The Commodity Futures Volatility and Macroeconomic Fundamentals – The Case of Oil and Oilseed Commodities in India

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ABSTRACT

Food price inflation results in uncertainty in the food markets and reduces real income as food covers a relatively large share of the households' expenditures in the LDCs. As price of food commodities are primarily governed by the underlying demand and supply conditions, we have analyzed the association of futures price volatility with the underlying macroeconomic variables. A strong association of futures price volatility with the underlying macro variables will imply that futures market operates based on the implications of the macroeconomic policies and are not merely driven by speculative motive. The association between futures price and the macroeconomic variables will help in developing policies aimed at stabilizing food prices. For our study we have considered the five major oil and oilseed contracts traded on National Commodity and Derivatives Exchange. We have considered the nearest three month contracts traded on the exchange. In our study we observe that Gross Domestic Product (GDP) and Index of Industrial Production (IIP) growth rate have significant impact on futures price volatility. We have also found a significant relation between futures price volatility and inflation. These findings have important implications for commodity production decision making, commodity hedging and commodity price forecasting.

Key words: *Food Price Volatility, Agricultural Commodities, Futures Price Volatility, Spot Price Volatility, Macroeconomic*
JEL Classifications: C12, G13, Q02

1. INTRODUCTION

The large increase in the price of commodities over the past decade has brought about renewed interest in the commodity markets for the investors, the policy makers and the financial economists. Price volatility is the most pressing issue faced by the producers of the primary commodities. The low prices of the basic commodities limit the income the farmers can receive for their products and the high volatility of these prices make it very difficult for them to optimize the use of this income (Morgan, 2001). The impact of volatility is more pronounced on producers in the Less Developed Countries than in their developed counterparts. For the poor countries food covers a relatively large share of the households' expenditures and hence food price increase lead to reduced real income as well as higher risks of malnutrition and higher uncertainty in food markets resulting from the food price inflation. It is important to analyze the main determinants of price volatility for policy recommendations as excessive price movements are harmful for both producers and consumers. Therefore, it is important to model commodity price volatility for all actors in the commodity market.

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Financial speculation in food commodity markets along with global financial markets' turmoil, export bans, adverse weather conditions, lack of efficient logistic system, infrastructure for food marketing and distribution, the dependence of the agricultural production on monsoon etc. have been held responsible for this food price jump. Von Braun and Torero (2009) have identified adhoc trade policy interventions and significant flow of speculative capital from financial investors into the agricultural commodity markets as the two major factors contributing to the 2007-08 international food price crisis. Conceicao and Mendoza (2009) have argued that lack of investment in the agricultural sector is the most critical factor for the food price increases. The volatility in the commodity prices are expected to be primarily driven by the underlying demand and supply conditions which are in turn affected by the macroeconomic policies, hence, it is important to study the causal association between commodity price volatility and the macroeconomic variables.

The changes in supply and demand conditions resulting from macroeconomic policy changes can significantly affect food price volatility. Uncertainty about future prices will impact the decisions of all the stakeholders in the commodity market – the producers, the consumers and the investors. If the macroeconomic factors are found to impact food price volatility, those should be factored in for formulating policies for the agricultural sector.

The crux of the food price challenge is about price volatility, rather than high prices per se. It is the rapid and unpredictable changes in food prices that cause anarchy in the markets and economic instability, rather than long-term structural trends in food prices. From the beginning, there have been interventions from the government of all the countries to artificially stabilize the prices, which pre-empted the development of a market based price risk management system. In the recent past; however, countries have begun to liberalize the commodity markets in the reversal of earlier trends; the development of commodity futures markets is being pursued actively with support from government. The rise in market based commodity risk management instruments has been significant in the last ten to fifteen years. The proliferation of these instruments is aided by the globalization of markets, market liberalization and lower trade & capital control barriers. At a micro level, the availability of futures prices for the coming season provides producers with an effective guide to decide which crops to plant –and in what quantities – in order to maximize expected returns at the time of the next harvest. Use of spot prices as a guideline – the way many farmers currently work – can lead to an exacerbation of inter-seasonal volatility, known as the "cobweb effect" of inter-seasonal price fluctuations. The futures price typically provides a more accurate indicator of the future spot price at the time of harvest. Therefore, at a macro level, if the market anticipates shortages for a given commodity next season, futures prices will rise and farmers will have a better incentive to plant that commodity, thereby mitigating the expected shortage (and vice versa). The commodity exchanges are expected to help the farmers protect themselves against the price risk but it has always been argued that too much speculation in the derivatives market and the evolution of commodity futures as an asset class for diversifying portfolio risks are leading to excessive price volatility.

In India there has been a prolonged debate regarding the impact of derivatives on volatility. The futures market has always been accused for increasing agricultural price volatility. The academic literature on the efficiency of derivatives to manage risk also does not have a unanimous opinion. As food prices are inherently volatile, the allegation that speculators in the futures market lead to increased volatility might not be entirely accepted. Speculators make money out of understanding and providing insurance against volatility. They do not create the

volatility themselves. The volatility inherent in the food marketplace causes speculation, not the other way around.

In order to understand the efficiency of futures market as a provider of hedge against future price risk we have analyzed the association of futures price volatility with the underlying macro conditions. This will help us understand whether the futures market is driven only by speculation or by information regarding the underlying asset. We have tried to analyze the role of macroeconomic policies on future price movements as it can help in policy formulations aided to help the farmers from irregular price movements in the market.

1.1. Objective of Study

In this paper we investigate the main drivers of futures price volatility of agricultural commodities. As it has been argued by many that excessive speculation in the commodity derivatives market have led to the increased volatility, we have tried to analyze the linkage between future price volatility, spot price volatility and the market fundamentals. We have considered five major oil and oilseed contracts traded on National Commodity and Derivatives Exchange (NCDEX), i.e., soybean, refined soyoil, castorseed, cottonseed oilcake and mustardseed.

Figure 1.1 Area under principal crops (2013-2014)

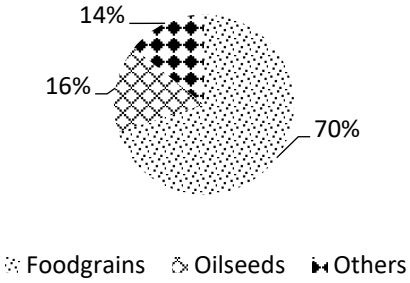
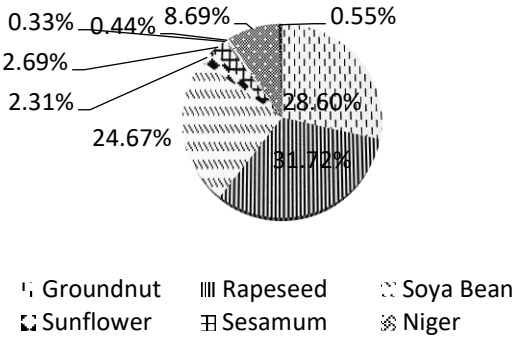


Figure 1.2 Production of major oilseed in India (2013-14)



Source: Government of India, Ministry of Agriculture.

India is one of the largest importers of edible oil in the world importing about half of domestic requirement. India is the 4th largest edible oil economy in the world and contributes about 10 per cent of the world oilseeds production, 6-7% of the global production of vegetable oil, and nearly 7 percent of protein meal. The oilseeds sector has an important place in the Indian agricultural sector covering an area of about 28.05 million hectares with a total production of 32.88 million tonnes in 2013-2014. The area under oilseeds constitutes about 16% of the cropped area. A wide range of oilseeds are cropped in India out of which groundnut, rape &

mustard seed and soybean account for about 88% of the production. The other major oilseeds are castor, sesame and sunflower. The major producers of oilseeds in India are Gujarat, Madhya Pradesh, Maharashtra and Rajasthan accounting for about 75% of the total. Oilseeds are primarily used for oil extraction and are also a major source of animal feed. The growing demand for protein meal has been the main driver behind the expansion of oilseed production in recent years.

As the commodity prices are primarily driven by the demand supply factors, the past performance of the commodity futures cannot be considered alone for forecasting the return from futures contracts. It is argued that commodity prices in India are controlled by the cash market and futures market has no role in the price discovery process. The efficiency of futures contract in predicting future price movements depends on its efficacy in the information dissemination process. As proposed by Fleming et al. (1996), the futures market is more responsive to new information than other markets; prices are first updated in the futures market which thus serves as a price discovery vehicle. Futures market will be able to play a significant role in the price discovery process if the information regarding future demand and supply conditions is first absorbed in the futures market. Hence the futures market is expected to be strongly connected to the market fundamentals. We have tried to analyze the significant factors affecting futures price volatility. We have tried to evaluate the linkage between futures and spot price movements and the market fundamentals.

1.2. Literature Review

The futures market in India has always been accused for increasing agricultural price volatility. The academic literature on the efficiency of derivatives to manage risk is also not in agreement as to the role of the derivatives market. There are studies which have pointed out the potential of the agricultural commodity derivatives market in performing the task of price discovery and price risk management (Naik and Jain, 2002; Karande, 2006; Lokare, 2007; Elumalai et al., 2009; Mukherjee, 2011). Ranjan (2005) found that futures trading did reduce seasonal price volatility in the case of Soya Oil. There are studies which, on the other hand, have found that agricultural futures market failed to exhibit the feature of market efficiency and price discovery (Sahi and Raizada, 2006; Sahi, 2007; Bose, 2008; Easwaran and Ramasundaram, 2008; Sen and Paul, 2010). Nath and Lingareddy (2007) in their study have attempted to explore the effect of introducing futures trading on the spot prices of pulses in India and have found that futures trading have increased price volatility especially in the case of urad. The study by Kabra (2007) has stated that the infrastructure, logistics management, linkages with the financial institutions and the information system needs to be improved to make futures market for commodities useful mechanism for price discovery and price risk management. Sabnavis and Jain (2007) have advised that the market should be allowed to grow so that all members of the value chain in the agricultural sector can receive the benefits of futures trading.

As per the Indian Institute of Bangalore (IIMB) study (2008) and the Abhijit Sen Committee report (Ministry of Consumer Affairs, 2008), "Futures market may not have served the purpose of risk management".

The studies on agricultural derivatives market in India have primarily concentrated on analyzing the efficiency of the futures market in predicting the future spot price but have not tried to study the causal relationship between commodity returns and the market fundamentals. They have not made any attempt to understand the linkage between futures price movements and the macroeconomic variables. The time variation of volatility and its significant factors have been

examined by several studies. The volatility clustering have been examined and modeled by different variants of the GARCH model but these studies have not identified the cause of the volatility.

The recent price swing observed during 2006-2009 has attracted the interest of many academicians to analyze the drivers responsible for these patterns. The studies have focused on the dynamics of commodity volatility but have failed to establish any causal relationship between volatility and its drivers. The vast majority of studies related to the analysis of commodity price volatility have primarily focused on the demand supply factor as fundamentals but the rise in the price of commodities in 2009 cannot be attributed only to the microeconomic factors, there is expected to be a significant impact of macroeconomic factors on commodity volatility dynamics overtime. There have been few studies conducted with regard to the developed markets to evaluate the role of macroeconomic variables as drivers of volatility. Roache (2010) found a significant role of inflation and exchange rates in affecting food price volatility. Due to the growth of futures market in the recent past the increase in volatility has been ascribed to be a phenomenon driven by speculative activities in the derivatives market. Attie and Roache (2009) and Leibtag (2008) have exemplified the role of food price volatility in affecting the portfolio choices of the financial investors. Zheng et al. (2008) examined whether unexpected news affects food price volatility. Hayo et al. (2012) and Manera et al. (2013) have evaluated the impact of US monetary policy and speculation on price volatility of different commodities. Donmez and Magrini (2013) have observed that incorporating economic fundamentals improves the capability of explaining price volatility dynamics. In the Indian context there is no significant work done to understand the causal relation between the futures market and the macroeconomic fundamentals.

The studies conducted in the Indian context have primarily tried to evaluate the role of commodity futures as an instrument of price risk management; they have evaluated the convergence between futures and spot prices but have not tried to understand the factors causing the volatility. There have been many studies on the identification of factors for rise in food prices in India but they have not tried to test the association between the rise in price and the futures market. Mishra and Roy (2011) have attributed inflation to production shocks and excessive government intervention in the food markets. Chand (2010) have observed that expansion in the buffer stock and improvement in the storage facilities can help to control food price inflation. Nair and Eapen (2012) argue that production shortfalls and cost of production played the major role in the inflation episode between January 2008 and July 2010. Nair (2013) have argued that demand side pressures and the rise in the cost of production are the main drivers of inflation with regard to the cereals. In this study we have tried to analyze whether underlying economic factors have any bearing on futures price volatility. We have evaluated whether the future prices are primarily driven by lagged future price movements and spot price movements or the macroeconomic variables also do impact. For our analysis we have considered the five major oil and oilseed contracts traded on NCDEX.

The paper is organized as follows – Section 2 contains a detailing on the data used and its description in the subsections, Section 3 describes the methodology adopted for the analysis and the results in the subsections. Finally, Section 4 concludes.

2. DATA

In order to test the existence of any causal relationship between futures price volatility and the underlying economic fundamentals we have considered five oil and oilseed contracts traded on

NCDEX like soybean, refined soyoil, mustardseed, castorseed and cottonseed oilcake. We use the daily closing prices of the futures contracts and daily spot price of the commodities for the period 2005 to 2015. We have considered the data from 2005 because consistent data for all the relevant commodities are available from April 2005. The number of contracts launched in a month varied for commodities and hence we have only considered the near three month contracts for all the six commodities considered from 2005 to 2014.

We have calculated the monthly standard deviation of futures price and spot price as a measure of volatility in the commodity prices. The monthly standard deviation of futures prices is measured for each month starting from the contract initiation. We have tried to test whether change in the macroeconomic variables do have an impact on futures price volatility. As agricultural prices are primarily dependent on the demand and supply conditions we have considered few variables which do have a strong association with them.

As agricultural prices and economic growth of a country are strongly connected, we have considered the monthly GDP growth rate in our model. The GDP growth rate is calculated as the percentage change in GDP over the period. We have considered the quarterly GDP growth rate and transformed it to get the monthly growth rate. To understand the impact of macroeconomic stability on futures price volatility, we have also included the Index of Industrial Production (IIP) as an explanatory variable in our model. We have considered the monthly growth rate (as measured by percentage change) of IIP with 2004-05 as the base period. The data on GDP and IIP has been collected from the Reserve Bank of India database. The commodity prices are primarily determined by the demand and supply conditions. In India majority of the farmers are small and marginal farmers with very small pieces of land and very low economic power, resulting in distress selling of their crops. It is observed that prices usually drop during the harvesting season; therefore, we have included dummies for sowing and harvesting season in our model in order to evaluate whether they have any impact on futures price volatility. To capture the role of monetary variable we have considered the interest rate as measured by the monthly 91 Day Treasury Bill yield for our study. As interest rates are an important cost to holding inventories of commodities, a strong negative relation is expected to prevail between interest rate and price volatility. High interest rate is expected to decrease the demand for storable commodities and increase their supply and vice versa. Commodity futures are expected to provide protection to the farmers against uncertain price movements in the future. The incentive to hold commodities is expected to increase with rising inflation and hence the price of future contracts is expected to move in tandem with inflation. We have considered the monthly growth rate of the Consumer Price Index for our study. A positive relation is expected between volatility and inflation. The classical monetarist notion is that inflation is the result of changes in money supply. It has been observed that higher monetary expansion caused by massive borrowing from the banking system to finance fiscal deficit has remained a principal source of accelerated inflation. We have considered the M3 measure of money supply, as received from RBI database, to determine the impact of monetary policy measures on the futures price volatility. We have considered the monthly change (as measured by percentage change) in money supply for our study. As majority information regarding the underlying asset is revealed in the contract maturity month we have also used dummies for the contract term in order to analyze whether maximum volatility is observed in the maturity month or not. In India the decision are taken by the farmers as to how much to bring in the mandis based on the price movements and on the expectation formed about future spot price. The daily arrival of commodities in the mandis is being considered to analyze whether it has an impact on the future price movements. We have collected the daily arrival data for all the commodities considering

the mandis in the leading producing states; then we have aggregated the data across mandis in the different states and summed over the daily data to get the monthly arrival data.

The contract details of the commodities we have considered for our study are mentioned in the table below.

Commodity	Number of Observations
Soybean	431
RM Seed	427
Refined Soyoil	301
Castorseed	427
Cottonseed Oilcake	317

Table 2.1 Contract details, Trading Period: April 2005 to July 2014.
Source: National Commodity and Derivatives Exchange of India

2.1. Descriptive Statistics

The descriptive statistics of futures and spot price volatilities are shown in Table 2.2 and 2.3 respectively below. Table 4a and 4b contains the descriptive statistics of the macroeconomic variables and quantity arrival of commodities respectively.

Contract Term		Soybean	Refined Soyoil	RM Seed	Castorseed	Cottonseed Oilcake
Nearest contract	Mean	50.38	7.26	40.67	50.81	19.89
	Median	42.17	5.93	34.34	21.00	15.29
	Std. Deviation	38.93	5.00	28.63	60.06	17.35
	Kurtosis	7.44	1.89	6.84	2.09	24.33
	Skewness	2.19	1.23	2.33	1.54	3.99
	Phillips-Perron test statistic	-6.027**	-8.52**	-3.34**	-6.08**	-1.70*
1 month to maturity	Mean	61.56	10.10	48.44	64.30	23.80
	Median	48.26	8.80	41.70	28.54	17.90
	Std. Deviation	49.60	7.03	36.25	72.45	19.85
	Kurtosis	6.03	4.73	3.90	1.99	5.72
	Skewness	2.13	1.60	1.95	1.42	1.94
	Phillips-Perron test statistic	-5.23**	-7.76**	-2.82**	-6.18**	-3.78**
2 months to maturity	Mean	60.91	10.58	50.73	63.58	22.29
	Median	49.01	9.02	41.37	33.44	17.55
	Std. Deviation	47.41	7.86	37.62	70.21	16.94
	Kurtosis	4.34	5.87	3.55	0.97	1.08
	Skewness	1.90	1.92	1.84	1.26	1.16
	Phillips-Perron test statistic	-9.12**	-9.71**	-6.20**	-5.65**	-5.03**
3 months to maturity	Mean	32.83	5.17	29.22	35.67	11.83
	Median	24.99	4.45	21.14	17.18	8.37
	Std. Deviation	26.96	3.77	21.62	48.12	8.74
	Kurtosis	6.61	2.66	0.95	7.09	0.41
	Skewness	2.17	1.48	1.26	2.39	0.93
	Phillips-Perron test statistic	-9.91**	-8.06**	-7.78**	-6.41**	-7.16**

Table 2.2 Contract details, Trading Period: April 2005 to July 2014.
Notes: ** Significant at 5% level of significance, * Significant at10% level of significance

We have presented the descriptive statistics of futures and spot price monthly variation by contract term. Monthly standard deviation is lowest for the contract with the maximum time to maturity, indicating that as maturity approaches volatility increases. Considering the skewness

values which represent the asymmetry in the series, all the futures price volatility series are positively skewed. The distributions are also observed to be leptokurtic as all the kurtosis figures are positive for the futures volatility series. The skewness of the spot volatility is positive indicating that the distributions are positively skewed and leptokurtic because of the positive kurtosis values.

	Contract Term	**Soybean Spot**	**Soyoil Spot**	**Castorseed Spot**	**RM Seed Spot**	**Cottonseed Oilcake Spot**
Nearest contract	Mean	58.09	8.85	67.22	53.69	28.95
	Median	45.72	7.65	27.75	45.85	21.48
	Std. Deviation	49.82	6.32	111.80	39.73	26.07
	Kurtosis	7.25	2.26	35.01	1.03	12.38
	Skewness	2.28	1.25	4.94	1.29	3.20
	Phillips-Perron test statistic	-11.87**	-7.44**	-18.24**	-6.81**	-14.71**
1 month to maturity	Mean	60.55	8.90	66.84	53.73	29.82
	Median	43.56	7.66	27.13	44.47	21.78
	Std. Deviation	64.22	6.40	112.22	40.44	26.41
	Kurtosis	23.37	2.09	34.88	0.87	11.39
	Skewness	4.06	1.23	4.94	1.27	3.06
	Phillips-Perron test statistic	-9.69*	-7.84**	-9.67**	-7.32**	-10.61**
2 months to maturity	Mean	58.19	8.90	63.99	53.46	29.37
	Median	42.61	7.65	26.51	45.38	21.69
	Std. Deviation	60.45	6.47	110.03	39.08	25.57
	Kurtosis	29.39	1.97	38.73	0.69	12.60
	Skewness	4.48	1.23	5.27	1.20	3.16
	Phillips-Perron test statistic	-6.69**	-7.38**	-9.73**	-7.06**	-9.71**
3 months to maturity	Mean	60.64	8.99	65.92	55.18	29.88
	Median	42.61	7.67	26.51	45.85	21.63
	Std. Deviation	65.81	6.46	112.01	40.74	26.99
	Kurtosis	21.51	1.92	35.70	0.62	10.45
	Skewness	3.94	1.20	5.03	1.18	2.96
	Phillips-Perron test statistic	-9.61**	-7.65**	-9.75**	-7.90**	-10.91**

Table 2.3 Descriptive Statistics of Monthly Standard Deviation of Spot Prices.
Notes: ** Significant at 5% level of significance, * Significant at10% level of significance

	Monthly GDP Growth Rate	Monthly Inflation All Commodities	Monthly Inflation Oilseeds	IIP Growth Rate	Change in Money Supply	Change in 91 Day Treasury Bill Yield
Mean	0.61	6.60	8.60	6.52	5.36	0.01
Median	0.19	6.93	8.28	5.60	0.99	0.01
Mode	-2.55	4.4	-13.5	-7.20	-49.08	0.00
Std. Deviation	2.05	2.63	11.27	6.74	30.48	0.08
Skewness	0.29	-0.40	0.00	0.39	0.69	0.07
Std. Error of Skewness	0.12	0.12	0.12	0.12	0.12	0.12
Kurtosis	-0.80	-0.19	-0.99	-0.36	0.07	10.73
Std. Error of Kurtosis	0.24	0.23	0.23	0.23	0.23	0.23
Phillips-Perron test statistic	-7.17**	-1.97**	-3.39**	-4.47**	-35.52**	-19.53**

Table 2.4a Descriptive Statistics of Macroeconomic Variables.
Notes: ** Significant at 5% level of significance, * Significant at10% level of significance

	Soybean Mandi Arrival	RM Seed Mandi Arrival	Castor Seed Mandi Arrival	Cottonseed Oilcake Mandi Arrival
Mean	63770.24	19154.47	15080.32	22074.20
Median	30846.50	773.0	10460.90	5110.50
Std. Deviation	110551.20	288.13.17	13828.92	37332.84
Skewness	5.04	2.79	1.93	3.64
Kurtosis	31.52	7.66	5.93	18.06

Table 2.4b Descriptive Statistics of Mandi Arrival of Crops (April 2005 to July 2014).

As we want to understand the linkage, if any, between the futures market and the macroeconomic fundamentals, we have considered different macroeconomic variables in our analysis like GDP growth rate, IIP growth rate, Inflation, Money Supply and Interest Rate. We have included the mandi arrival of the crops as an explanatory variable to analyze its impact on future price movements. The descriptive statistics of the macroeconomic variables and mandi arrival data are presented in Tables 4a and 4b respectively. The mandi arrival data shows that there has been extreme variability in the quantity arrival of the commodities. The farmers in India due to their poor economic conditions go for distress selling leading to significant increase in supply after the harvest. The inappropriate storage conditions and poor financial condition of the farmers is likely to lead to this variation in quantity arrival. To determine the significant factors affecting futures price volatility we have done regression analysis. A necessary condition for running regression is the stationarity of the series, hence, we have tested whether the series has a unit root or not. The Phillips-Perron test for both the spot and futures price volatility series of all the commodities and the series of the macroeconomic variables leads to the rejection of the null hypothesis of unit root leading to the conclusion of stationary series. To take care of the Heteroscedasticity and serial correlation we have used the Phillip-Perron test for non-stationarity rather than the conventional Dickey Fuller test.

3. THE LINKAGE BETWEEN FUTURES VOLATILITY AND MARKET FUNDAMENTALS

3.1. Methodology

In our study we have tried to understand whether futures market react to some news about the market fundamentals. Investment in commodity futures cannot be driven by the same factors as for equities because commodities are consumption assets. Thus, we have tried to analyze the factors which can impact decisions about taking positions in the futures market. The agricultural commodities are perishable in nature and hence require proper storage facilities for holding the short position in futures contract till further increase in prices. As in India, majority of the farmers are poor, it is difficult for them to take position in the futures market. There have been many initiatives taken in many states by cooperatives to collect the produce from the individual farmers and take positions in the derivatives market on behalf of the farmers to hedge the price risk. It is considered that if futures market operates efficiently, they can provide the farmers protection against future price movements. The spot and futures market react to the same information but it is the time of reaction which determines the price discovery process.

There exist two views on the relationship between commodity spot and futures price. The first theory is related to the cost and convenience of holding inventories while the second theory applies a risk premium to derive a model for the relationship between the two.

As per the Cost-of-Carry hypothesis formalized by Kaldor (1939) and Working (1948, 1949), a commodity futures price is the current spot price net of costs of storage and a convenience yield. As per the arbitrage argument, futures price is equal to the spot price plus the carrying cost; i.e., the futures price must be high enough to offset the storage cost of holding the commodity till the delivery period. The convenience yield, on the other hand, represents the benefit of holding physical commodity, i.e., extra profits from temporary local shortages. Convenience yields depend on the level of inventories and reflect expectations about the availability of commodities. The productive value of inventories is inversely related to the storage levels; the value is high with low storage levels and vice versa. Low inventories, therefore, imply high convenience yields and vice versa.

As per the Cost-of-Carry model, in equilibrium, an explicit relationship can be derived between the spot and futures price.

$$F_{t,T} = S_t\,(1 + r_{t,T}) - CY_{t,T} + k_{t,T}$$

where, $F_{t,T}$ is the futures price at time t for delivery at time T; S_t is the spot price at time t, $r_{t,T}$ is the risk-free interest rate for period, $CY_{t,T}$ is the convenience yield and $k_{t,T}$ is the cost of physical storage over the holding period.

$$F_{t,T} = S_t\,(1 + r_{t,T}) - (CY_{t,T} + k_{t,T})$$
$$F_{t,T} = S_t\,(1 + r_{t,T}) - \psi_{t,T}$$

where, $\psi_{t,T} = (CY_{t,T} + k_{t,T})$ is the convenience yield net of storage cost.

$$F_{t,T} - S_t = S_t\,r_{t,T} - \psi_{t,T}$$
$$\frac{F_{t,T} - S_t}{S_t} = r_{t,T} - \frac{\psi_{t,T}}{S_t} \qquad (3.1)$$

Therefore, by the theory of storage, the spread between contemporaneous future and spot prices can be explained by the interest foregone in storing the asset, the storage costs and the convenience yields.

Another view as proposed by Cootner (1960), Dusak (1973), Breeden (1980) and Hazuka (1984) splits the futures price into an expected risk premium and a forecast of the future spot price. The difference between futures price and current spot price can be expressed as the sum of an expected premium and an expected change in the spot price:

$$F_{t,T} - S_t = \mathrm{E}_t\,(S_T - S_t) + \Pi_{t,T} \qquad (3.2)$$

where, $F_{t,T}$ is the futures price at time t for delivery at time T; S_t is the spot price at time t, S_t is the spot price at time T, $\Pi_{t,T}$ is the expected risk premium for holding the commodity from time t to T; E_t is the expectation formed in the futures market at time t. The expected risk premium is defined as the bias of the futures price as a forecast of the future spot price,

$$\Pi_{t,T} = F_{t,T} - \mathrm{E}_t\,(S_T) \qquad (3.3)$$

Keynes (1930) proposes that producers short contracts in the futures market to hedge risk due to possible spot price decreases. Thus they transfer the risk to long-side investors of the contracts. If the futures market is efficient then any information related to the underlying commodity is expected to be incorporated immediately in the future prices. Long-side investors should be compensated with a risk premium.

The two views, though alternative, are not competing. The expected risk premium in Equation (3.2) translates into the interest foregone, the storage cost and convenience yields in Equation (3.1). As per Equation (3.1), the basis as measured by $(F_{t,T} - S_t)$ will be positive if interest rate foregone and storage cost is higher than the convenience yields. For periods between harvests, as inventories are high the low convenience yields are outweighed by the storage and interest cost. From Equation (3.2) as the expected spot price is expected to fall after harvest, we can expect a positive risk premium and a positive basis.

From Equation (3.1) and (3.2) we get,

$$\frac{\mathrm{E}_t(S_T - S_t)}{S_t} = r_{t,T} - \frac{\psi_{t,T}}{S_t} - \Pi_{t,T} \qquad (3.4)$$
$$\mathrm{E}_t(R_{t,T}) = r_{t,T} - \psi_{t,T} - \pi_{t,T} \qquad (3.5)$$

where, $R_{t,T}$ is the return, $\Psi_{t,T}$ and $\pi_{t,T}$ are the convenience yields and risk premiums as percentage of spot price at time *t*.

The convenience yield depends on the current price level, the price volatility, and the level of storage. An increase in spot price reflects the imbalance between supply and demand. As the shortage of supply increases, the demand for storage will increase, driving up the value of storage. The lower the storage level is, the higher the value will be for the marginal storage. The lower the level of storage, the higher will be the convenience yields. Therefore, convenience yields depend on the demand and supply conditions and the storability of the commodity; convenience yields will be higher if there is an unexpected demand of a commodity or a supply shock. The demand for storage is also higher during periods of high market volatility due to the greater need to buffer fluctuations in production and consumption. The storage costs will be higher if there is an expectation of future price rise and hence convenience yield is also related to the rate of inflation.

As per the theory of commodity price determination, the risk premium depends on the current spot price, price volatility, risk free interest rate and the convenience yield. Risk premium is expected to depend positively on the convenience yield, the risk premium will be higher if convenience yield is higher. Risk premium, therefore, depends on the inventory level. The risk premium will be higher for low inventories and vice versa. The risk premium is also positively related with the interest rate, as interest rate increases the opportunity cost of holding the asset increases leading to higher risk premium. Therefore, convenience yield and risk premium can be presented as:

$$CY_{t,T} = f\,(S_t, \text{Vol}S_t, \text{Seasonality, Inventory Level}) \quad (3.6)$$

$$\Pi_{t,T} = f\,(S_t, \text{Vol}S_t, r_{t,T}, CY_{t,T}) \quad (3.7)$$

where, $CY_{t,T}$ is the convenience yield, S_t is the current spot price of the commodity, VolS_t is the spot price volatility at time *t* and $r_{t,T}$ is the risk free interest rate. As nominal interest rate depends on real interest rate and rate of inflation, therefore risk premium and hence expected return will depend on inflation rate.

The efficiency of the futures price as an estimator of future spot price depends on the convenience yields, the interest foregone for purchasing the commodity at time *t* & holding it till the delivery period and the risk premium for bearing the risk of purchasing the commodity. As the convenience yields and the risk premium depend on market fundamentals like the demand and supply conditions, the current economic situation, the current spot price, the price volatility, the inflation rate, the level of storage, the sowing and harvesting seasons etc., the futures price volatility is expected to be driven by these fundamental variables. The convenience yield and risk premium are expected to significantly depend on inventory levels and hence futures prices are expected to significantly depend on past future and spot volatilities. The futures and spot price volatilities are expected to be affected by change in inventory levels.

The past performance of future contracts is considered to be the most significant factor in forecasting future returns. In India as agricultural commodity prices are considered to be primarily driven by the cash market we have first evaluated the association between futures price volatility, lagged futures volatility, contemporaneous and lagged spot volatility and dummies for contract terms. We have done regression analysis to test whether lagged futures volatility and contemporaneous & lagged spot price volatility significantly impact futures volatility. In order to capture the seasonality in agricultural prices, we have also considered the 6 month and 12 month futures price volatility as explanatory variables in our model. The volatility is expected to reduce with contract maturity. Since we have considered contracts up

to three months to maturity, we have considered three dummies to capture the term pattern in futures price volatility. We have done the regression analysis with futures volatility, as measured by monthly standard deviation of future prices, as the dependent variable. We have evaluated the following regression model for our analysis:

$$VF_{i,t} = \alpha + \beta_1 VF_{i,t-1} + \beta_2 VF_{i,t-6} + \beta_3 VF_{i,t-12} + \gamma_1 VS_{i,t} + \gamma_2 VS_{i,t-1} + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + u_{i,t} \quad (3.8)$$

where $VF_{i,t}$ is the futures price volatility of commodity i at time t, $\beta_1 VF_{i,t-1}$ is the futures price volatility of commodity i for lag of 'l' periods, $VS_{i,t}$ is the spot price volatility of commodity i at time t, $VS_{i,t-1}$ is the spot price volatility of commodity i for lag of 'l' periods, D_j is the dummy for contract term with j = 0,1,2,3 months to maturity and $u_{i,t}$ is the error term. β_{is}, γ_{is} and δ_{is} are the regression coefficients to capture the impact of futures price volatility, spot price volatility and contract term respectively.

To understand the impact of market fundamentals on futures price volatility we have done a regression analysis by including some indicators of economic environment of the country like GDP growth rate, IIP growth rate, inflation, interest rate and money supply as explanatory variables in our regression model. To determine the impact of economic stability we have considered the monthly GDP growth rate and the monthly IIP growth rate with 2004-05 as the base period. To evaluate the role of monetary policies on futures price volatility we have calculated the monthly change in money supply considering the M3 measure of money supply, the change in the monthly yield on 91 day treasury bill, the monthly inflation rate based on the CPI index. We have included dummies for sowing and harvesting season as convenience yields and risk premium do have a seasonal pattern and are expected to vary with the inventory levels. We have included the monthly arrival of commodities in the mandis as explanatory variables as a proxy for the inventory level. The quantity brought forward by the farmers in the mandis is expected to depend on the production level and their expectations regarding future spot price and hence is expected to affect futures price movements.

We have tested whether the explanatory power of the model increases by adding the macroeconomic variables and have tried to determine the significant economic factors. We have evaluated the following regression model for our analysis:

$$VF_{i,t} = \mu + \beta_1 VF_{i,t-1} + \beta_2 VF_{i,t-6} + \beta_3 VF_{i,t-12} + \gamma_1 VS_{i,t} + \gamma_2 VS_{i,t-1} + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \lambda_1 \Delta GDP_{t,t-1} + \lambda_2 \Delta IIP_{t,t-1} + \xi_1 QM_{i,t} + \theta_1 S_1 + \theta_2 H_1 + \eta_1 \Delta r_{t,t-1} + \eta_2 \Delta MS_{t,t-1} + \eta_3 Inf_t + \nu_{i,t} \quad (3.9)$$

where $VF_{i,t}$ is the futures price volatility of commodity i at time t, $VF_{i,t-1}$ is the futures price volatility of commodity i for lag of 'l' periods, $VS_{i,t}$ is the spot price volatility of commodity i at time t, $VS_{i,t-1}$ is the spot price volatility of commodity i for lag of 'l' periods, D_j is the dummy for contract term with j = 0,1,2,3 months to maturity, $\Delta GDP_{t,t-1}$ is the monthly growth rate of GDP from t-1 to t, $\Delta IIP_{t,t-1}$ is the monthly growth rate of IIP, $QM_{i,t}$ is the quantity brought forward of commodity i in the mandi at time t, $\Delta r_{t,t-1}$ is the change in the interest rate from t-1 to t, $\Delta MS_{t,t-1}$ is the change in money supply from t-1 to t, Inf_t is the rate of monthly inflation of oilseed prices at time t, S_1 and H_1 are dummies for sowing and harvesting seasons respectively and $\nu_{i,t}$ is the error term. β_{is}, γ_{is}, δ_{is}, λ_{is}, ξ_1, θ_{is} and η_{is} are the regression coefficients to capture the impact of futures price volatility, spot price volatility, contract term, GDP and IIP growth rates, quantity brought in the mandis, sowing and harvesting seasons, change in interest rates, change in money supply and inflation rate respectively.

We have done the analysis for five different commodities like soybean, refined soyoil, mustardseed, castor seed and cottonseed oilcake and have tried to understand whether there is uniformity in the association of futures market with the market fundamentals. We have also

considered the effect of the sowing and harvesting seasons because the prices are usually expected to drop during the harvesting season due to increased supply in the market.

GDP and IIP growth are expected to reduce volatility as they increase the confidence of the people on the future growth prospects of the economy. During harvesting season, inventories go up and the demand for storage increases and outweighs the convenience yield for holding the physical asset. After harvest the number of producers taking short positions in the market will increase and hence the speculators will demand more risk premium for providing insurance against price risk. Therefore, there is high probability of volatility to rise after harvest. The opposite is expected to happen during the sowing season. A rise in the interest rate increases the opportunity cost of holding inventories and can lead to decreased volatility. Inflation on the other hand is probable to increase volatility. Similar result is likely for the change in money supply.

3.2. Results

The regression results for the contracts considered as per the model presented in Equation (3.8) and Equation (3.9) are presented in Table 3.5 below for the individual commodities. If any variable is not significant (at10% level) for any of the commodities considered, we have not included the results in the regression table. We have done a comparison between the two regression models, with and without the macro variables for all the commodities in order to understand the explanatory power of the macroeconomic variables.

From the regression model as represented in Equation (3.8) we find that, the past performance of the futures contracts do significantly affect futures price movements; the regression coefficients of one period lagged futures volatility are positive and significant implying that higher volatility one month earlier leads to increased volatility in the current month. For all the commodities under study, the most significant factor explaining futures price volatility is the contemporaneous spot price volatility. This shows that both the markets react simultaneously to any flow of information.

The regression coefficient is positive and significant for all the commodities under study. For soybean and cottonseed oilcake, the one month lagged spot volatility is also significant which might be an indication that for these two commodities people make investment decisions based on past spot price movement; the coefficient is negative suggesting that higher price movements in the cash market in the prior month leads to comparatively less future price movements. But this phenomenon is not observed for the other commodities, though the coefficients are negative for castor seed and soyoil as well but they are not significant. To capture the existence of seasonality pattern, if any, we have included the 6 months and 12 months lagged futures price volatilities. For mustardseed, castor and cottonseed the 12 month lagged futures price volatility is observed to have an impact on the decisions of the investors; the regression coefficients are negative and significant indicating that there is a probability that people make decisions about the future production based on futures price movements leading to lower volatility in the futures prices. As a time pattern is expected to be observed in the futures price movements, the volatility is expected to be higher for the contracts closest to maturity. To capture the time pattern we have included dummies for the contract term. For all the commodities, the contracts with three months period to maturity is observed to have significantly lower volatility as compared to the contracts expiring in the current month. For all the commodities, the most significant factor is the contemporaneous spot price volatility.

Considering the results as per the regression model (3.9), the explanatory power of the model increases with the inclusion of the macro variables suggesting a strong linkage of the futures market with the market fundamentals. A rise in the economic growth is expected to improve market sentiments and hence reduce volatility. For soybean, castorseed and cottonseed we observe a significant role of GDP growth on volatility, for soyoil also the coefficient is negative but not significant. Another indicator of the economic growth is the increase in the Index of Industrial production (IIP). An increase in IIP increases the confidence of the people and hence might reduce the volatility in the financial market leading to lower volatility in the commodities market. For all the commodities we observe a significant impact of IIP on futures price volatility, futures volatility is observed to decrease with increase in IIP growth rate.

Another factor being considered is the interest rate. Interest rates are important costs to holding inventories in commodities. A negative relation is expected between interest rate and volatility; a decline in interest rate reduces the opportunity cost to hold inventories, hence making the market thinner and reducing the ability to cope with the shocks. We observe a significant negative relation between interest rate and futures price volatility for soybean and soyoil, but not for the other commodities. The difference in results might have resulted from the disparity in the volume of trading of the commodities. As interest rate is the opportunity cost of holding inventory till contract expiration, it is observed to strongly impact future price movements for the two most actively traded commodities in the oil & oilseed group, i.e., soybean and refined soyoil. For all the commodities, except soybean volatility is observed to increase with inflation; for soybean also the regression coefficient is positive but not significant. A rise in inflation might attract the consumers to protect themselves against further price rise by taking long positions and similarly the producers will be interested to hold the commodity for future price gain leading to increased volatility. The change in money supply is not observed to be significant for any of the commodities concerned.

The agricultural commodities follow a cycle; during the harvest months, the newly harvested crops come to the market and supply is higher. On the other hand, before the harvest, the source of supply is from crops harvested during the previous season. Hence, sowing and harvesting seasons are expected to have an impact on futures price movements. To capture this seasonality, we have included dummies for sowing and harvesting periods of the crops. We observed that for soybean and mustardseed, the coefficient of harvesting dummy is negative which indicates that volatility reduces during the harvesting periods. For soybean and mustardseed, volatility is observed to be higher during the sowing period. During the sowing period, the trading is primarily on previous harvests and high uncertainty regarding the future production might have resulted in high volatility. But the same results are not observed for soyoil, castorseed and cottonseed. Hence, there is ambiguity on the impact of seasonality on futures price volatility.

The daily arrival of the commodities in the mandis is likely to reflect information about the inventory situation. Higher supply in the market can be an indication of higher inventory of the crop. As per the Cost-of-Carry model, if inventory is high, the convenience yield will be low leading to lower futures prices. Hence futures prices are expected to move based on inventory conditions. To capture the impact of inventory on futures price movements, we have included the daily arrival of commodities as an explanatory variable in our model. For each crop we have considered the state with the highest production of the crop. We have considered the common mandis in the producing states for the years from April 2005 to July 2014 and have summed the daily arrival to get the monthly arrival data. The arrival is not observed to significantly impact the futures price movements, which might have resulted from paucity of data. If data on

arrival is available for all the mandis where the crop is traded, the impact of crop arrival on futures price movements can be studied adequately.

	Soybean		Refined Soyoil		Mustardseed		Castorseed		Cottonseed Oilcake	
Explanatory Variables	**Eq. (3.8)**	**Eq. (3.9)**	**Eq. (3.8)**	**Eq. (3.8)**	**Eq. (3.8)**	**Eq. (3.9)**	**Eq. (3.8)**	**Eq. (3.9)**	**Eq. (3.8)**	**Eq. (3.9)**
One Period Lagged Futures Volatility	0.138** (3.09)	0.06 (1.37)	0.07* (1.67)	0.03 (0.807)	0.018 (0.26)	-0.07 (-0.98)	0.15 (2.85)	0.063 (1.27)	0.24** (3.07)	0.173** (2.25)
Contemporaneous Spot Volatility	0.7** (22.27)	0.65** (19.27)	0.65** (19.43)	0.64** (18.26)	0.68** (13.52)	0.56** (9.77)	0.56** (14.02)	0.435** (11.21)	0.39** (6.12)	0.37** (5.95)
One Period Lagged Spot Volatility	-0.113** (-2.53)	-0.08* (-1.92)	-0.003 (-0.068)	-0.015 (-0.341)	0.029 (0.41)	0.078 (1.11)	-0.03 (-0.604)	-0.021 (-0.511)	-0.17** (-2.35)	-0.13* (-1.95)
12 Month Lagged Futures Volatility	-0.03 (0.71)	-0.01 (-0.29)	0.003 (0.06)	0.015 (0.45)	-0.12 (-1.72)	-0.13** (-2.00)	-0.11** (-2.36)	-0.17** (-4.20)	-0.29** (-3.24)	-0.16** (-2.28)
Dummy _Maturity Horizon_1 month	0.102** (2.656)	0.104** (2.9)	0.19** (4.66)	0.18** (4.79)	0.12* (1.93)	0.12** (2.13)	0.101** (2.10)	0.107** (2.547)	0.20** (2.41)	0.17** (2.24)
Dummy _Maturity Horizon_2 months	0.106** (2.789)	0.113** (3.16)	0.21** (5.21)	0.21** (5.34)	0.18** (2.96)	0.17** (3.00)	0.105** (2.18)	0.106** (2.52)	0.03 (0.386)	0.07** (0.914)
Dummy _Maturity Horizon_3 months	-0.195 (-5.1)	-0.18** (-5.12)	-0.15** (-3.68)	-0.15** (-3.72)	-0.16** (-2.66)	-0.13** (-2.34)	-0.104** (-2.18)	-0.093** (-2.21)	-0.234** (-2.789)	-0.16** (-1.96)
GDP Growth Rate		-0.07* (-2.21)		-0.06 (-1.55)		0.024 (0.451)		0.183** (3.16)		-0.243** (-3.04)
IIP Growth Rate		-0.20** (-6.2)		-0.121** (-3.55)		-0.14** (-2.83)		-0.17** (-4.49)		-0.25** (-3.46)
Inflation		0.048 (1.51)		0.073** (2.19)		0.26** (4.61)		0.104** (2.91)		0.173** (2.73)
Change in Interest Rate		-0.057* (-1.87)		-0.026* (-0.783)		0.001 (0.014)		0.025 (0.69)		0.13* (1.85)
Sowing Period		0.06* (1.88)		-0.001 (-0.029)		0.14** (2.79)		-0.107** (-2.28)		0.184** (2.314)
Harvesting Period		-0.09* (-2.60)		0.127** (3.48)		-0.07 (-1.35)		0.15** (3.33)		0.049 (0.727)
Adjusted R2	0.582	0.639	0.543	0.573	0.50	0.577	0.37	0.52	0.29	0.40
n	431	431	427	427	301	301	427	427	317	317
Degrees of Freedom	429	427	421	419	209	207	406	404	172	171
Regression F – Statistic	100.523	54.82	84.226	44.32	35.30	21.13	35.47	30.38	11.24	8.57

Table 3.5 Regression Analysis of Futures Price Volatility on Contemporaneous & Lagged Futures and Spot Price Volatility and Macroeconomic Variables.
Notes: *** Significant at 5% level of significance, * Significant at10% level of significance*

4. CONCLUSION

In this study we have tried to determine the main drivers of commodity price volatility. For our analysis we have considered the monthly standard deviation of daily futures and spot prices of five oil and oilseed contracts, i.e., soybean, soyoil, mustardseed, castor seed and cottonseed oilcake. We have evaluated the relation between futures and spot market volatility to evaluate the information dissemination role of the two markets. We have also assessed the explanatory power of the macroeconomic fundamentals using regression analysis with futures price volatility as the dependent variable. In our study we observe that the spot market and futures market react simultaneously to any information regarding the underlying asset which is expressed by the strong positive regression coefficient of contemporaneous spot price volatility. The futures price is also observed to be driven by one period lagged futures price volatility indicating that players in the market make decisions based on previous performance of the contracts. The volatility is observed to depend on the contract term as well; the volatility of the contract with three month maturity is significantly lower as compared to the nearest contract.

The inclusion of the macroeconomic variables increased the explanatory power of the model for all the contracts considered. But as we include the macroeconomic variables in the model the significance of the one period lagged volatility is not observed. This reflects the coordination of the futures market with the market variables; the futures price are expected to

move based on expectation formation of the producers and the consumers. The hedgers form expectations based on the current economic phenomenon and react accordingly. The changes in the variables lead to change about future price expectation leading to change in the decision of the players in the market resulting in price movements of the future contracts. The impact of IIP growth rate observed shows that people take positions in the market based on their forecast about future economic growth; an increase in IIP index growth will boost the confidence of the people and hence will reduce volatility. Similar result is observed for the GDP growth rate showing that an improvement in GDP growth reduces volatility. The futures price volatility moves in accordance with inflation indicating higher inflation results in higher volatility.

Based on the observed impact of macroeconomic variables on futures volatility, we can say that the futures market is not only driven by speculative activity. The players in the market make decisions based on forecast regarding future demand and supply conditions which are driven by changes in the fiscal and monetary policies. The speculators do not increase the volatility but tries to take positions in the market based on their understanding of volatility and hence provide liquidity to the market. The growth of the commodity futures market is expected to further strengthen the linkage of the futures market with the basic economic fundamentals.

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