CHAPTER 2

LITERATURE REVIEW AND RESEARCH GAPS

Our study combines three strands of research: one, market efficiency and price discovery role of commodity futures markets; two, impact of futures trading activity on spot price volatility; and three, factors affecting the dynamics of commodity futures volatility. In this chapter, we present literature review of these three strands followed by the research gaps identified.

2.1 Market efficiency and price discovery role of commodity futures markets

The concept of futures market efficiency is of considerable significance to any investor who wishes to use these markets to hedge against price risk. Market efficiency entails that the present futures price, \( F_t \), of a commodity futures contract expiring in \( t+1 \) should equal the commodity spot price expected to prevail in \( t+1 \), i.e. \( F_t = E(S_{t+1}/I_t) \). Hence, \( F_t \) is the best forecast of \( S_{t+1} \), and that \( F_t \) incorporates all pertinent information including past spot and futures prices. A futures market is efficient conditioned upon the information set such that only new unanticipated information directs to a price change. Therefore, profitable trading strategies cannot subsist in an efficient market. Competitive market conditions will compel the price to adjust instantly to any new piece of information and hence all the available information is reflected in present prices. Efficiency in futures markets is usually defined in terms of the zero expected net profit canon, which states that the game is “fair”, and is explained into the following connection between any futures price and the expectations of its realization at the delivery date:

\[
E_t \left( S_T - F_{t,T} / \Phi_t \right) = 0
\]
where, $S_T$ is the spot (delivery) price at time $T$, $F_{t,T}$ is the futures price quoted at time $t$ for delivery at time $T$, $\Phi$ is the information set at time $t$ and $E_t$ is the mathematical expectation operator as of period $t$.

A number of studies in the 1970’s and 1980’s investigate the efficiency of futures markets for a variety of commodities. These studies employ a conventional approach for testing the efficiency, (e.g., Tomek and Gray, 1970; Kofi, 1973; Cargill and Rausser, 1975; Goss, 1981; Leuthold and Hartman, 1979; Gupta and Mayer, 1981; Goss, 1983, 1988 and Garcia et al, 1988). These tests were based on the historical sequence of prices and regressing spot price at contract maturity on a previous futures price and assume models of the form:

$$S_T = \alpha + \beta F_{t,T} + u_t$$

The hypothesis that the market is efficient is formulated in this model by the null hypothesis $H_0: \alpha = 0$ and $\beta = 1$, under the assumption that $u_t$, the random disturbances, is independent and identically distributed with $u_t \sim N(0, \sigma^2)$. The postulation that no serial correlation exists means that observing linear patterns in past forecast errors will not improve future forecasting performance. If the slope is one and the intercept coefficient is zero, the market is considered as efficient, and the futures price is considered to be an unbiased predictor (unbiasedness hypothesis) of the subsequent cash price.

The proposition that futures prices are unbiased predictors of spot prices is a joint hypothesis that markets are efficient ($\beta = 1$) and risk premiums are absent ($\alpha = 0$). The latter presumes that market participants are risk neutral, a statement that is neither theoretically justifiable nor empirically plausible. For instance, if risk-averse producers demand futures contract to hedge their production, a risk premium would be created and that takes futures prices away from expected spot prices. Furthermore, a fundamental predicament connected with the
above mentioned model is that the validity of hypothesis tests is acutely complicated by the nonstationarity of the time series. Normally futures and spot prices are found to be nonstationary, it hoists a severe problem for the unbiasedness testing of the hypothesis. Engle and Granger (1987) show that, since nonstationary variables have infinite variances and the standard errors are not consistent that make the $F$-tests or $t$-tests invalid, the standard hypothesis testing does not apply to time series with unit roots. As a result, conventional statistical procedures are not suitable for testing market efficiency, because they have a propensity to bias toward incorrectly rejecting efficiency.

The works by Granger (1986), Engle and Granger (1987) and Johansen (1988) introduce the statistical concept of cointegration of time series. The application of cointegration approach suitably accounts for the nonstationary behavior of futures and spot price series. A vector of time series, every element of which is dominated by a unit root and, thus, stationary only after proper differencing, may have linear combinations that are stationary without differencing. In such a case, the variables in the vector are said to be cointegrated and can be articulated as a cointegrating vector. Cointegration entails a long-run equilibrium relationship among the variables, which will commonly have an economic elucidation. Market efficiency means cointegration since the same factors that determine the future spot price are reflected in the current futures price, as a result the two should not drift apart. The market efficiency hypothesis, conversely, requires that the future spot price and the current futures price of a commodity are “close together.” If these two price series are not cointegrated, they will have a tendency to deviate apart without bound, which is converse to the market efficiency hypothesis.

There are many studies that provide insights into the causal relationship between commodity spot and futures prices. The seminal work of Garbade and Silber (1983) develop a
partial equilibrium model which characterizes the price movements in cash and futures markets for storable commodities. They study seven commodities in the US context and found that all markets are integrated over a month or two, but there was a considerable slippage between cash and futures markets over shorter time intervals. They conclude that, in general, futures markets dominate and lead cash market price changes. Oellermann and Farris (1985) investigate causal relationship between change in futures and spot price for live beef cattle between 1966 and 1982. The study employs Granger causality test for various sub samples of their data and the results show that change in live cattle futures price led change in live cattle spot price. The study also finds that the spot market responded to change in futures price within one trading day. The study concludes that the cattle futures market is the dominant player in the price discovery process for live beef cattle and suggests that a possible justification for the results is that the futures market serves as a central point for information assimilation. Koontz et al. (1990) examine the dominance of futures market in price discovery by using Granger causality in the live cattle market. The study divides the sample period into three sub periods of four year each to analyze the dynamic nature of price dominance. The results show the changing dominance pattern as a result of structural change in the industry. The major finding is that the price discovery process is dynamic in nature and dependent on the structure of futures and spot market. The authors conclude that the spot market is becoming less dependent on futures market for price discovery.

Chowdhury (1991) examines the efficient market hypothesis for four nonferrous metals-copper, lead, tin, and zinc- traded in the London Metal Exchange (LME) over a period 1971 to 1988. Empirical results confirm that the presence of unit roots in the spot and futures price of copper, lead, tin, and zinc. This indicates nonstationarity in the price series of these metals, and thus points out serious concern about the results of the previous studies that have used the levels
of spot and futures prices for testing the market efficiency of these metals. In order to address the nonstationarity behavior of the price series, this article uses the cointegration approach. The empirical results specify the nonexistence of cointegration relationship for four nonferrous metals and thus rejection of the efficient market hypothesis. The novelty of this article is that it highlights the problems of traditional hypothesis testing which ignores the nonstationarity behavior of the price series and recommends how the cointegration approach can be used to avoid some of these difficulties. Bessler and Covey (1991) investigate the price discovery role of live cattle futures market by using cointegration analysis. The study finds minor evidence of cointegration between nearby futures and spot price but no evidence of cointegration when more distant futures contracts are considered. Schroeder and Goodwin (1991) study the live hogs market in order to analyze the short and long run price relation between Omaha spot and Chicago Mercantile Exchange (CME) futures market. The study finds that the futures and spot series operate to some extent autonomously and the long term relationship is generally nonstationary. The study concludes that that futures market dominates spot market for live hogs.

Quan (1992) uses monthly crude oil price with the help of a two step procedure to study the price discovery role of futures market. The steps entail first creating a long term relation between futures and spot price using cointegration analysis and then testing lead lag relationship by using Granger causality test. The study finds that spot price lead futures price and thus spot market is acting as dominant player in the price discovery process. Fortenbery and Zapata (1993) use cointegration to analyze price dominance by using futures and spot prices of corn and soya bean. The study finds evidence of cointegration for all spot and futures market pairs under the study. The study suggests that inclusion of interest rate as an additional explanatory variable would provide a more appropriate specification because the cost of maintaining inventory is high
in case of all most all the storable commodities. Schwarz and Szakmary (1994) replicate Quan’s (1992) empirical work by using daily observations and find that futures market dominates spot market. The results of this study are contradictory to that of Quan but in conformity with other studies. The study highlights that Quan’s failure to find the presence of price discovery function of futures market may be due to inappropriate choice of data and time interval. The study concludes that the petroleum futures and spot markets are cointegrated and futures market dominates in price discovery in all three petroleum product markets.

Schwarz and Szakmary (1994) investigate the interrelationship and arbitrage activity between futures and spot prices for crude oil, heating oil, and unleaded gasoline traded at the NYMEX. The study uses error-correction models and Garbade and Silber (1983) partial equilibrium models. The results robustly indicate that futures market dominates in the price discovery process in all three petroleum product markets. The results also signify that the supply of arbitrage services in these markets is indistinguishable to those of other commodities while the price discovery role of futures market has been fully established. Beck (1994) examines the long run and short run market efficiency in US commodity futures markets for 8 and 24 weeks horizons. The study uses daily data of live hogs, orange juice, soy beans, live cattle, cocoa, copper and corn over a period 1966 to 1987. The study employs cointegration and error correction model and the results indicate that all the markets are sometimes inefficient but no market rejected efficiency all the time. Zapata and Fortenbery (1996) introduce interest rate as an augmentation in the cointegration model and find that interest rate is imperative in describing the price discovery relation between futures and spot market for storable commodities. Foster (1996) examines the movement in the price of crude oil futures and spot market in the USA and UK during the 1990–91 Gulf war. The objective of the study is to examine price discovery by giving
emphasis on its time varying nature. The results show that such relationship is robustly temporal and market conditions are having an influence on the price discovery process. The study finds that price dominance of the futures market is time varying which implying that the use of time invariant point estimation may not sufficiently elucidate the price discovery relationship. Fortenbery and Zapata (1997) study the long run equilibrium relationship between futures and spot market for cheese and the price dominance of one market as the centre for price discovery. The study employs cointegration test and result shows that there is no evidence of a firm long run relationship between futures and spot market for cheese.

Silvapulle and Moosa (1999) examine the relationship between the spot and futures prices of WTI crude oil using daily data from NYMEX over a period 1985 to 1996. They use both linear and non-linear Granger causality tests. Linear causality test results indicate that futures prices lead spot prices, but nonlinear causality testing indicates a bi-directional casual relationship between the two. McKenzie and Holt (2002) study the long run and short run market efficiency by using cointegration and GQARCH-M-ECM. They use daily futures and spot data of four US commodities-live cattle, hogs, corn, and soybean meal- over the period 1959 to 2000. The results show that live cattle, hogs, corn and soybean meal futures markets are both efficient and unbiased in the long run, however, inefficiencies and pricing biases in the form of a dynamic lag structure exist in the short run. Chen and Lin (2004) use linear and non-linear Granger causality tests to examine the dynamic relationship between spot and futures prices of lead contracts traded in the LME over a period 1964 to 1995. Linear causality test result indicates the presence of bi-directional causal relationship, but nonlinear causality test result indicates a uni-directional casual relationship between the two.
Karande (2007) examines price discovery function of castorseed futures markets in India by using daily data over a period 1985 to 1999. The study uses cointegration test and concludes that castorseed futures market both at Mumbai and Ahmadabad exchanges performs the function of price discovery. Bekiros and Diks (2008) examine the linear and nonlinear causal relation between daily spot and futures prices of US West Texas Intermediate (WTI) crude oil over a period 1991 to 2007. The results indicate that linear causal linkage vanishes after VECM cointegration filtering, nonlinear causal relationships in some cases continue even after GARCH filtering. This shows that spot and futures returns may reveal asymmetric GARCH effects or higher order conditional moments. In addition, if nonlinear effects are accounted for, neither market leads or lags the other persistently, implies that the pattern of leads and lags changes over time.

Iyer and Pillai (2010) examine the dominant role of Indian commodity futures markets in the price discovery process. The study uses daily data of six commodities- chana, copper, gold, nickel, rubber and silver- from MCX over a period 2005 to 2008. The study extends the framework developed by Garbade and Silber (1983), by superimposing a two-regime TVAR model to quantify the price discovery process. The results indicate that price discovery process happening in the futures market in five out of six commodities. Even though, the rate of convergence of information is slow, especially in the non-expiration weeks. For commodities like copper, gold and silver, the rate of convergence is almost instantaneous during the expiration week of the futures contract insisting the efficacy of futures contracts as a hedging tool. But, in case of chickpeas, nickel and rubber the convergence exacerbates during the expiration week showing the inefficiency of futures contract as a hedging tool.
Ali and Gupta (2011) examine the efficiency of commodity futures market in India for 12 agricultural commodities—wheat, rice, maize, chickpea, black lentil, red lentil, guar seed, pepper, cashew, castor seed, soybean and sugar—by using daily data over a period 2006 to 2009. They use Johansen's cointegration and Granger causality tests. Results show that cointegration exists significantly in futures and spot prices for all the selected agricultural commodities except in case of wheat and rice. The Granger causality results show that there is a bi-directional causal relationship exists between futures and spot prices for maize, black lentil and pepper. Overall results indicate that futures markets have stronger ability to predict subsequent spot prices. Sehgal et al. (2012) examine the role of price discovery of Indian commodity futures market by using daily data of ten agricultural commodities—chana, guar seeds, soya bean, kapas, potato, turmeric, pepper, barley, maize and castor seeds—traded on National Commodity Exchange of India. They use cointegration and Granger causality tests. The results of Johansen’s cointegration test show that there is long run equilibrium relationship for nine out of ten commodities. The results of Granger causality test indicate that there is a bi-directional causality between spot and futures in all agricultural commodities except for one commodity in which there is no cointegration and causality exists, i.e. turmeric.

The review of the existing literature associated with price discovery and market efficiency reveals that although a number of studies have examined the inter-temporal relationship between spot and futures prices, they analyze the data at their original level (time domain) and provide a one-shot measure of short or long run causality which is supposed to apply across all periodicities. Further the studies evaluating the extent, strength and the direction of causality across frequency bands leading to a complete inter-frequency characterization is almost non-existent. In a purely competitive market, the information about the strength and
direction of such temporal causal relationship is very crucial for the market participants for an effective financial risk management through arbitraging and hedging.

2.2 Impact of futures trading activity on spot price volatility

In this section we provide a brief review of the empirical work regarding the impact of futures trading on spot price volatility. Impact of futures trading on spot market prices is, perhaps, the most litigious issue among policymakers and researchers. There are generally two points of view in this regard, the stabilizing and destabilizing role of futures market on spot market volatility. The advocates of derivative markets argue that speculation in the futures markets mainly helps the dual economic functions of risk transfer and price discovery and thus stabilizes the spot market volatility. But, on the other hand, it has often been claimed that futures trading destabilizes the spot market by escalating spot price volatility. Futures markets have been considered as the speculators’ haven with the accusation that excessive speculation in the futures market has led to enhance in volatility of the price of underlying commodities in the spot market. Theoretically, futures trading enhance market liquidity by bringing more market participants. The participation of more speculators in the futures market increases liquidity but makes the spot price more raucous and noisy if the new speculators are less informed than traders existing in the market. Thus, speculation in the futures market is passing on to the underlying spot market through arbitrage and results in increased price volatility in the spot market and creates destabilizing forces which generate undesirable bubbles. In this context, we review selected studies to understand the effect of futures trading activity on spot market price volatility.

Early research on the consequence of futures trading in commodities has commonly concluded that the existence of a futures market tends to stabilize price in the spot market. Working (1960) and Gray (1963) study the impact of futures trading on spot onion price and they
conclude that futures trading reduced the range between high and low spot price of onion over a crop year. Taylor and Leuthold (1974) examine live cattle futures by comparing the variance of price between a period with and without futures trading and find that the spot price was more stable when futures market was in existence. Cox (1976) investigates the effect of organized futures trading on information in the spot market. Empirical evidence shows that futures trading enhanced traders’ information about underlying demand and supply conditions. The study concludes that the spot market functioned more efficiently in the presence of futures trading.

Brorsen et al. (1989) examine live cattle market with the help of both theoretical and empirical models and suggest that a successful futures market for cattle advances spot market efficiency; but short run spot price risk also increases. The fact that volatility has augmented in the short run could be an imperative factor in understanding why cattle producers observe the futures market as unflatteringly affecting spot price. Weaver and Banerjee (1990) study whether futures trading of cattle and other related commodities destabilize spot price. They find that futures trading does not lead to dynamic volatility of spot price. In spite of the finding of a noticeable role for external information in determining cattle price, the results shore up the conclusion that futures trading of cattle and other commodities did not cause to dynamic volatility of cattle price in the study period. Antoniou and Foster (1992) examine the effect of futures trading on spot price volatility for Brent crude oil in UK and the study find no substantiation to conclude that there has been a spillover of volatility from futures to spot market.

There are many studies which examine the impact of futures trading on spot price volatility in the equity markets as well. Brorsen (1991) tests for homogeneity of variance in the S&P 500 index for time periods before and after the commencement of futures trading and finds that though the variance of daily price changes augmented considerably, the variance of five day
and twenty day price changes continued the same. He suggests that short run volatility can be reduced by any measure that increases friction such as increasing futures margins or raising transaction cost for arbitrageurs. Baldauf and Santoni (1991) investigate the increased volatility in the S&P 500 index from the time when the introduction of futures trading. Spot price was modeled for periods before and after futures trading and the study find no support for a shift in the model parameters signifying no effect of futures trading on spot volatility. Lee and Ohk (1992) study the index futures and find that the volatility of stock returns in Japan, UK and USA increased considerably but not in Australia and Hong Kong. The results show that although stock index futures wield a volatility increasing influence on daily stock prices, it makes the stock market comparatively more efficient as volatility shocks are dispersed more rapidly.

Kamara et al. (1992) investigate the effect of futures trading in S&P 500 on stability of the underlying index. From both parametric and non parametric tests the volatility of daily returns in the post futures period was higher than in pre futures period; however the volatility of monthly returns remained unaffected. The authors find that distribution of daily returns is frequently changing and finally they conclude that the considerable increase in volatility of daily returns is not futures induced. Antoniou and Holmes (1995) examine the impact of trading in FTSE 100 stock index futures on volatility in the underlying spot market in UK. The results imply that futures trading has led to increased volatility, but the temperament of volatility has not changed post futures. Further, the results indicate that there was an enhance in spot price volatility on a daily basis, however this was due to improved information flow in the market and not due to speculators having an adverse destabilizing effect. Holmes (1996) investigates the impact of futures trading on price volatility in the underlying spot market for FTSE Eurotrack. Results show that even though low futures trading volume, the existence of futures market
enhanced the rate at which information was incorporated into the spot price and reduced persistence of volatility. The results imply that futures trading fetches beneficial effect to the underlying spot market even if trading is thin.

Pericli and Koutmos (1997) study the impact of S&P 500 index futures and options on volatility in the spot market. The results show that for weekly returns the unconditional variance reduced in the post futures period, while the reduction was not significant. The study concludes that the introduction of index futures and index options created no structural transform in either the conditional or unconditional variance. Antoniou et al. (1998) investigate the impact of futures trading on stock market volatility for six countries. The results imply that even though futures trading had a limited impact on the level of stock market volatility over the study period, it had an effect on the dynamics of the market. Chang et al. (1999) suggest new tests to inspect the influence of index futures on Nikkei stock price volatility. The tests divide spot portfolio volatility into the average volatility of returns and the expected cross-sectional dispersion on the portfolio’s constituent securities. The results specify that futures trading enhanced spot portfolio volatility however the volatility impact did not spill over to other stocks in which futures were not traded. They find that a large amount of the variation in spot market volatility is related to the disturbance in broad market factors. The increase in volatility influenced by futures trading can only be identified when tests appropriately control for these factors.

Gulen and Mayhew (2000) study stock market volatility pre and post introduction of equity index futures trading in 25 countries. The study find that, apart from for USA and Japan, introduction of futures market had a significantly negative impact in 17 countries and no significant effect in the remaining six countries on the underlying spot market volatility. McKenzie et al. (2001) examine the impact of futures trading on the conditional volatility in the
underlying spot market. The results reveal that trading situations associated with individual markets like liquidity, trading volume, open interest etc. are the more possible reasons for different findings. Further, the results indicate that markets act differently depending on the contiguous circumstances. Rahman (2001) studies the impact of trading in Dow Jones Industrial Average index futures and options on the conditional volatility of constituent stocks. The study finds that the introduction of index futures and options on the DJIA created no structural change in the conditional volatility of constituent stocks.

Lokare (2007) examines the efficiency of Indian commodity derivatives in facilitating the price risk management by using daily data of 22 commodities for a period from 2003 to 2006. The study uses cointegration tests for examining the operational efficiency and the ratio of standard deviation for analyzing the volatility. The analysis reveals that almost all the commodities show the presence of co-integration in both spot and future prices, indicates that the operational efficiency of these markets improving, even though, at a slower rate. The volatility analysis indicates that in the case of nine commodities, the volatility in the future price has been considerably lower than the spot price signifying an inefficient utilization of information. The study also points out with the help of volatility analysis; several commodities appear to magnetize wide speculative trading during the study period.

The Abhijit Sen Expert Committee (2008) examines the efficiency and volatility dynamics of 24 commodities, having a weight of 11.73 in the wholesale price index (WPI) basket. Altogether, these commodities accounted for 98.7 per cent of the entire value of futures trading of agricultural commodities in financial year 2006-07. The analysis shows that the WPI trend growth rate increased in the post-futures period in 14 out of 21 commodities. But ten of the remaining commodities under study; there was a decline in the pre-futures period indicating a
better price discovery. The committee concludes that even if the agricultural price inflation is increased during the post futures period, the same cannot be attributed only to the trading of futures contract in essential agricultural commodities. A part of this price acceleration may be due to a rebound or recovery of the past trend of relatively low agricultural prices observed during the pre-futures period. Moreover, the period during which futures trading have been in operation in India is too short to discriminate effectively between the consequence of initiating futures trading and a normal cyclical adjustment. In addition, the committee suggests for strengthening of the Forward Markets Commission (FMC) and recommends measures to enhance farmer participation and highlights the need to set up a Committee on Commodities Market similar to the high level committee on capital markets.

IIM Bangalore (2008) examines the performance of futures trading and its impact on spot market price of wheat, chana, sugar, guar-seed, urad and tur by using cointegration test and daily volatility analysis for a period from 2005 to 2007. Other than sugar, in all crops the study finds price increase in the post-exchange period compared to the pre-exchange period. The cointegration analysis shows the presence of long run equilibrium between spot and futures in all the commodities. The results of volatility analysis reveals that there is no major change observed in the volatilities in spot prices for chana, tur and sugar but in case of guar the volatility has condensed after the introduction of futures trading. The study concludes by highlighting the fact that the changes in the fundamentals (primarily the supply) appears to be the major reason for this change, so the role of futures trading on the extent of this change is not clear.

Nath and Lingareddy (2008) examine the impact of futures trading on agricultural commodity prices in India by using daily data of urad and gram covering a period from 2001 to 2007. The study employs regression analysis to study factors influencing urad and gram price
and the Granger causality test for testing causal relationship between two price series. The results of regression of urad indicate that the coefficients included in the fitted regression equation explained about 68 per cent of the variation in the dependent variable. The coefficients of urad with one lag, prices of gram and pulses were found to be significant. Regression results of gram, on the other hand, indicated that only 52 percent of variation in gram prices was explained by the fitted regression. Further, only the coefficients of urad and pulses were found to be statistically significant. Results of Granger causality indicate a significant and direct causal influence on urad prices whereas the same has not been statistically significant in the case of gram. Finally, the study concludes that the argument of futures activity causing an increase in price volatilities is found to be true in the case of urad but enough statistical evidence could not be found in case of gram.

Mahalik et al (2009) examines the volatility spillover between Indian commodity futures and spot markets by using bivariate EGARCH model. The study uses daily data of four MCX futures and spot indices spanning over a period from 2005 to 2008. The bivariate EGARCH results indicates that the past innovation in futures significantly influence spot volatility, except for agricultural indices, where volatility spillover is from spot to future. The study concludes that the volatility of commodity price in futures market will increase due to the increased flow of information, and thereby, generating an increased volatility in the spot market. Mukherjee (2011) examines the impact of futures trading on agricultural commodity market in India by using daily data for a period from 2004 to 2010 for nine major agricultural commodities. The study employs bivariate GARCH model to measure the volatility spillover from futures market to spot market and vice versa. The empirical findings significantly prove that the relative advantage of futures market in propagating information, leading to efficient price discovery and risk management.
The study concludes that instead of curbing the commodity futures market, various steps have to be taken in order to strengthen the commodity futures market to achieve the broader target. Srinivasan and Ibrahim (2012) examine the volatility spillovers in Gold futures and spot markets of National Commodity Derivatives Exchange (NCDEX) by employing the bivariate ECM-EGARCH (1, 1) model. The study uses daily futures and spot prices from 2009 to 2011. The empirical results prove that the spillovers take place from spot market to futures market and the spot market of gold has the potential to disclose the all new information through the channel of its innovation in price discovery.

The review of the existing literature focusing on the impact of commodity futures trading on spot price volatility reveals that the previous studies are not categorizing the total futures trading activity into expected and unexpected in order to capture the effect of excessive speculation in the futures market. Moreover, considering the futures trading volume alone as a proxy to represent the futures trading activity would not provide a complete measure of information flow (trading activity). Inclusion of open interest as an additional proxy to measure the trading activity would bring more additional explanatory power.

2.3 Factors affecting the dynamics of commodity futures volatility

Over many years of research, several approaches were developed to explicate what determines commodity futures prices volatility and role of information in the pricing mechanism of commodity futures. The possibility that the volatility of the price of a futures contract could increase as the delivery date approaches, have been recognized by many researchers and Samuelson (1965) is the first to give a notional argument in support of this phenomenon. Assuming the price of the commodity for immediate delivery (the cash price) follows a stationary first-order autoregressive process and the price of the commodity for deferred delivery
(the futures price) is an unbiased predictor of the price at delivery date, then the variance of the daily price changes increases as the delivery date approaches. This is more commonly known as Samuelson Hypothesis or Maturity Effect.

Rutledge (1976) investigates the Samuelson hypothesis by employing futures price series of the Kansas City Board of Trade September 1969 wheat contract, the New York Cocoa Exchange December 1970 cocoa contract, COMEX March 1970 silver contract and the Chicago Board of Trade May 1971 soybean oil contract. By using daily price series, the paper uses a goodness of fit test for a three-way contingency table with data grouped by volatility of futures price, volatility of cash price and time to maturity. The study rejects the Samuelson hypothesis for wheat and soybean oil but accepted it for silver and cocoa. Miller (1979) examines the Samuelson hypothesis by using the June and December live beef contracts of the Chicago Mercantile Exchange for the period 1964-1972. The study uses the changes of the logarithm of the daily closing price and the classical normal test for the simple correlation coefficients between dispersion and time to maturity. The paper concludes that there is a significant inverse relationship between futures price volatility and time to maturity and hence supports the Samuelson hypothesis.

Anderson and Danthine (1983) give a new elucidation to the maturity effect. The time pattern of future price volatility has been explained by state variable hypothesis. According to this proposition, the time to expiry has no role in deciding the volatility, but the degree to which the uncertainty is retracted on account of the arrival of new information to the market. Generally information arrives to the market close to the maturity period, leading to a larger level of volatility and the Samuelson hypothesis becomes operational. Conversely, substantiation for
Samuelson’s proposition is uncertain due to the discrepancy of futures product line and the variations in the country’s economic conditions.

Serletis (1992) studies the consequence of maturity and trading volume on the price volatility of NYMEX energy futures contracts for the period of 1987 to 1990. The study employs Samuelson volatility–maturity model by incorporating observations on trading volume in the specification. The commodities under study include unleaded gasoline, crude oil and heating oil. The sample for each contract consists of all observations from the first trading day to maturity. The study determines volatility by using Parkinson (1980) and Garman and Klass (1980) high-low model and carries out analysis on a contract-by-contract basis. The empirical results for crude oil discloses that whenever trading volume is added to the specification, the number of contracts that depicts significantly negative coefficients on maturity plunges to about 30% from 65% when maturity is specified alone. The other two commodities also confirm the same pattern of results. One of the main shortcomings of Serletis work is the insertion of all observations from the first trading day to maturity. The initial trading days of the contracts are far away from maturity, the market’s focus is not on these contracts, and reflection of price is far-off from the current physical market activity.

Bessembinder and Seguin (1993) use a different modeling approach. Rather than investigating single contracts by contracts, the study employs a measure of volatility based on daily closing prices. Furthermore, in addition to trading volume the study includes open interest as a measure of trading activity, in order to assess the market depth. The results show that trading volume used as a proxy for information flow has a significant positive effect on volatility, whereas open interest has a significant negative effect. Herbert (1995) investigates the inter-relationship among maturity, trading volume and volatility for the natural gas futures traded on
the NYMEX. The data sets include the period from 1990 to 1994. The study employs the same high low price measure of volatility as Serletis (1992), but it employs the observations for near-month contracts only. The reason behind including the observations from near-month contracts only is because of the lack of trading activity during the early days of trading in a contract. However one of the limitations of this approach is it decreases the average number of observations per contract to approximately twenty. The results of the study are not in support of Samuelson hypothesis. In case of the natural gas contracts, even when maturity is specified separately, the significantly negative coefficients account only 28%. Once trading volume is included in the specification, this descends to 6%. Finally, the study concludes that trading volume dominates maturity in explaining futures price volatility.

Ripple and Moosa (2009) extends the research of Serletis (1992) and Herbert (1995) by using the high–low price measure of volatility and bring open interest into the analysis. The study examines the relations both on a contract-by-contract basis and in a single-constructed (spliced) time series framework. The paper corrects the stated data issues in both approaches. For the contract-by-contract analysis, the study takes a transitional position between Serletis (1992) and Herbert (1995) by using two months of observations for each contract. This helps in adding useful observations without reaching too far into the relatively frivolously traded past of a contract. The results hold earlier findings of a positive and significant role for trading volume, and also show the significance of open interest in determining volatility, exercising a significant negative effect. The full-period time series analysis also exhibits the major role played by open interest in determining futures price volatility, further corroborating the importance of trading volume.
The review of the existing literature reveals that the previous studies are not categorizing the total futures trading activity (trading volume and open interest) into expected and unexpected in order to capture the effect of excessive speculation in the futures market. Moreover, previous studies ignored the stylized facts of commodity futures returns like volatility persistence, clustering and leverage effect. Examining volatility persistence and clustering would help to understand the connection between information transmission and volatility explicitly, since any change in the rate of information arrival to the market will change the volatility. At the same time, negative shock raises volatility more than positive shock of the same magnitude in the market (Nelson, 1991; Wu, 2001; Thomakos et al., 2008). An empirical investigation of leverage effect may helps to draw insight about asymmetric impact of good news (positive shock) and bad news (negative shock) on volatility.

2.4 Gaps in the Literature

After the extensive literature review, we identify the following research gaps in the existing literature.

1. In India, even though the national level commodity exchanges started functioning in the year 2003, the commodity futures market is in the emerging stage. Moreover, empirical studies on price discovery role of the Indian commodity market are few in numbers and most of the studies examine the price discovery role by using commodity indices or few commodities from the same category of commodities. However, each commodity has its own unique set of characteristics, examining the price discovery role of Indian commodity market specifically at individual commodity level and including actively
traded commodities from all categories may bring more insights into the inter-temporal causal relationship between commodity futures and spot prices.

2. Although a number of studies have examined the inter-temporal relationship between spot and futures prices, they analyse the data at their original level (time domain) and provide a one-shot measure of short or long run causality which is supposed to apply across all periodicities. Further, studies evaluating the extent, strength and the direction of causality across frequency bands leading to a complete inter-frequency characterization are almost non-existent. However, the direction, extent and strength of causality may differ between frequency bands and in a purely competitive market, the information about the strength, extent and direction of such temporal relationship is very crucial for the market participants for an effective financial risk management through arbitraging and hedging.

3. The expert committee appointed by the Government of India in the year 2007, under the chairmanship of Prof. Abhijit Sen, to examine the presence and extent of contribution of futures trading on the unexpected rise in the prices of agricultural commodities, failed to arrive at any unanimous conclusion. The committee concludes that the period during which futures trading have been in operation in India is too short to discriminate adequately between the effect of initiating futures trading and a normal cyclical adjustment. Thus, the question whether the unexpected commodity futures trading activity causes spot price volatility need to be investigated empirically with relevant and adequate time period in order to bring more insights into this issue.
4. The literature review on the factors determining commodity futures price volatility reveals that studies focusing on the time-varying volatility and leverage effects are almost non-existent. The study about time-varying volatility and asymmetric impact of good news (positive shock) and bad news (negative shock) on volatility may bring more insights into the determinants of commodity futures price volatility because it may help to understand the connection between information transmission and volatility explicitly. Moreover, the previous studies are not categorizing the total futures trading activity (trading volume and open interest) into expected and unexpected in order to capture the effect of excessive speculation in the futures market.