

Number of obs = 195
Wald chi2( 5) = 11.65
Prob > chi2 = 0.0399

| s_price_vol | Coef. | OPG Std. Err. | z | P>\|z\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| s_price_vol | | | | | | |
| arrival | -.0681991 | .0370743 | -1.84 | 0.066 | -.1408635 | .0044653 |
| f_vol_lag | -.0611468 | .0774154 | -0.79 | 0.430 | -.2128782 | .0905846 |
| f_price_vol | .0720471 | .0478176 | 1.51 | 0.132 | -.0216738 | .1657679 |
| _cons | 2.566433 | .4980532 | 5.15 | 0.000 | 1.590266 | 3.542599 |
| ARMA | | | | | | |
| ar | | | | | | |
| L1. | .1124067 | .0800394 | 1.40 | 0.160 | -.0444677 | .2692811 |
| L2. | .1272727 | .1028703 | 1.24 | 0.216 | -.0743493 | .3288947 |
| /sigma | .6914266 | .0279727 | 24.72 | 0.000 | .6366012 | .746252 |

# APPENDIX 4

```
. varbasic F_Volume f_price_vol, lags(1/2) step(8)

Vector autoregression

Sample:     3 - 203                         No. of obs      =        201
Log likelihood =   -655.7031                 AIC            =   6.623912
FPE            =    2.581003                 HQIC           =   6.690412
Det(Sigma_ml)  =    2.336503                 SBIC           =   6.788255

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
F_Volume              5    1.67996   0.2438   64.8174   0.0000
f_price_vol           5     1.0977   0.0688  14.85038   0.0050
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
F_Volume     |
    F_Volume |
         L1. |   .3736528   .0806709     4.63   0.000     .2155407    .5317648
         L2. |   .1597482   .0801353     1.99   0.046     .0026859    .3168106
 f_price_vol |
         L1. |  -.4395643   .1234917    -3.56   0.000    -.6816035   -.1975251
         L2. |  -.1705184   .1248325    -1.37   0.172    -.4151856    .0741488
       _cons |   6.508282   .8250089     7.89   0.000     4.891294     8.12527
-------------+----------------------------------------------------------------
f_price_vol  |
    F_Volume |
         L1. |  -.0605921   .0527107    -1.15   0.250    -.1639032     .042719
         L2. |  -.1000735   .0523608    -1.91   0.056    -.2026988    .0025517
 f_price_vol |
         L1. |   .1109061     .08069     1.37   0.169    -.0472434    .2690556
         L2. |   .1063773   .0815661     1.30   0.192    -.0534894    .2662439
       _cons |    4.81794   .5390645     8.94   0.000     3.761393    5.874487
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |          F_Volume        f_price_vol |  20.644     2    0.000    |
  |          F_Volume                ALL |  20.644     2    0.000    |
  |--------------------------------------+---------------------------|
  |       f_price_vol           F_Volume |  10.943     2    0.004    |
  |       f_price_vol                ALL |  10.943     2    0.004    |
  +------------------------------------------------------------------+

. sureg (f_price_vol = F_Volume arrival OI) (F_Volume = f_price_vol s_price_vol arriva
> OI)

Seemingly unrelated regression
----------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       chi2        P
----------------------------------------------------------------------
f_price_vol       196      3    1.027115    0.1043     141.50   0.0000
F_Volume          196      4    1.430197    0.3948     257.65   0.0000
----------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
f_price_vol  |
    F_Volume |   .5035728   .0430839    11.69   0.000     .4191299    .5880156
     arrival |  -.0179849   .0801909    -0.22   0.823    -.1751561    .1391863
          OI |   -1.00186   .1430791    -7.00   0.000     -1.28229   -.7214299
       _cons |   10.18586   1.513458     6.73   0.000     7.219539    13.15219
-------------+----------------------------------------------------------------
F_Volume     |
 f_price_vol |   .9936646   .0844826    11.76   0.000     .8280816    1.159247
 s_price_vol |  -.1313287   .1299801    -1.01   0.312    -.3860851    .1234277
     arrival |   .0952238   .1113311     0.86   0.392    -.1229811    .3134286
          OI |   1.867733   .1769891    10.55   0.000     1.520841    2.214625
       _cons |  -14.57761   2.099873    -6.94   0.000    -18.69329   -10.46194
------------------------------------------------------------------------------
```