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# A Comparison of Hemler & Longstaff Model and Cost of Carry Model: The Case of Stock Index Futures

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***Abstract:***
*The study empirically tests and compares the pricing performance of two alternative futures pricing models ; the standard Cost of Carry Model and Hemler & Longstaff Model (1991) for three futures indices of National Stock Exchange (NSE), India – CNX Nifty futures, Bank Nifty futures and CNX IT futures. It is found that, Hemler & Longstaff Model in a continuous economy with stochastic interest rate and Market volatility provides better pricing performance than standard Cost of Carry Model for CNX Nifty futures and Bank Nifty Futures market. The regression results of CNX Nifty and Bank nifty futures are consistent with the empirical implications of the Hemler & Longstaff's equilibrium model and supports Market Volatility related to stock index futures prices. The regression results of CNX IT Futures support the Cost of Carry model and provides better pricing performance than Hemler & Longstaff Model. On the basis of pricing performance, in terms of Mean Absolute Pricing Error( MAPE) , the preferred contract is CNX Nifty futures contract, followed by Bank Nifty futures and CNX IT futures contract for both the pricing models.*

***Keywords:*** *Pricing Performance, Cost of Carry Model, Hemler & Longstaff Model, CNX Nifty Futures Index, Bank Nifty Futures Index and CNX IT Futures Index*

## 1. Introduction

Right from launch of Index futures and individual stock futures on June 12 2000 and November 2001 respectively, the futures market in India constantly growing on annual basis in terms of number of contracts traded and turnover. In the case of Index futures, the growth of number of average daily contracts rapidly increased 10262% from 2001-02 to 2013-14. Similarly the growth of average daily turnover gradually increased 14352% from the year 2001-02 to 2013-14. The average daily turnover in the Index futures derivatives segment have grown rapidly from Rs 21483 Crore during 2001-02 to 3083103 crore during 2013-2014. In percentage, the growth of average turnover gradually increased 14352% from the year 2001-02 to 2013-14.The numbers of average daily contracts in the Index futures derivatives segment have grown rapidly from 1025588 during 2001-02 to 105252983 during 2013-2014. In percentage , The number of average daily contracts in the Index futures derivatives segment have grown rapidly from 10262% from 2001-02 to 2013-14. Thus, the growth of Indian futures market motivated to study the behavior of Indian futures market and the pricing performance of established futures pricing models.

Pricing performance of stock index futures markets has triggered a substantial volume of research by finance academicians. Many of this literature have considered efficiency of futures pricing relative to the spot market. A number of researchers have made an extensive effort to predict stock index futures price under various assumptions and economic conditions. Review showed that many researchers used two important pricing models to determine future pricing performance – Standard Cost of Carry Model (CCM) and Hemler & Longstaff model (HLM) (1991).

The cost of carry model has been considered as the standard model for pricing stock index futures. The difference between index futures price and spot index futures will reflect the carrying cost. Further analysis can be done based on whether carrying cost is positive or negative. Cornell and French (1983a, b) used an arbitrage argument to develop a pricing model of stock index futures under the following assumptions:

1. Capital markets are perfect - No transaction costs and taxes and, no restrictions on short sales, and divisibility of securities.
2. No limits exist on borrowing or lending at the same risk-free rate.
3. The risk-free interest rate is known with certainty.

Many researchers has been documented the existence of mispriced futures contract i.e. the spot price of futures was persistently below the theoretical value of futures estimated by the cost of carry model in the respective markets. [Fung and Draper (1999) examined affect of mispricing of futures contracts using Cost of carry model by various economic factors including, relaxing short sale restrictions, cash market volatility, Time- to – maturity of the contract, trading costs and dividend payout rates. Darren Butterworth & Phil Holmes (2012) studied on UK stocks and index futures market (FTSE 100 and FTSE mid 250 index futures). Panayiotis C. Andreou and Yiannos A. Pierides (April 2008) examined Athens futures market. Brailsford and Cusack (1997) studied individual shares on Australian Stock Exchange. Gay & Jung, (1999) examined under pricing in stock index futures market by transaction costs and short restrictions. Wolfgang Buhler &Alexander Kemp (1995) examined German market. Brenner, Subrahmanyam, Uno, Jun (1990), studied on Japanese Stocks and futures market]. They all found that Actual futures price significantly below the theoretical value predicted by cost of carry model.

From the above literatures its clearly indicates that many empirical researchers have tested Cost of Carry model and found significant discrepancies between actual futures prices and theoretical price estimated by CCM.Cost of Carry model clearly states that Market volatility should not have explanatory power for futures prices. However some researchers found a significant correlation between Index futures mispricing and Index volatility. Fung, Joseph K W; Draper, Paul (1999) analyzed Hong Kong Hang Seng Index futures contracts and found that the size of the pricing error is positively related to market volatility. This result is consistent with that of Yadav and pope (1990) for FTSE 100 index futures Market. Gay and Jung (1999) examined the relationship between Volatility and mispricing of Korean Stocks Index futures market. John J. Merrick, Jr (1987) examined S& P 500 Index futures market and found stronger evidence that Volatility causes mispricing than do the spot- futures mispricing causes volatility. 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. Nai-fu chen, charles j. Cuny, and robert a. Haugen (1995) examined S& P 500 futures market and found that Inverse relationship between volatility and mispricing, means increased volatility lowers pricing error means increased volatility decreases the basis ( Market futures price minus theoretical futures price of CCM).

Panayiotis C. Andreou and Yiannos A. Pierides (April 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. Thus, from the above discussion, stock market volatility seems to be one of the important factors. Moreover, in determining stock index futures prices. Stock market volatility is excluded from the cost of carry model and states that Market volatility should not have explanatory power for futures prices. Motivated by these considerations Michael L. Hemler and Francis A. Longstaff (1991) followed the CIR (Cox *et al.*, 1985a,b) framework and developed a closed form general equilibrium model of stock index futures prices in a continuous economy with stochastic interest rate and market volatility. Hemler & Longstaff (1991) tested the implications of general equilibrium model for stock index futures prices and found that it is different from those of the cost of carry model and are testable using regression analysis. When the natural logarithm of the dividend adjusted futures to spot price ratio can be represented as linear function of two variables, the risk free interest rate and the market volatility, they find that market volatility has significant explanatory power. These results are consistent with the general equilibrium model, but not the cost of carry model

Many previous studies ( Janchung Wang (2009) , Janchung Wang(2007) , Janchung Wang & Hsinan Hsu (2006 a) , Janchung Wang & Hsinan Hsu (2006 b) , Janchung Wang & Hsinan Hsu (2005), Gay, Gerald D & Jung, Dae Y (Apr 1999), T.J. Brailsford and A.K Cusack (August 1997), Michael L. Hemler and Francis A. Longstaff (1991) and Bailey (1989) ) compared Cost of Carry model with other pricing models .Motivated by the above considerations the present study compares pricing performance of Hemler and Longstaff model (1991) with standard Cost of Carry Model (CCM).

*1.1. CNX Nifty, Bank Nifty and CNX IT Futures Index: History and Institutional background*

| | **CNX NIFTY Futures** | **BANK NIFTY Futures** | **CNX IT Futures** |
|---|---|---|---|
| Opening Date | June 12, 2000. | June 2005 | August 2003 |
| Underlying Index | CNX NIFTY | BANK NIFTY | CNX IT |
| Contract Size | The value of the futures contracts on Nifty may not be less than Rs. 2 lakhs at the time of introduction. Lot Size- 50 | The value of the futures contracts on BANK Nifty may not be less than Rs. 2 lakhs at the time of introduction. Lot Size- 25 | The value of the futures contracts on CNX IT may not be less than Rs. 2 lakhs at the time of introduction. Lot Size- 25 |
| Contract Months | The near month (one), the next month (two) and the far month (three). at any point in time, there will be 3 contracts available for trading in the market | The near month (one), the next month (two) and the far month (three). at any point in time, there will be 3 contracts available for trading in the market | The near month (one), the next month (two) and the far month (three). at any point in time, there will be 3 contracts available for trading in the market |
| Minimum price change | 0.05 | 0.05 | 0.05 |
| Price limits | +/- 10% LTP | +/- 10% LTP | +/- 10% LTP |
| Last trading Day | Last Thursday of delivery month | Last Thursday of delivery month | Last Thursday of delivery month |
| Settlement | Cash | cash | cash |

*Table 1 : Main specifications of the CNX NIFTY, BANK NIFTY & CNX IT Futures contracts of NSE*
*Source: Retrieved & Adapted from http://www.nseindia.com*

| Descriptive Statistics of daily Volume | | | | | Negative Basis | |
|---|---|---|---|---|---|---|
| **Contract & Contract Period** | **N** | **Mean** | **Max** | **Min** | **Number of Negative Basis** | **Number of Negative Basis (%)** |
| CNX Nifty Futures | 1741 | 442492.6 | 1338598 | 1935 | 550 | 31.59140 |
| Bank Nifty Futures | 1741 | 52007.03 | 256601 | 7 | 599 | 34.40551 |
| CNXIT Futures | 1741 | 305.26 | 3037 | 1 | 640 | 36.76048 |

*Table 2: Descriptive Statistics on daily trading volume and frequency of negative basis of all the three futures indices*
*Source: Collected and Compiled by the Authors*

NSE is India's leading Stock Exchange incorporated in the year 1992. Index value calculates based on Free Float market capitalization Method (After 2008). Currently about 1500 securities listed on NSE. NSE futures contracts have a maximum of 3-month trading cycle - one month (near), the two month (next) and the three month (far). A new futures contract is introduced on the immediate next trading day of the expiry of the near month contract. The new contract will be introduced for three month duration. This way, at any point in time, there will be 3 contracts available for trading in the market i.e., one near month, one second month and one far month duration respectively. Nifty futures contracts mature on the last Thursday of every month. If the last Thursday of every month is happened to be a trading holiday, the contracts expire on immediate previous trading day. The futures contract is cash settle only. Table 1 lists the main features of the three futures contracts.

From table 1 and 2 , lists specifications and average trading volume of three futures indices . Currently there are 10 futures indices trading in NSE. Only three indices (S&P CNS Nifty futures, CNXIT futures & CNX Bank futures) have selected for the study. Indices selected based on number of years their trading in NSE. The CNX Nifty Index futures contract are based on popular underlying index and market bench mark CNX Nifty Index, constitutes 50 major stocks and began trading on NSE on 12 June 2000. Average daily trading volume during the period of the study was 442492 contracts. The importance of CNX Nifty Index cannot be under rated as it constitutes 66.85% of free float market capitalization of NSE. This data is collated as on June 30, 2014. The CNXIT Index futures contract are based on the underlying index of CNXIT Index, constitutes 20 major stocks from IT sector which trade on the National Stock Exchange and began trading on august 2003. Average daily trading volume during the period of the study was 305 contracts. Since CNX IT Index represents only the IT industry the overall representation to NSE is much lower than CNX Nifty. CNX IT index indicates 11.27% of the free float market capitalization of NSE and 97.25% of the free float market capitalization of the stocks constituting part of the IT sector as on June 30, 2014. The Bank Nifty Index futures contract based on the underlying index of CNX Bank Nifty Index constitutes 12 stocks from the banking sector which trade on the National Stock Exchange. As for the Bank Nifty index futures market the history is relatively short compared CNX Nifty Index futures. Began trading on June 2005 and Average daily trading volume during the period of the study was above 52007 contracts. Since CNX Bank Nifty index represents only the Bank industry, the overall representation to NSE is too much lower than CNX Nifty index. The CNX Bank Index represents about 15.55% of the free float market capitalization of the stocks listed on NSE and 89.90% of the free float market capitalization of the stocks constituting part of the Banking sector e as on June 30, 2014.

Additionally as shown in the table 2, the MAPE of CCM is lowest for Nifty futures index having lowest frequency of negative basis (31.59%) during the sample period, followed by, bank nifty futures index having next lowest frequency of negative basis (34.40%) after nifty futures and then highest MAPE for CNXIT futures index having highest frequency of negative basis (36.76%) . This result implies that frequency of negative basis might influence performance of the futures market.

*1.2. Futures Pricing Models*

Two alternative futures pricing models are compared in the present study. i.) Cost of Carry Model (CCM) ii.) Hemler and Longstaff Model (HLM)

i.) Cost of Carry Model (CCM)

If dividend yield is non-stochastic, Cornell and French (1983) show that the index futures price can be estimated by

$$F_t = St\, e^{(r-q)(T-t)}, \quad (1)$$

Where $F_t$ is the theoretical futures price at time t for a contract that matures at a time T, $S_t$ is the current stock price at time t; r is the annualized risk free interest rate (Cost of financing); q is constant annual dividend yield, T-t represents time to maturity.

ii.) Hemler and Longstaff model (1991)

$$L_t = \alpha+\beta_1 r_t+ \beta_2 v_t +\boldsymbol{\varepsilon_t} \quad (2)$$

Where $L_t = \ln (F_t e^{q\tau}/S_t)$ is the logarithm of the dividend adjusted futures / Spot price ratio, $F_t$ is the theoretical Futures price, $S_t$ is the underlying spot index, $\tau$ is the time to maturity ( T-t) , $r_t$ is the Risk free interest rate $V_t$ is the market volatility $\alpha, \beta_1$ & $\beta_2$ are the regression coefficients. $\varepsilon$ is the error part assumed to be normally distributed with mean zero.

The empirical testing of Hemler and Longstaff model involves two stage procedures. One , it is assumed that theoretical futures price derived from Hemler &Longstaff equilibrium model differ from actual or observed futures prices by a mean of zero . Hence the regression coefficients of α, β1 & β2 can be obtained. Second stage involves substituting the estimated α, β1 & β2 to the Hemler and Longstaff equilibrium model to generate the estimate of the dividend adjusted futures / Spot price ratio Lt. Finally the theoretical futures price ($F_t$) can obtain by inferring Lt.

**2. Data and Methodology**

Currently there are 10 futures indices trading in NSE. Only three indices (S&P CNS Nifty futures, CNXIT futures & CNX Bank futures) have selected for the study. Top three futures indices have been selected based on their highest trading history in NSE.

For the CNX Nifty futures, CNX IT futures and Bank Nifty futures contract, only near month (one month) contracts were considered for this study because the nearest maturity contracts have significant trading volume compares to next month (two months) & far month (three months) contracts. Daily closing prices were obtained for all the three futures indices for the period from 1st April 2007 to 31st March 2014. The 364- day government of India Treasury bill rates were used as proxy for risk free interest rates and obtained from RBI database. Daily dividend yield for all the three futures indices obtained from National Stock Exchange (NSE). The study used equally weighted moving average of past spot index returns to estimate the variance of underlying index returns.

*2.1. Hypothesis*

$H_o$ = There is no significant difference in MAPE statistics generated form Cost of Carry Model and Hemler and Longstaff Model

Independent t test is used to test whether the MAPE statistics generated from each model is significantly different.

*2.2. Measuring the Pricing Performance for the Two Models*

Following Hsu& Wang (2004), pricing performance between Cost of Carry Model (CCM) and Hemler and Longstaff model (1991) can be measured by Calculating the mean absolute error (MAE), the mean percentage error (MPE) and mean absolute percentage error (MAPE) are illustrated as follows.

Pricing Error (ε) $= AF_t - F_t$ (3)

$$MAE = \frac{1}{N}\sum_{t=1}^{N}|AFt - Ft| \quad (4)$$

$$MPE = \frac{1}{N}\sum_{t=1}^{N}\frac{AFt - Ft}{AFt} \times 100 \quad (5)$$

$$MAPE = \frac{1}{N}\sum_{t=1}^{N}\left|\frac{AFt - Ft}{AFt}\right| \times 100 \quad (6)$$

Where $AF_t$ is the actual price of stock index futures at time t and $F_t$ is the theoretical price of stock index futures at time t. Further, to compare the futures pricing error statistics between Hemler and Longstaff model (1991) and Cost of Carry Model (CCM) t- test was used to test whether the MAPE statistics obtained from two pricing models were significantly different.

*2.3. Parameter Estimation of the Hemler and Longstaff Model*

Volatility of the underlying index returns ($V_t$) is the only parameter that cannot be directly observed in Hemler and Longstaff model. To estimate time varying volatility in underlying index returns, equally weighted moving average method is commonly employed by the estimators.

Following Hsu & Wang (2004), the study used equally weighted moving average of past spot index returns to estimate the variance of underlying index returns.

Where

$$V_{dt} = \frac{1}{N}\sum_{i=t-N}^{t-1}(R_i - \overline{R})^2 \quad (7)$$

$$R_i = ln(S_i|S_{i-1})$$

$$\overline{R} = \frac{1}{N}\sum_{i=t-N}^{t-1} R_i$$

Where $V_{dt}$ is the variance of underlying index returns estimate on day t; $R_i$ is the spot index return on day i; $S_i$ is the spot index price on day i ; $\overline{R}$ denotes the mean return of spot index; and n is the length of the period set to a value of 20 days, as suggested by Chiras and Manaster (1978). The variance of underlying index returns per annum ($V_t$) should be calculated from the variance per trading day $V_{dt}$ using the formula.

$V_t = V_{dt} \times$ (Number of trading days per annum) (8)

**3. Empirical Results**

| SCRIP | N | α | β1 | β2 | $R^2$ | F | DW |
|---|---|---|---|---|---|---|---|
| NIFTY | 1703 | -0.0012*** (0.005) | -.005*** (0.000) | .044*** (0.000) | 0.057 | 51.793*** (0.000) | 0.536 |
| BANK | 1703 | -0.003*** (0.000) | 0.064*** (0.000) | -0.014 ** (0.026) | 0.059 | 53.108*** (0.000) | 0.557 |
| IT | 1703 | 0.0000 (0.897) | 0.024 *** (0.001) | -0.05*** (0.000) | 0.024 | 21.28*** (0.000) | 0.897 |

*Table: 3 Cost of Carry model versus Hemler & Long staff model for all the three futures indices.*
*Source: Collected and Compiled by the Authors*

Table 3 summarizes the results of the linear regression model given in expression (2) and also tested the specifications of two pricing models CCM model and Hemler and longstaff model. According to the HLM equilibrium pricing model, the regression coefficients of equation (2) would be $\alpha \neq 0$, $\beta_1 > 0$, and $\beta_2 \neq 0$. In contrast, if the CCM model holds, the coefficients of the H& L equation would be $\alpha = 0$, $\beta_1 =$ T-t and $\beta_2 = 0$.

If the Hemler and Longstaff equilibrium model holds the constant coefficient (α) should not equal to zero. As shown in the table 3 the coefficients (α) of Nifty futures and Bank nifty futures index statistically different from zero. This finding supports Hemler and Longstaff model and contrary to CCM model but the constant coefficients (α) of CNX IT futures index and not statistically different from zero. This finding supports the CCM model and contrary to the Hemler and Longstaff model. Further CCM model implies that the interest rate coefficients ($\beta_{1)}$ should equal to the average contract maturity during the sample period is 0.04182 years for all three futures indices. The table 3 presents that all the interest rate coefficients ($\beta_{1)}$ are not exactly equal to the 0.04182 years. This finding supports equilibrium model and contrary to the CCM model. In addition to this if the Hemler & Longstaff equilibrium model holds then interest rate coefficient should greater than zero( $\beta_1>0$ ). As shown in the table 3 all the interest rate coefficients ($\beta_1$) are positive. This finding supports Hemler & Longstaff model and contrary to CCM model. Further Nifty index futures, whose interest rate coefficients are negative and significant. So this finding supports CCM model and contrary to Hemler & Longstaff model.

Further, CCM model implies that market volatility should not have explanatory power for $L_t$ i.e $\beta_2= 0$. In contrast, Hemler & Longstaff model implies that the logarithm of the futures / spot ratio ($L_t$) can be represented a linear regression on risk free interest rate and market volatility (eq-2). The table 3 reveals that market volatility coefficients ($\beta_2$) of three index futures stocks are negative and significant .This finding strongly supports H &L model and contrary to CCM. The regression results of CNX Nifty and Bank nifty futures are consistent with the empirical implications of the H & L equilibrium model and supports Market Volatility significantly impact the natural logarithm of the dividend – adjusted futures to spot ratio. Janchung Wang (2009) found that regression results support the specification of the Hemler- Long staff model for both the TAIFEX and SGX futures contracts.

| SCRIP | N | Absolute Error | | Percentage error | | Absolute Percentage error | |
|---|---|---|---|---|---|---|---|
| | | Mean (%) | SD (%) | Mean (%) | SD (%) | Mean (%) | SD (%) |
| NIFTY | | | | | | | |
| CCM | 1741 | 12.0680 | 11.7802 | -0.1484 | 0.3441 | 0.2530 | 0.2765 |
| HLM | 1703 | 12.0092 | 10.3505 | -0.0243 | 0.3316 | 0.2440 | 0.2258 |
| BANK | | | | | | | |
| CCM | 1741 | 23.77 | 24.0362 | -0.1460 | 0.3605 | 0.2731 | 0.2768 |
| HLM | 1703 | 25.0662 | 23.3729 | 0.0054 | 0.3620 | 0.2701 | 0.2410 |
| IT | | | | | | | |
| CCM | 1741 | 15.34 | 15.7949 | -0.1620 | 0.3960 | 0.2896 | 0.3149 |
| HLM | 1703 | 67.0291 | 64.4995 | -0.0298 | 1.8954 | 1.3148 | 1.3652 |

*Table 4: Descriptive statistics of pricing Errors of CCM & HLM for all the three futures indices.*
*Source: : Collected and Compiled by the Authors*
*Note: OP- Over Price, UP – Under Price; OP= -ve (Ft > AF), UP = +ve ; Ft < AF*

| Futures Index | Pricing Models | N | t- value | Sig ( 2- tailed ) |
|---|---|---|---|---|
| CNX NIFTY | CCM vs HLM | 1741 - 1703 | 18.242*** | 0.000 |
| BANK NIFTY | CCM vs HLM | 1741 - 1703 | 28.641*** | 0.000 |
| CNX IT | CCM vs HLM | 1741 - 1703 | -188.230*** | 0.000 |

*Table 5: Results of statistical tests for difference in MAPE between the futures pricing models.*
*Note. *** Significant at the 1 % Level.*

### *3.1. Pricing Performance of CCM & HLM for All the Three Futures Indices*

According to table 4, the percentage error, CCM overprices all the three futures indices – Nifty futures, bank nifty futures and IT futures contract by an average of -0.1484%, -0.1460% and -0.1620% respectively. The largest overprice of CCM is an average of -0.1620% for IT futures index. HLM overprices two futures indices – Nifty futures index and IT futures index by an average of -0.0243% & -0.0298% respectively. Additionally, HLM under prices Bank nifty by an average of 0.0054.

On the basis of percentage error it is found that, the MPE of CCM is the highest for IT futures Index by an average of -0.1620% .Table 4 shown the results on the basis of MAPE, it clearly indicates that the MAPE of CCM is the highest for Nifty & IT futures index and lowest for IT futures index compares to HLM. For two indices – Nifty & IT futures index, HLM is preferred over CCM. Overall, on the basis of mean percentage error (MPE) & MAPE, the best model preferred is HLM than standard CCM. This result is consistent with Hsu &Wang (2006) and Janchung Wang (2007). From table 5, Independent t test is used to test whether the MAPE statistics generated from each model is significantly different. For all the three futures indices – CNX Nifty, Bank nifty and CNX IT futures index the, table 5 clearly indicates that the MAPE statistics generated from each model is statistically significant at 1 %. Further the table 4 reports pricing performance statistics of two pricing models. The pricing performance of CNX Nifty futures contract is significantly better than that of Bank Nifty futures and CNX IT futures contract for both the pricing models.CNX Nifty futures contract with highest trading history and average trading volume has smallest pricing errors than Bank Nifty futures and CNX IT futures.

Pricing performance statistics of two pricing models clearly indicates that the MAPE of all the three indices is lowest for CNX Nifty futures index having highest average trading volume during the sample period (4, 42,492), followed by Bank nifty futures index having next highest average trading volume after Nifty futures index (52,007) and then highest MAPE for CNXIT futures index having the lowest average trading volume of only 306. Additionally as shown in the table 4, the MAPE of CCM is lowest for Nifty futures index having lowest frequency of negative basis (31.59%) during the sample period, followed by, bank nifty futures index having next lowest frequency of negative basis (34.40%) after nifty futures and then highest MAPE for CNXIT futures index having highest frequency of negative basis (36.76%) .This result implies that frequency of negative basis might influence performance of the futures market.

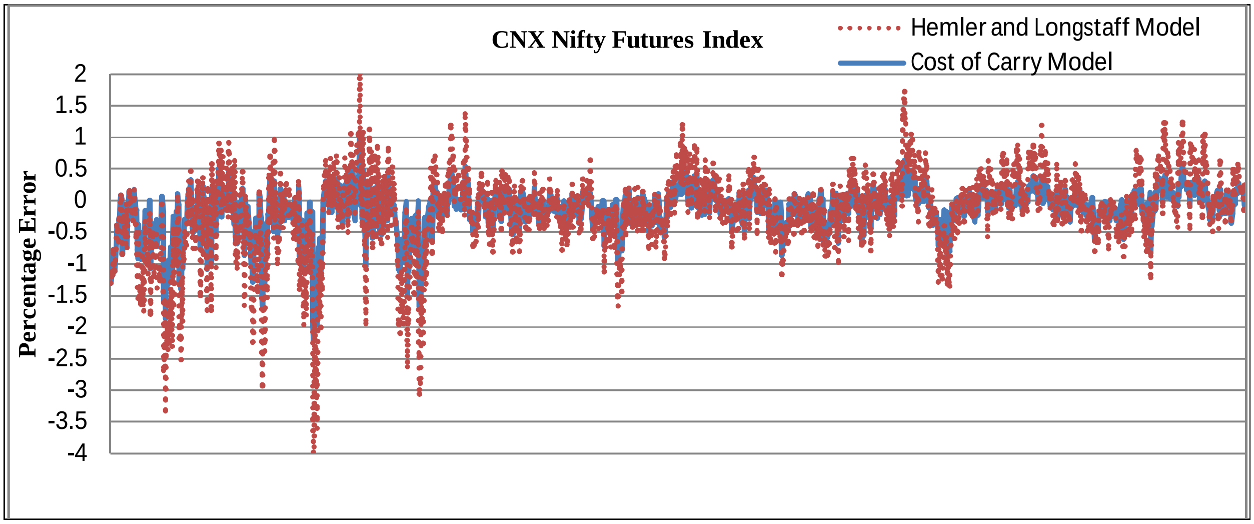


*Figure 1: Percentage Errors Cost of Carry Model and Hemler & Longstaff Model for CNX Nifty Futures Index*

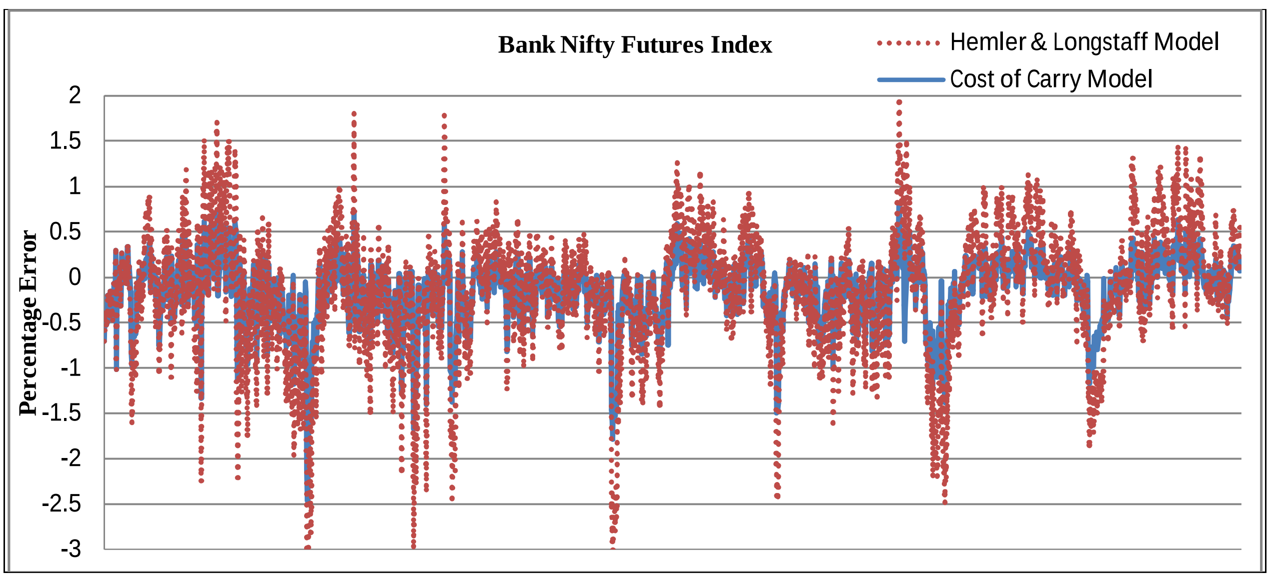


*Figure 2: Percentage Errors Cost of Carry Model and Hemler & Longstaff Model for Bank Nifty Futures Index*

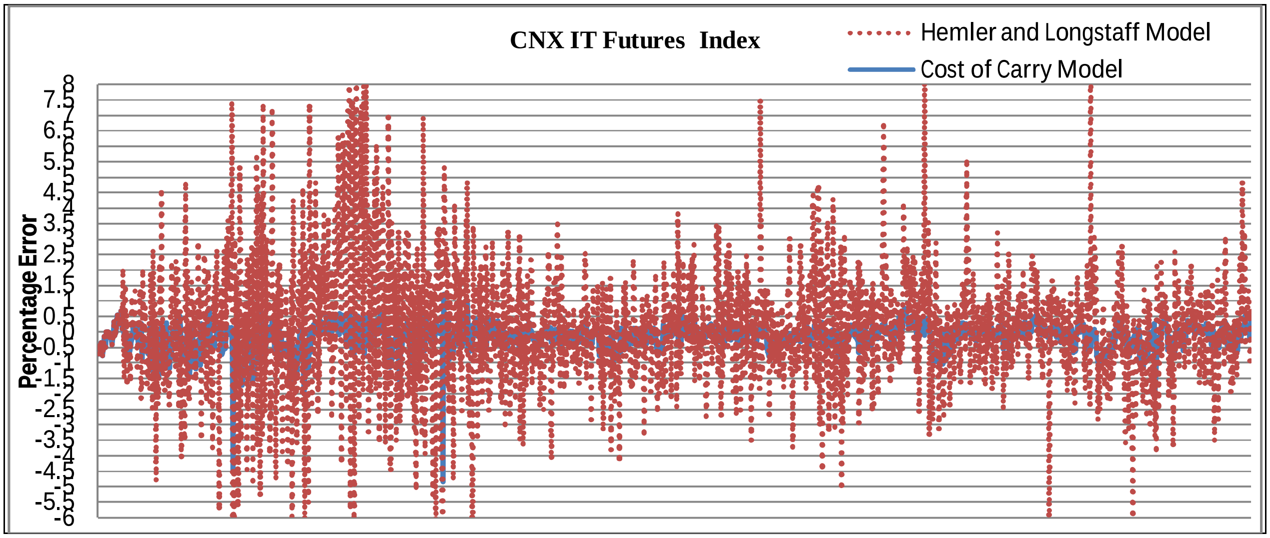


*Figure 3: Percentage Errors Cost of Carry Model and Hemler & Longstaff Model for Bank Nifty Futures Index*

Figures 1 to 3 plot the percentage errors Cost of Carry Model and Hemler & Longstaff Model for all the three futures indices. It clearly shows that Percentage errors of the Hemler and Long staff Model much higher than standard Cost of Carry Model for CNX IT Futures market. Finally, from table 4 and figures 1 to 3 , both CCM and HLM overprices all the three futures markets.

## 4. Conclusion

The study has been carried out to predict index futures prices using two alternative pricing models – The standard Cost of Carry Model and Hemler & Longstaff Model (1991) for three futures indices of National Stock Exchange (NSE), India – CNX Nifty futures, Bank Nifty futures and CNX IT futures. The result of testing CCM & HLM specifications supports the implications of HLM for CNX Nifty Futures and Bank Nifty futures contracts but supports the implications of CCM for CNXIT futures contract.
Moreover, the Hemler and Longstaff Model with stochastic interest rate and market volatility provides better pricing performance than the standard cost of carry model for CNX Nifty futures and Bank Nifty futures contract. It indicates Market Volatility related to these stock index futures prices and market participants should consider market volatility when predicting stock index futures. Additionally the standard CCM provides better pricing performance than Equilibrium model for CNXIT futures market and the study observed larger magnitude of mispricing from Hemler and Longstaff Model for CNX IT futures market. CNX IT futures contract with lowest average daily trading volume has worst pricing performance than Bank Nifty futures and CNX IT futures. Further, CNX Nifty futures market with highest trading history and volume of contracts traded has lowest MAPE than Bank Nifty futures and CNX IT Futures Index for both the Pricing models. The study suggests further research of investigating pricing performance of CCM and HLM for Indian futures markets and reason for failure of Hemler & Longstaff Model for CNXIT Futures market.

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