CHAPTER - 2
REVIEW OF LITERATURE

The previous chapter discussed introduction to research topic, statement of the problem, objectives of the study, hypothesis of the study, research methodology-type of research, selection of samples, analytical tools, and significance of the study and limitations of the study.

This chapter deals with review of literature on futures price, underlying spot price, the relationship between futures and spot prices, price discovery of individual stock futures and stock index futures in relation to the underlying stocks and indices. Futures price has concentrated on many related issues like nature of price discovery, developing and testing of futures pricing models, magnitude of mispricing and causes of mispricing, arbitrage opportunities & its mechanism, various factors that influence pricing of futures market and the performance of futures pricing models. Finally based on the review of literature the research gaps have been identified.

Several researchers have attempted to explain the behaviour of stock & index futures in relation to the underlying stock and index prices. These include Pratap and Rajjib (2011), Kailash and Bhat (2009), Panayiotis and Pierides (2008), Janchung Wang (2007), Janchung Wang & Hsinan Hsu (2006 a & b), Ramaswamy, Suganthi; Shanmugam, Bala (2004), Gay & Jung (1999), Braisford and Cusack (1997), Hemler and Longstaff (1991), Daigler (1990), Modest & Sundersan (1985), Ramaswamy and Sundaesan (1985), Cornell and French (1983) and many more. Consequently a great number of arguments and explanations for stock and index futures pricing have been proposed in the literature and they can be grouped broadly as follows.

2.1 The lead-lag relationship between the futures and spot prices
2.2 Empirical testing of futures pricing models. Prediction of futures prices using futures pricing models further classified in to three sub groups.
2.2.1 Futures pricing models were developed under the assumption of perfect market, no arbitrage argument, and risk free or constant interest rate
2.2.2 Futures pricing models were developed under assumption of perfect market, no arbitrage argument and risk free interest rate with considering the effect of market volatility.
2.2.3 Futures pricing models were developed under the assumption of imperfect market and incomplete arbitrage argument

2.3 Comparison of pricing performance of different futures pricing models.

2.4 The arbitrage opportunities and mispricing of stock index futures market

2.5 The relationship between futures price & market volatility and the relationship between futures price and trading volume.

2.6 Finally, the last group contains several miscellaneous studies that do not fit into the above groups

2.7 Research gaps

2.1 Lead- Lag relationship between spot and futures market

Financial derivative instruments are originally developed for price discovery and hedging risk. According to CCM theory, the futures prices will more than spot prices by the cost of carry. The cost of carry equal to the interest to be paid (cost) to hold the underlying asset less the cash dividend received (benefit). CCM was developed under the assumption of capital markets are perfect and complete arbitrage mechanism or no arbitrage argument. Suppose both actual futures prices and theoretical price estimated by CCM are not equal then arbitragers use an opportunity and earn riskless profit. Kailash and Sham (2009) and Suganthi and Shanmugam (2004) explain in perfect market, the index returns from both cash and futures markets should be perfectly and contemporaneously correlated. Therefore any new information circulating in to the market must be immediately reflected in both futures and underlying prices by stimulating stock trading in one or both the markets at the same time. Thus, there should not be any time lag between spot and futures prices.

However Hsu & Wang (2004) argued, there are enough reasons to believe real capital markets are not perfect or frictionless and incompleteness of stock index arbitrage. From these considerations the purpose of present study related to test the futures pricing models empirically and analysing its pricing performance and investigates the available literature to understand spot and index futures price discovery process in following aspects i. whether new information is reflected first in the futures market or spot market ii. Lead - lag relationship between underlying index returns and futures returns. Lead- lag relationship basically determines which of the two markets reacts...
more rapidly to new information thus leading it iii. Bi-directional casualty exists between underlying index and futures market.

H. Kemal Ilter and Ayhan Alguner (2013) examined price discovery in Turkish underlying and futures market. The author found that the new information is reflected more rapidly in the Turkish index futures market than the spot market so the new information first reflects in the futures market.

Yi-Tsung Lee Wei-Shao Wu Yun Hong Yang (2013) examined the information effects between the Taiwan spot and index futures returns. The study found that futures returns lead spot returns. It indicates that informed traders might be there in futures market. The study found that Foreign Institutional Investors (FII) is the significant source of informed trades and other categories of traders are information laggards.

Zukarnain Zakaria and Sofian Shamsuddin (2012) analyzed the relationship between underlying and index futures on Malaysian market using granger causality regression and co integration. The authors found that both cash and index futures in Malaysia are co integrated. Further, the study shows the cash market in Malaysia reflects new information more rapidly than futures market.

Yang Hou. Steven Li (2012) examined price discovery of CSI300 index futures in China. The author found that the new information is reflected more rapidly in the CSI300 index futures market than the spot market so the new information first reflect in the futures market

Nidhi Aggarwal and Susan Thomas (2011) examined the role of single stock futures in price discovery. The authors found that liquidity of the stock futures have very strong role in influencing price discovery process. Spot market also have major role especially with illiquid stocks.

Pratap Chandra Pati and Prabina Rajjib (2011) investigated the relationship between Futures and its spot returns (CNX Nifty index). Authors found that Nifty futures prices lead underlying prices and also claim that Nifty futures market provides more contribution in price discovery.
Erik Theissen (2011) examined the process of price discovery in German spot and futures market (DAX). Authors observed that DAX futures prices lead underlying prices and generally, new information reflects first in futures market than underlying market.

Dr. Chin-Yu Tsai, (2011) examined price discovery for Taiwan options and index futures. He found that index futures lead the underlying stock index. The study says that futures and options trading provide lower cost than underlying stock market. This result can be supported by the extensive trading volume.

Dr. Hiren M Maniar (2010) examined the nonlinear relationship between Nifty futures and spot index of NSE. Author found that the existence of nonlinear relationship between futures and cash indexes. He found that that the new information is reflected in both the market simultaneously. Thus, the futures and cash prices affect each other and both futures and spot markets contributes price discovery. While outside the arbitrage bounds, the new information is reflected first in the futures market, it indicates that the price discovery takes place in futures market. Author also claims that change in the basis can affect the cash price and positively correlated, it implies that there is a possibility of arbitrage opportunities. However, the futures price is not positively related with change in the basis may be due to, an emerging market like India the trading cost is high and has trading restrictions. Author also observed a positive correlation between stock index arbitrage and trading volume in both underlying and futures market.

Kailash Chandra Pradhan and K. Sham Bhat (2009) examined the process of price discovery. The results revealed that there is a long relationship between spot and futures prices and this can be considered in forecasting future spot prices. The results indicate that the underlying spot market leads the stock futures market. Further, underlying market prices try to discover new information faster than stock futures prices. The study also explains Indian futures markets are in immature stage. Thus, Investors are confused and facing difficulty to entry in to the stock futures market. Finally, they say that price discovery process take place first in underlying market.
Ramakrishna and Jayasheela (2009) examined hedging effectiveness of Nifty futures and price discovery process. Authors found that hedging effectiveness for Nifty index futures but not effective for stock futures. Additionally, the volatility of underlying index (Nifty) has been decreased significantly, once the index futures trading started. Further authors found one way casualty from underlying market to futures market for near month and middle month contract. Additionally found two way causality in case of far month contract.

Kapil Gupta and Dr. Balwinder Singh (2008) using tick-by-tick data and examined the price discovery process and efficiency for Indian underlying and futures market (Nifty). They found that a very strong and firm association exists for long run between Indian underlying and futures markets. Nevertheless, the authors observed eloquent diversion from equilibrium relationship for the short run. Thus, it indicates that both the markets (cash and futures) contribute price discovery. Further futures market dominates the information propagation. Furthermore the authors found that there is no significant role of expiry duration in price discovery of futures contracts. Further, the authors claim that regulatory constraints on the market participant’s especially institutional traders might an important factor influencing negative relation between expiry duration and futures mispricing.

Chung, Sheng and Chen (2008) argued market imperfection vary in different markets of different countries and making their dynamic interrelationship unequal and examined the robust interrelationship between underlying index return and implied expected growth rate of index futures in an emerging market (TAIFEX) and the developed market (Nikkei 225, S&P 500). Authors found that lead- lag relationship should be more significant in the emerging Taiwanese market than developed US market. Additionally empirical results show that the dynamic interrelationship is stronger in the Taiwanese market (emerging market) than in the US & Japanese market (Developed market).

Hsinan Hsua, Ching-Chung Lin, Chin-Sheng Huang and Yi-Chen Wu (2007) followed Hsu and Wang (2004) and examined lead lag relationship between spot market return & implied expected growth rate of index futures prices. The authors
found the relationship between the lead lag relationships of underlying market return & implied expected growth rate of index futures prices and DOMI. The lead-lag relationship is weaker in developed markets than emerging market like Taiwan Market. Further, the study found that lead-lag relationship between the spot index return and the implied expected growth rate is less significant as the DOMI decreases.

Suchismita Bose (2007) examined the process of price discovery in S&P CNX Nifty index futures prices traded on the NSE, India. She found that a clear bidirectional information flows between futures and spot markets if we consider the long run relationship between cash and futures price series. Further she claims that both the markets (underlying and futures) contribute price discovery equally and futures market slightly edge over the underlying market. So it indicates that futures market quickly responses and readjusts to the market-wide information. Thus, the volatility which created by the flow of new information reduces in the futures market.

Ramaswamy, Suganthi; Shanmugam, Bala (2004) examined the Malaysian stock index futures market from 15th December, 1995 to 30th June 2001 by in three different subgroups. The study investigated to find out the lead–lag relationship between two markets (underlying and futures) of Malaysia. The results indicate that index futures returns lead the underlying index returns for the duration of one day and two days in case of high volatility period. The study identified presence of contemporaneous relationship and co integration between the two markets.

Kedarnath and Mishra (2004) used intraday minute-by-minute data for the period of six months (April - September 2004) and examined the lead – lag relationship of volatility and return between Nifty underlying index and stock index futures in India. They found that bi directional flow of information and contemporaneous relationship between the markets. Furthermore underlying stock index leads the stock futures market, it indicates spot market disseminate new information faster than futures market. Author claims that though interdependence (in both direction) and almost symmetric volatility spill over between stock and futures return. Finally he concludes that there is no role of Indian futures market in price discovery.
Donald Lien Y K and Xiben Zhang (2003) examined the relationship between two Nikkei stock index and futures price based on the timing of structural changes. They found that market changes have begun from underlying market and then extend to the futures market.

Christopher J. Green and Emmanuel Joujon (2000) examined whether unified causality between French CAC-40 underlying index and index futures prices is inconsistent with the CCM. The study found that one way casualty between the market returns is not inconsistent with CCM. The author also found that little evidence of systematic one way casualty from futures to spot.

Alphonse (2000) examines aggregation of information in French CAC-40 underlying and index futures markets. He found that at least 95% of the price discovery and mispricing originates mainly through futures market and the underlying stock market adapts immediately to the new equilibrium price.

Broussard, John Paul, G Geoffrey and Loistl, Otto (1998) examined price discovery of DAX index futures in German. The author found that the new information is reflected more rapidly in the DAX index futures market than the underlying market, so the new information first reflect in the futures market.

Fleming, Ostdiek & Whale (1996) examined price discovery process in S&P 500 Futures, S & P 100 options and for their underlying index portfolios. Authors used trading cost hypothesis and found that for index stocks, the derivative markets offer the investors the opportunity to trade at substantially lower costs than trading directly in the underlying stock market. For individual stocks, stock market offers lower transaction cost than derivative market. Further authors’ claim that the market which has lower trading cost can react more quickly to the arrival of new information than other market. Finally authors indicated that a low trading cost of S & P index futures contracts lead the S & P 500 stock market.

De Jong and Donders (1996) examined lead – lag relationship between Amstradam EOE (AEX) a European market futures and stock index returns. They found index futures returns lead both underlying and options index returns about close to 10
minutes. Further according to authors, futures market leads both options and cash index due to (1) Infrequent trading of basket of component stocks (2) Lower transaction cost including bid-ask spread for futures than for transaction in options. This reason is almost similar to the reasons given by Daigler (1990).

Dejong and Nijman (1995) examined lead-lag relationship between S & P stock market index and futures return one minute frequency analysis. Authors identified that index futures lead the underlying index by minimum 10 minutes while the underlying index lead the stock futures by utmost 2 minutes.

Stoll and Whale (1990) investigate the time series properties of 5 min, intraday returns of S & P 500 MM stock index and stock index future contracts. Authors found that S & P 500 and MM index futures return lead underlying stock returns by almost 5 minutes. It shows that new information disseminated first in the futures market. Authors indicated that relationship between stock index and index futures was not unidirectional. In large part, the returns in the futures and stock market appear to be contemporaneous. Furthermore, they also showed that cash index lags behind the index futures even after purging the infrequent trading effects.

Kawaller, Koch & Koch (1987) used minute to minute data and investigated intraday price relationship between S & P 500 futures and underlying index. The study shows index futures consistently lead the underlying index by utmost 20-45 minutes. Further, the authors claim underlying index lead index futures utmost one minute. Thus, it proposes that arrived new information first reflected in the futures market.

2.2 Empirical testing of futures pricing models

2.2.1 Perfect market model - Cost of carry model

Many researchers derived and tested different pricing models and obtained different results. Cost of Carry model (CCM) has been considered as standard and most widely used model for pricing stock index futures. Cornell and French (1983) were derived under assumption of perfect markets and no-arbitrage arguments. Capital markets are perfect – There are no taxes or transaction costs, there are no restrictions on short
sales and assets are perfectly divisible. The risk–free borrowing and lending rates are equal and constant. Underlying index or stock is earning constant income (dividend). Darren Butterworth & Phil Holmes (2010) found larger and more persistent mispricing in UK index futures market (FTSE 100 and FTSE mid 250)
Panayiotis C. Andreou and Yiannos A. Pierides (2008) examined Athens futures market. They found that a large part of the mispricing between actual futures price and the theoretical price determined by the CCM

Janchung Wang & Hsinan Hsu (2005) examined the pricing performance of CCM in two different imperfect markets, first one emerged market (S&P 500) and second one developing market (Taiwan futures Exchange ((TAIFEX)). Overall, the results showed that pricing errors of CCM are the lowest for emerged market than the TAIFEX. Thus, the authors claim that CCM is more appropriately applied to the emerged markets and market participants are advised to assess the market imperfection before applying CCM.

Gay, Gerald D & Jung, Dae Y (1999) observed that persistent under-pricing in the Korean stock index futures market i.e. the actual futures price was persistently below the theoretical price determined by the CCM. Wolfgang Buhler & Alexander Kemp (1995) examined German market and found that actual futures price significantly below the price predicted by CCM.

Brenner, Menachem; Subrahmanyam, Marti G;Uno, Jun ( 1990) found that Japanese stock index futures exhibited persistent declines from ‘fair Price ’ of CCM in their first two years of listing.

Barford Cornell and Kenneth R. French (1983) derived and tested the performance of the S&P 500 and the New York Stock Exchange (NYSE) composite index futures price assuming markets are perfect with constant dividend pay-out and the interest rate. They found that the actual futures prices are below the value of the perfect market model (cost of carry model).
2.2.2 Perfect market model with market volatility - Hemler and Longstaff model - General Equilibrium Model.

From the above literatures it clearly indicates that many empirical researchers have tested CCM and found significant deviations between actual futures prices and theoretical value obtained by CCM.

CCM clearly states that market volatility should not have explanatory power for futures prices. However, few researchers found a significant positive relationship between stock index futures mispricing and underlying market volatility.

Panayiotis C. Andreou and Yiannos A. Pierides (2008): Examined Athens futures market. They found that large part of mispricing estimated by CCM is due to transaction costs, volatility and time to maturity. Authors found that index futures provide profitable arbitrage opportunities to large institutional traders (low cost traders). Using regression they identified that a greater portion of mispricing is because of transaction costs time to maturity and expected volatility. Further they also claim that Athens derivatives market was inefficient and persistent arbitrage opportunities were identified during its early trading history even after considering impact cost of other futures markets.

Stephen P. Ferris, Hun Y. Park & K wangwoo Park (2002) examined S & P 500 futures market and found that inverse relationship between volatility and mispricing means increased volatility lowers pricing error. This claims that as market volatility increases, investors sell their underlying and futures positions with relatively larger drops in futures prices.

Fung & Draper (1999) analysed Hong Kong Hang Seng Index futures contracts and found that the pricing errors have positive relationship with market volatility. This result is consistent with that of Yadav and Pope (1994).

examined S & P 500 index futures market and found stronger evidence that volatility causes mispricing than do the spot-futures mispricing causes volatility. Thus, stock market volatility can be considered as one of the important factor which influences futures mispricing.

While determining stock index futures prices, stock market volatility is not considered for the standard CCM and says that market volatility should not have explanatory power for stock index futures prices. Motivated by these considerations Michael L. Hemler and Francis A. Longstaff (1991) followed the CIR (Cox et al., 1985a,b) framework and derived a closed form general equilibrium model of stock index futures prices in a continuous economy with risk-free interest rate and market volatility. The implications of HLM are different from standard CCM for stock index futures and verifiable using regression analysis. When the natural logarithm of the dividend–adjusted futures/spot price ratio is regressed on market volatility and risk free interest rates, they found market volatility can influence significantly futures prices. These results are consistent with the HLM, but not the CCM.

2.2.3 Imperfect Market Model - Hsu – Wang Model

From the above discussion it clearly implies that CCM and HLM are based on the assumption that perfect market and no–arbitrage argument. Recently Hsu- Wang (2004) derived futures pricing model of stock index futures by incorporating price expectation parameter with an argument of arbitrage mechanism cannot be completed in imperfect markets (here after Hsu- Wang model). Hsu &Wang explains market imperfection or imperfect in the one which involves (1)Transaction costs including brokerage commission, bid & ask spread (2) Taxes including service tax on brokerage, stamp duty, security transaction tax (3)There are constraints on short sales –. Restrictions on short sales means. If any of the security declines more than a particular percentage in a day, the circuit breaker would be triggered and prevented from further trading of that security in that day. (4) Securities are not perfectly divisible or indivisible - preventing investors from buying or selling exact quantity of securities. (5) Its not possible to borrow and lend at the same risk free interest rate. (6) Traders may have heterogeneous or asymmetric information
A number of studies support Hsu-Wang arguments and found real capital markets are not perfect. Andreou and Pierides (2008) examined futures pricing behaviour in the Athens Derivatives Exchange and found that larger mispricing of CCM due to trading costs. Further, he examined Athens futures market. They found that large part of mispricing estimated by CCM is due to transaction costs and volatility.

Gay and Jung (1999) observed the trading costs and constraints on short sales are potential contributing factors on continuous mispricing – in particular underpricing in the Korean stock market. Garry J. Twite (1998) examined Australian index futures contracts and found that presence of trading or transaction costs are the main cause for the divergence between actual futures prices and theoretical prices.

Cakici and Chatterjee (1991) examined S & P 500 market and claims stochastic interest rate model gives significantly better and different prices compared to the non-stochastic interest rate model.

Brenner, Subrahmanyam and Uno, (1990) observed trading costs and constraints on short sales are the most vital factors affect the under-pricing in the Japanese futures market. Further states that these factors have an adverse impact on financial market efficiency. Bailey (1989) examined Nikkei 225 and stock 50 contracts and found that there are strong links between stochastic behaviour of the underlying stock averages and futures prices and volumes.

Modest & Sundersan (1985) argue that mispricing of options derivative contracts on index futures (S & P 500) can be better explained by stochastic interest models.

Further Hsu - Wang (2004) proposes that in perfect markets if any deviation of theoretical price determined by the CCM from actual futures price, then the arbitragers can earn a riskless arbitrage profit by making no investment. Under the assumption of capital markets are perfect, the arbitrage process completes. Thus, a hedged position constitutes of underlying stocks and futures will be remain riskless by continuous rebalancing. However, many researchers found that the capital markets are not perfect and unable to completion of arbitrage mechanism and thus, in real capital markets index arbitrage will expose to such a large risk. Index arbitrage involves three
main types of risk: (1) Uncertainty about dividend payments on the underlying stocks and there is a practice of some firms pay irregular and lumpy dividends in a year. (2) It is difficult to buy or sell the underlying stocks simultaneously in precise weights. (3) Tracking error risk: arbitrageurs carry out index arbitrage by grouping a set of stocks which are representative of underlying index or proxy stock index. Suppose the proxy stock index unable to replicate the real spot index, then such index arbitrage known for involving tracking error risk.

Further, he states that the CCM is not possible to explain the negative basis (difference between futures and spot price). As per CCM, the basis is just the reflection of carrying cost and the carrying cost should be positive (Futures price > Underlying spot price). As long as dividend yield is more than risk free interest rate which seldom takes place. Additionally, Hsu – Wang (1999) investigated Taiwan stock index futures market during Asian crisis period (1998-1999) and found that a significant relationship may appear between negative basis i.e. investors expect negative growth rate of the stock or not occurrence of negative basis. Thus, they claim that price expectation is one of the critical parameter, one must consider in estimating stock index futures prices.

Motivated by the above considerations Hsu and Wang (2004) assume that incomplete arbitrage mechanism, incorporates expected growth rate parameter and derived a futures pricing model in imperfect markets. Moreover, the authors proposed three approaches to estimate an unobservable model parameter (Price expectation). Finally, the theory of the DOMI is defined and its valuation model proposed. Additionally the authors suggest three directions for future research.

- One direction is to empirically compare the price performance of Hsu- Wang model with other pricing models.
- The second direction is to develop methodologies for estimating the unobservable model parameter (Price expectation).
- Finally, the last direction is to empirically investigate the degrees of market imperfection in different markets, which may prove to be useful to investors.
2.3 Comparison of pricing performance of different models

Janchung Wang (2009) examined to test the HLM for stock index futures by incorporating market volatility and risk free interest rates for TAIFEX and the SGX futures. The study measured and the compared pricing performance of CCM. Study tried to examine the five volatility estimators and identify the estimator which can increase the forecasting performance of HLM. He found that HLM provides lowest pricing errors than CCM for TAIFEX and the SGX. Thus, the HLM provides lowest pricing errors in the market which is having higher volatility. Further, the EWMA and GERCH (1, 1) methods provide accurate market volatility and improves the pricing performance of HLM than other four volatility estimators.

Janchung Wang (2007, a) applied the HLM (1991) during a Asian crisis, using three index futures the Hang Seng, the Nikkei 225, and the KOSPI 200 (South Korean composite stock index 200). The study compared the pricing performance of HLM and CCM for three futures contracts. He found that HLM provides better pricing performance during Asian crisis period than the CCM. It implies that HLM gives more accurate and better pricing performance in the market which is having highest market volatility. Thus, the market participants should consider degree of market volatility for the market they would like to participate.

Janchung Wang (2007 b) examined and compared the magnitude of pricing errors of HWM and HLM for four futures markets of Asia during Asian crisis period. Author considered stock index futures of the respective markets from Asia. The study found that imperfect model (Hsu & Wang model) which incorporates DOMI gives better and accurate pricing performance than the CCM. Further study shows that, researchers should determine the DOMI for the capital markets in which they intend to participate.

Janchung Wang & Hsinan Hsu (2006 a) used the pricing model developed by Hsu and Wang (2004) to assess the DOMI for emerged (S & P 500) and emerging markets (TAIFEX & SGX-DT). The study directs few theoretical hypothesis and tests about the relation between pricing model performance and market imperfection. The findings imply that the theoretical model derived by Hsu &Wang (2004) provides reasonable measure of DOMI for capital markets. The study found a very strong
correlation between DOMI and pricing errors. Thus, market participants are advised to identify DOMI for the market they intended to participate.

Janchung Wang & Hsinan Hsu (2006 b) investigated the pricing performance of Hsu and Wang (2004) for emerged market (S& P 500) and the emerging markets (TAIFEX) and compared the magnitude of pricing errors of three different futures pricing models: the CCM, the HLM (1991) and the HWM (2004). Authors observed that the HWM provides the lowest MAPE than the CCM and HLM for emerging futures market (TAIFEX). Further, the CCM provides better pricing performance than the HWM and HLM for emerged futures market (S&P 500). More interestingly, the HLM provides better performance than standard CCM in TAIFEX futures. This results indicate that Taiwan stock market which has higher market volatility can incorporate market volatility in to its model in order to estimate the TAIFEX futures prices. Finally the authors claim that the Hsu–Wang model provides substantially better pricing performance than other two futures pricing models in the markets which are highly imperfect.

Janchung Wang & Hsinan Hsu (2005) compared pricing performance of the CCM for two index futures market, emerged market (S & P 500) and the emerging markets (TAIFEX). Empirical results indicate that pricing performance of CCM is better than TAIFEX for emerged market. Authors claim that investors should consider the DOMI when they intended to use the CCM for pricing both developed and emerging futures markets.

Alexander Kempf (2000) examined theoretically and empirically the impact of liquidity on index futures prices of German stock index (DAX). Further compare the results with two benchmark models – CCM and two factor models of Ramaswamy and Sunderesan. Author shows that his model has explained behaviour of futures prices significantly better than the CCM both in the sample and out of the sample data. The author found his liquidity model is better pricing performance than Ramaswamy and sunderesan in the sample but out of sample. Further, author states that pricing performance of both the model are almost equal for short and mid contracts. However, the author’s liquidity model is superior to the two factor model
for long term contracts. Finally the author claims that that liquidity risk can be considered to estimate the futures prices for long term maturity contracts.

Gay and Jung (1999) examined the pricing performance CCM and HLM for Korean stock index futures market. They found mixed results. The authors not able to reject the CCM and the HLM provides a reasonable explanatory power. Finally, they claim that the standard CCM not explains persistent under pricing of the study.

T.J. Brailsford and A.K Cusack (1997) examined individual security futures in Australian futures market and compare the pricing performance of three models CCM and two other models (HLM and Ramaswamy- Sunderesan model). The authors state that all the selected three futures pricing models provide almost equal pricing performance and none of the model clearly preferred. Moreover, the author ranked the HLM first in terms of MAPE. Finally they claim that the CCM will sufficient to determine futures price of selected contracts.

Michael L. Hemler and Francis A. Longstaff (1991) examined NYSE stock index futures data and compared equilibrium model In and Out of sample performance to that of CCM. They claim that HLM provides superior performance than the CCM during highly variation or volatile period (October 1987) for NYSE futures contract. More interestingly, the CCM outperforms the HLM for remaining observations. This clearly indicates that the HLM can more suitable and it can be preferred to markets which have high volatility.

Cakici & Chatterjee (1991) examined S & P 500 futures market and compared pricing performance of constant risk free interest model of futures and stochastic interest rate models. The authors actually examined two version of the stochastic interest rate model. First version known as “Squared root process” in which the standard deviation of interest rate change is proportional to the squared root of the spot interest rates. Second version known as “Log- normal process” in which the standard deviation is proportional to the spot interest rate itself.

The study found that the stochastic interest rate model may give significantly different and substantially better “prices“ compared to the non-stochastic interest rate model
even when the coefficient of correlation between the index price changes and change in the short term interest rates (β) is zero. From this author claims that correlation coefficient (β) is not the most important parameter and does not appear to have any significant influence. Finally, the author indicates that the stochastic model gives significant better results when the constant risk free interest rate is far away from the long term mean, it supports that stochastic model depends on the impact of the mean reversion factor.

Bailey (1989) examined Nikkei 225 & Osaka stock -50 futures contracts of Japan and compared the pricing performance of CCM and continuous time model were presented by Ramaswamy and Sundaresan (1985). The author found that the small pricing errors reported by both the models and author claims the pricing errors from continuous time model are not substantially different from CCM. Thus, continuous time model with stochastic interest rate offer no improvement over the CCM in terms of pricing performance. Additionally author states that observation errors, trading costs, short sale restrictions, different borrowing & lending rates and other market imperfections are main causes for mispricing.

2.4 The arbitrage opportunities and mispricing of stock index futures market
Panayiotis C. Andreou and Yiannos A. Pierides (2008) examined behaviour of futures prices in Athens Derivatives Exchange. Stock index futures provide profitable arbitrage opportunities to institutional traders (low cost traders). Using regression authors identified that of transaction cost, expected volatility and time to maturity will contribute larger futures mispricing.

Dheeraj, R Kannan & Sangeeta (2006) examined the violation of cost of carry principle in case of CNX Nifty index futures and identified the factors which influence for this violation. The authors found that there is a violation of cost of carry principle and it further indicates possibility of arbitrage profits. Additionally, they found more arbitrage profits in three month futures contracts, undervalued futures markets and high liquid futures contracts.
Frino, Alex, McKenzie and Michael D (2002) examined the behaviour of spread mispricing on Sydney Futures Exchange. The study found that sharp increases in the magnitude of spread mispricing immediately just before near month contract expires.

Darren Butterworth & Phil Holmes (2000) examined the pricing efficiency of the two indices of UK (FTSE 100 and FTSE mid 250). Study found that the actual futures prices deviate from its theoretical ‘fair price’ determined by CCM. These pricing errors are small in magnitude and constrained in the range 0.5% ± 1.0%. These pricing errors are well within the no arbitrage limits. This indicates profitable arbitrage opportunities are very rare for the arbitrageurs. Further authors state that magnitude of mispricing for the mid 250 contracts is larger and more persistent than FTSE 100 contract.

Gay and Jung (1999) examined the efficiency Korean Stock Index futures market. They observed persistent mispricing in particular under-pricing in the Korean stock index futures market. Authors explain various scenarios under which mispricing of futures can be measured (1) As a percentage of deviation of actual futures market prices from theoretical prices determined by CCM (2) In presence of alternative set of transaction costs and short sale restrictions faced by different trade groups mispricing rates has been computed relative to the corresponding i. Upper bound (Ft^u) ii. Lower bound (Ft^l) of no arbitrage bands. If any violations of these bands by actual futures prices leads to potential arbitrage opportunities.

Authors found that a major portion of the futures under-pricing can be explained by trading cost and attributes short sale restrictions specially under-pricing during periods of downward market price changes. Further authors explain persistent mispricing using regression framework.

i. There is an uncertainty of how long arbitrage position (long the underlying asset and short the futures) will actually need to maintained by an investor to earn arbitrage profit. Because of this investors may unwind the positions; hence it clearly indicates that long term contracts are relatively more misprices.

Market volatility can be considered as one of the important explanatory power for stock index futures pricing and effect of market volatility can be included to examine futures mispricing.
Fung and Draper (1999) analyse the mispricing of the Hong Kong Hang Seng index futures contracts and examined effect of changes in short sale constraints on mispricing of index futures contracts. Authors found reduction of size and frequency of futures mispricing due to removal of constraints on short selling. Authors also state that the size of the mispricing are positively related to time to maturity, market volatility, dividends and time to maturity.

Alexander Kemp (1998) examined the impact of arbitrage trading on the mispricing process in presence of market frictions and early unwinding opportunities in German stock index futures DAX and the results state that short selling restrictions and early unwinding strategies of arbitrage traders have strong impact on mispricing behaviour.

Hong Bae, Chan & Cheung (1998) examined profitable arbitrage strategies between index futures and options in Hong Kong index market. The study found that percentage of observations crossing no-arbitrage boundaries are substantially reduced when bid-ask quotes are considered instead of transaction prices. They further indicate that a larger mispricing which may arise when bid-ask spread is wider and does not imply profitable arbitrage opportunities.

Twite, Garry J (1998) investigates the futures pricing behaviour of Australian markets by considering taxes and transaction costs. The study also analyses violations of arbitrage boundaries and offer profitable arbitrage opportunities. He found that the magnitude of the arbitrage boundary violations are positively related with transaction costs. Author observed arbitrage boundaries violations offer profitable arbitrage opportunities to investors when 0.2% and 1% of bid-ask spreads to be included as transaction costs in futures and stock market respectively.

According to Braisford and Cusack (1997) identified four causes for observed violations of index futures prices from its theoretical price estimated CCM.

1. The daily data are associated with problems of nonsynchronous trading between futures and spot indices.
2. The underlying stock indices on which futures are traded are not tradable instruments, because of this, in practice an exact position in the underlying asset is not possible and specification risk introduces, these may induce violations.
3. The dividend misspecification has been observed, when estimating index futures prices using CCM. CCM was developed under the assumption of dividends are constant and continuous. In practice this assumption is unrealistic.

4. Tax timing options can create a deviation of actual futures price from its theoretical price.

5. The standard CCM does not incorporate the transaction cost includes brokerage, duties and exchange levies and bid–ask spread cost.

Wolfgang Buhler & Alexander Kemp (1995) examined German market and found that actual futures price significantly below the theoretical value predicted by cost of carry model. Swinnerton, Eugene A; Curcio, Richard A, Yonan, Michael R (1995) determined the effect of index arbitrage activity on intraday stock price changes in the Japanese stock markets. Further authors assess the ability of futures mispricing, lagged futures and cash index price changes to predict intraday stock price changes in the Nikkei 225 stock index. Authors found that index arbitrage activity has a modest impact on intraday stock price changes and arbitrage opportunities. Authors also claim that lagged futures changes are less predictive than futures mispricing of intraday stock price.

Yadav and Pope (1991) examined the validity of Saunder and Mahajan’s (SM) pricing efficiency tests in the UK FTSE-100 contract traded on London International Financial Futures Exchange (LIFFE). The results showed that failure to reject the “efficiency “using SM test does not necessarily preclude the existence of arbitrage profits, if the arbitrages holds the contract till maturity or other trading conditions.

Swati Bhatt & Nuset Cackici (1990) examined S & P 500 futures contract and found that most of the contracts are selling at premium relative to its theoretical price when contracts are mispriced. These results are inconsistent with results of earlier researchers who found contracts are selling at discount. Further from regression results, he states that the mispricing is positively related with dividend yield and time to expiry for both near and long maturity contracts.
Pradeep K. Yadav and Peter F. Pope. (1990) present empirical evidence and the results of trading simulations on the pricing of stock index futures and arbitrage process based on a non-US data set, the UK FTSE-100 contract traded on London International Financial Futures Exchange (LIFFE). They found that options to unwind early or roll over an arbitrage positions are valuable and provide heavy transaction cost discount and arbitrage profits rather simple to hold till expiration where it provides limited arbitrage opportunities. The average of mispricing returns is essentially zero, with mispricing constrained to a window by the actions of the arbitragers.

Brenner, Menachem, Subrahmanyam, Marti G & Uno, Jun (1990) examined futures mispricing and profitable arbitrage opportunities in the Japanese stock markets. Authors found that actual futures prices were persistently lower than the ‘Fair value’ estimated by CCM, offer potentially profitable arbitrage opportunities. Authors claim that these deviations can be caused by relatively high transaction costs, restrictions on short selling and arbitrage activities by Japanese firms. Further as the markets have matured and new contracts have introduced then the transaction costs have declined and trading restrictions have been eased.

Many previous research employed end of the day data and not considered the effect of lag in the cash price and found risk free arbitrage profit but Robert T Daigler (1990) used five minutes intervals data of S & P 500, MMI and NYFE contracts to examine stock index arbitrage opportunities and also studied lead- lag relationship using intraday data between futures and cash prices. He concludes that for the studies employed end of the day data without considering time lag between futures and spot indices, the stock index arbitrage provides risk free profits on a consistent basis. He showed that 5 minutes intraday data by considering lag, the index arbitrage provides smaller profits due to the time lag between the futures and cash indices.

Further Author explains three reasons that futures lead the cash index

1. The significantly lower transaction cost of futures over cash (the opinions concerning the market are registered first in the futures market)
2. The futures market has higher liquidity
3. The smaller stocks in the index generally not trade frequently, thus, create timing differences between underlying and index futures reported prices
In addition author explains factors that affecting arbitrage by as follows

1. Cost of carry pricing – According to’ Cost of carry’ principle mispricing exists when the actual futures price deviates from theoretical price determined by CCM. Further, the arbitrage profits exist when the pricing errors of the index futures are larger than transaction cost bands (upper and lower) created when the arbitrage trade is undertaken.

2. Author states that the operational and implementation mechanisms of stock index futures arbitrage are vital in order to know if any mispricing is large enough to cross arbitrage boundaries. He explains operational issues consist of the size of the arbitrage trade, the time interval to employ in the analysis, and the choice of the risk-free rate and dividend yield in the analysis.

3. Transactions Costs- Author claims that calculating an accurate value of trading cost is critical to determine if the arbitrage trade will be profitable or not. He also explains the total costs incurred for arbitrage trade involves two types of cost, trade commissions and one half the bid-ask spread for both the cash and futures trades.

4. Risk - Author states that there are five potential types of risk exist for investors who intend to carry out stock index futures arbitrage process. They are short sale restrictions, tracking risk, stochastic dividend payments, mark-to-market effects and dividend uncertainty.

Edward M Saunders, Jr and Arvind Mahajan (1988) proposed an arbitrage model of index futures pricing and empirically examined the proximity of composite stock index futures prices to associate normative prices with an arbitrage argument in S& P 500 and NYSE index futures. The results support the hypothesis that observed futures market price is consistent with the perfect market equilibrium model (proposed arbitrage model) implying that as the index futures markets has matured with the passage of time, systematic and significant arbitrage opportunities have disappeared. Authors also suggest that through arbitrage, any transaction costs associated with the daily settlement of futures contracts do not materially impact index futures pricing. Finally, authors observed correlation between index futures prices and daily spot index values is consistent with the market efficiency.
John J. Merrick, Jr (1987) examined S & P 500 index and NYSE index futures. The study found that a significant unidirectional relationship flow from NYSE arbitrage mispricing to NYSE cash market trading volume. Further author claims that a stronger evidences that volatility causes mispricing than the spot- futures mispricing causes volatility.

2.5 Relationship between futures price & market volatility. Further, relationship between futures price and trading volume.

Ming - Hsien Chen & Vivian W. Tai (2014) examined the relationship among trading volume, open interest, volatility and market return on Taiwan futures market. The authors found that expected day trading volume and open interest are positively correlated with futures market return, but one day lagged trading volume is negatively correlated with futures market return. Further the study strongly suggests the daily trading transactions information shared by the stock exchanges to achieve high transparency.

Sheetal Kapoor (2014) examined the effect of introduction of stock index futures on underlying market volatility on Indian futures market. He found that futures trading stabilizes the market. The notion of index futures trading effects markets volatility is a myth.

Ki-Hong Choi, Zhu-Hua Jiang, Sang Hoon Kang, Seong-Min Yoon (2012), examined the relationship between futures trading volume and stock market volatility using GARCH framework on Korean Stock Market. The authors found that significant positive relationship between market volatility and futures trading volume. The study suggests trading volume can be used as tool in order to forecast market volatility of Korean Stock Market.

Wee-Yeap Lau and You-How Go (2012) examined the casual relationship between futures return and trading volume using unilabiate autoregressive generalized autoregressive conditional heteroscedasticity model ((AR-GARCH) on Kuala Lumpur options and financial futures exchange. The authors found feedback effect which influences from futures trading volume to return.
Manmohan Mall, B. B. Pradhan & P. K. Mishra (2011) examined volatility of Indian futures market using GARCH model and found persistence volatility in Indian futures market. Authors also found that any bad news with respect to Indian futures market influences volatility of futures market positively.

Pratap Chandra Pati and Prabina Rajib (2010) examined the effect of trading volume on persistence of index futures volatility using Nifty index futures at National Stock Exchange, India. The authors used GARCH model and found that the inclusion of lagged trading volume and contemporaneous volume in the GARCH model reduces the market volatility.

P. Sakthivel and B. Kamaiah (2009) examined the relationship between futures trading volume and underlying market volatility using GARCH framework on Nifty futures market. The study found that there is a positive relationship between spot market volatility and unexpected futures trading volume.

Kiran & Chakrapani (2007) examined price relationship between spot and futures markets on Incan futures market. The authors found that futures market contributes more towards price discovery and having higher trading volume. Further, the trading cost for futures market is lower compared to cash market.

Floros, Christos and Vougas, Dimitrios V (2006) examined the effect of futures market on the volatility of spot market. The authors found that futures trading reduced market volatility of FTSE/ASE -20 market, but futures trading increased market volatility of FTSE/ASE mid 40 market.

Jung-Lieh Hsiao (2004) examined relationship between futures market returns and trading volume of four futures contracts of Taiwan Stock Exchange. The author found that (1) past futures returns can be used to predict the trading volume for the SIMEX-TW contract. (2) The futures trading volume can be used to forecast the futures returns of TE contracts.
Raju and Kiran (2003) studied price discovery and volatility on Nifty futures market at the time of introduction of CNX Nifty futures at NSE, India. The authors used Cointegration and GARCH techniques and found that price discovery takes place in both spot and futures market. Additionally, they observed reduction of underlying after the introduction of Nifty index futures.

Snehal and Ghosh (2003) investigated the effect of introduction of index futures on spot market volatility. Authors used ARCH/GARCH technique and they observed reduction of underlying after the introduction of index futures.

Shang-wu yu (2001) employed GARCH (1, 1)-MA (1) model to verify the effect of stock index futures on underlying market volatility. The author observed that introduction of stock index futures influences increase of the volatility of underlying market returns in the Australia, France, and Japan and USA significantly.

Yen, Chung and Hung (1999) examined the effect between volatility and maturity in the Nikkei index futures market. The authors constructed an economical model which focuses on the basis (between Futures and Spot prices). The rationale of basis must converge to zero as the contract expires, so authors expect that the volatility of the basis must zero as the maturity shortened. The authors found that the volatility of the futures price decreases when the contract approaches to its maturity. This result contrary to the Samuelson effect.

Jacobs, Michael, Jr, Onochie and Joseph (1998) examined the relationship between futures trading volume and futures return using GARCH & ARCH model on international futures markets. The study found significantly positive relationship between futures trading volume and futures return for various international futures markets. Further the study found futures trading volume positively influences variance of index futures price changes.

Vanitha Ragunathan & Albert Peker (1997) studied to determine the exact nature of the relationship between price variability and trading volume for four of the most highly traded futures contracts in the Sydney Futures Exchange. In this study it was found that conditional returns were not related to lagged returns and were influenced by lagged volatilities for two contracts. Furthermore, the study found that volatility in
the Australian futures market was more likely to be influenced by lagged volatility, which is consistent with the conclusions of other papers. Further, unexpected volume can have higher effect on market volatility than expected volume. The results show that positive volume and open interest shocks have a more effect on volatility than negative volume and open interest shocks. Thus, authors claim that market depth effect significantly on volatility.

Charles S. Morris (1989) examined S&P 500 index futures and showed stock index futures has provided high liquid and low cost financial tool for managing risk.

Anver Sadath and B Kamaiah examined the impact of expiration of individual stock futures on spot market. Authors found that positive abnormal return and volume on, the day before the expiration date.

Naima Kazmi examined the impact of introduction of index futures on underlying market in terms of volatility and lead- lag relationship. The author found that introduction of Nifty index futures improves liquidity and stabilizing the underlying market as a whole.

2.6 Miscellaneous studies

Sobhesh, Agarwall & Joshy (2014) examined alleged manipulation of the settlement price of Indian single stock futures (cash settled) contracts on high frequency circular trading. Authors developed an econometric technique which can be integrated with technology and used high frequency data to identify suspected cases of manipulation at futures contracts expiry.

Dr Manjusmita Dash (2011) examines the relation between price and open interest in the Indian Stock Index (Nifty) Futures Market. The study employed Granger Causality test which suggests the future price tends to drive open interest in the long run but not the other way around. Author further claims that that the information of open interest can be used to predict the future prices in the long run.

Sarno, Lucio;Valente, Giorgio (2000) examined the interrelationship between underlying and futures prices in S&P 500 and FTSE 100 market by employing a class
of non-linear, regime-switching–vector–equilibrium-correction models. Results are shown that a long run co-integrating relationship between spot and futures prices exists which implies mean reversion of the basis and this is consistent with the prediction of the CCM.

Shang-wu Yu (1999) employed Neural Network model to forecast the basis in Singapore International Monetary Exchange (SIMEX) Nikkei 225 stock index futures. He found that Neural Network model provides the arbitrageurs more arbitrage profits than the standard CCM even though Neural Network model observed relative less profitable arbitrage timing.

Chance Don M (1994) developed a model of futures pricing in the presence of limits and study the impact of price limits on the CCM futures pricing model. He found that price limits can control default risk and other costs. Author indicates that traders can consider price limits in the expectation of the bull and bear market and when they try to take advantage of mispricing of cost of carry model, so they benefit in the form of cut in to mark-to-market gains and reduced mark-to-market losses.

Cornell and French (1983 a & b) examined the effect of tax on pricing of stock index futures in S&P 500 and NYSE index. Authors found two reasons for deviations of actual futures prices from spot prices and assumed that taxes are levied on both realized and unrealized capital gains (1) Futures traders do not receive any kind of dividends but paid to the stock holders (2) payment to purchases underlying stock is required today but the payment for stock futures is deferred till the expiration date. They observed that stock index futures prices are generally below the price determined by CCM. Further author states that the taxes are the main causes for discrepancy between actual and estimated futures prices. As for the spot index, investors have valuable tax option. If the underlying stock price drops, the investor can incur loss by selling the stock, this way they can reduce the tax. On the other hand if the stock price arises investors deferring capital gains by not realizing the gain. Since this timing option is not available to stock index futures traders, authors argue that futures price will be lower than theoretical futures price estimated by standard CCM. Finally authors indicated that short sale restrictions in the stock market prevent arbitrage in the futures market.
Hsiou, Jai and Yuan derived a general equilibrium model in a closed form and studied the effect of regular and irregular stochastic market volatilities on index futures pricing. The authors found disputed result compared to literature result among economic variables which can be presented by different dimensions of market volatility.

2.7 Research gaps

1. Different price expectation parameter can be used to test Hsu & Wang model for different markets
2. The applicability and performance of the futures pricing models can be assessed for different markets.
3. The literature clearly indicates that majority of the study done on index futures pricing, a very few studies hardly one or two, considered Individual Stock Futures (ISF’s) for pricing (Brailsford and Cusack (1997))
4. Degree of market imperfection can be determined and examined its impact on pricing errors for different markets.
5. Arbitrage opportunities can be identified for Indian futures market.
6. Relationship among futures price or return, trading volume and market volatility can be assessed for Indian futures market.